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SEMINAR ON INFANT MORTALITY IN RELATION TO THE LEVEL OF FERTILITY

6-12 May 1975

BANGKOK (Thailand)

CICRED 1975

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CICRED : 27, rue du Commandeur – 75675 PARIS-CEDEX 14 (France)
Cable address : INEDEMO – PARIS
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FOREWORD

by Jean BOURGEOIS-PICHAT
Chairman of Cicred

1. *The third Cicred Seminar was held in Bangkok (Thailand) from 6th to 12th May, 1975.* "Infant Mortality in relation to the Level of Fertility" *was the theme of the discussion.*

2. *It is a subject on which the Population Commission of the Economic and Social Council of the United Nations was very keen and, on several occasions, it had asked that studies be undertaken in an attempt to reply to the following question :*

In teaching mothers to look after their children, does one give them the preference for having less of them ? Or, inversely, in allowing women to have less children, does one create conditions leading to the children being better cared for ? It is understandable that the reply to such a question can have important practical consequences for the orientation of action programmes in family planning.

3. *The subject is difficult and in studying it, it is easy to take the effect for the cause. Therefore, the organisers of the Seminar knew that they would not settle the question of the alternative : contraception/ maternal and child protection. On a more modest scale, they wanted to draw up a plan of new research to be undertaken, as had been requested, moreover, by the Population Commission.*

4. *The organisers were not starting from scratch. There is already an abundance of literature on the subject and promising research has already been undertaken or is underway. One country in particular was interested in the question : India. Therefore, it had been thought that this country could host the Seminar. Mr. A. Chandra Sekhar, then Registrar General of India, accepted to undertake discussions with his Government and to take upon himself the physical organisation of the Seminar in New Delhi (India).*

Mr. R. B. Chari, successor to Mr. A. Chandra Sekhar as Registrar General, carried on where the latter had left off. Cicred owes it to itself to thank both of them for the excellent preparatory work which they accomplished.

5. *But we had not counted on the hazards of international politics. Meanwhile, India, although known for its great liberality, was obliged to modify its reception policy and it seemed at the last minute that we were going to be faced with difficulties for visas. Cicred, by its very vocation even, could not enter into the game of discrimination and we had to decide on abandoning New Delhi.*

6. *The Economic and Social Commission for Asia and the Pacific (ESCAP), informed about these developments, proposed that Cicred and the Commission undertake the Seminar jointly. The crisis was past and it is thus that the meeting took place in Bangkok. The Executive Secretary of the Commission, Mr. J. B. P. Maramis, is to be congratulated and warmly thanked for having taken this decision, on the advice of his collaborator, Mr. Carl Frisen, Director of the Population Division of ESCAP. It was on Mr. Frisen and his secretariat that fell the difficult task of the material organisation of the Seminar and all that to be done in a very short space of time. The sessions took place in a Bangkok hotel : the First Hotel, ESCAP having obtained free of charge from the management of this hotel, the use of some rooms for the meeting.*

7. *The member centres of Cicred in the host country also participated actively in the physical organisation of the Seminar. As for the two preceding Seminars, the Director of one of these centres was chosen to fill the role of Director of the Seminar. This was Mr. Visid Prachuabmoh, Director of the Institute of Population Studies of Chulalongkorn University. It is a task which can seem purely formal when everything is going nicely, but at the least incident, it is the Director who must intervene and Mr. Visid Prachuabmoh is to be thanked for having kindly accepted this task.*

8. *Mr. Samuel H. Preston, of the Center for Studies in Demography and Ecology of the University of Washington (Seattle) had kindly accepted to be the Technical Director of the Seminar. He had the task of drawing up a programme, choosing the subjects of the background papers, as well as their authors. At the opening of the Seminar, he presented the subjects to be discussed, directed the debates and, during the last meeting, he finally tried to draw the conclusions from the debates. These conclusions have been set down in*

writing and are printed at the end of this volume. Indeed, they represent the document which the Seminar had aimed to produce. Now, it remains to persuade the demographic research centres to include the proposed research in their programme.

9. *Father Francis C. Madigan of the Mindanao Center for Population Studies of the Xavier University (Philippines), kindly accepted the difficult task of drafting the final report of the Seminar, giving a summary of the discussions. This report was adopted by the participants at the last session.*

10. *The expenses of the Seminar were borne by the United Nations Fund for Population Activities (UNFPA). It is fitting to thank the Director of the Fund, Mr. R. Salas, for having kindly accepted this financing and also, the donor countries, for having followed the Director of the Fund in the financing of the project, which could have appeared to them as not entering, strictly speaking, into the mandate of the Fund as defined by them.*

11. *Here is the participation of Centres at the Seminar :*

Continents, Regions, Countries	Demographic Research Centres and other bodies	Number of people
Africa	3	3
Latin America	3	3
Canada	1	1
United States of America	5	5
Asia (Thailand excepted)	22	23
Thailand	4	9
Australia	2	2
Europe	6	6
Partial Total	46	52
International governmental organisations	10	9
Other organisations	3	0
Secretariat of the Economic and Social Commission for Asia and the Pacific	1	14
Cicred Secretariat	1	4
Interpreters		6
Grand Total	61	85

12. *In Annex I is to be found the list of participants, in Annex II, the programme of the Seminar with mention of the names of the Chairmen, discussion leaders and rapporteurs for each session. Also included therein are the names of authors of background papers. The Technical Director of the Seminar, Mr. Samuel H. Preston, had asked for 12 background papers to be prepared. These papers are published here. Certain participants distributed communications themselves. Some of them were extremely interesting and it was decided to publish them. They form Annex III of this book.*

13. *All these documents are published here in the language in which they were written by their authors. It was not possible to keep to the same formula as was adopted for the two preceding Seminars, when an English version and a French version were published (1). In general, almost two years pass between the moment when a request is made to the United Nations Fund for Population Activities and the moment when the manuscripts are sent to the printer. The increase in prices has been such that the initial budget, at constant prices, has been progressively reduced during these last two years and it was almost the case that the last phase of the project – the printing of the proceedings of the Seminar – was impossible to realise.*

14. *To facilitate the reader's work, the following texts are, however, published in English, French and Spanish : the Foreword by the President of Cicred, the Introductory Remarks of Samuel H. Preston, the Final Report of Father Madigan and the Conclusions of Samuel H. Preston. Finally, each background paper is preceded by a summary in the three languages.*

(1) Thanks to the generosity of CELADE, it had been possible to publish a Spanish version of the Proceedings of the Seminar on "Demographic Research in relation to Population Growth Targets".

15. *The Seminar was inaugurated by Mr. Nibhon Sasithorn, Minister of Education of the Thai Government. The Executive Secretary of ESCAP, Mr. J. B. P. Maramis, took the floor next, followed by Mr. Visid Prachuabmoh, the Director of the Seminar. Mrs. Gwendolyn Johnson Acsadi, Head of the Section of Fertility Studies at the Population Division of the United Nations and who was representing this Division, made a short speech. Finally, Mr. Carl Frisen, Director of the Population Division of ESCAP and Mr. Jean Bourgeois-Pichat, Chairman of Cicred, gave some information of a practical nature. After a brief interruption to the session, the work of the Seminar was begun by the introductory speech of Mr. Samuel H. Preston.*

AVANT-PROPOS

par Jean BOURGEOIS-PICHAT
Président du Cicred

1. *Le troisième Séminaire du Cicred s'est tenu à Bangkok (Thaïlande) du 6 au 12 mai 1975.* "La mortalité infantile en liaison avec le niveau de la fécondité", *tel était le thème de la discussion.*

2. *C'est un sujet auquel tenait beaucoup la Commission de la population du Conseil Economique et Social des Nations Unies qui, à plusieurs reprises, avait demandé que des études soient entreprises pour essayer de répondre à la question suivante :*

En apprenant aux mères à soigner leurs enfants, leur donne-t-on le goût d'en avoir moins ? Ou, inversement, en permettant aux femmes d'avoir moins d'enfants, crée-t-on des conditions faisant que les enfants sont alors mieux soignés ? On comprend que la réponse à une telle question peut avoir des conséquences pratiques importantes pour l'orientation de programmes d'action en matière de planning familial.

3. *Le sujet est difficile et il est aisé dans son étude de prendre l'effet pour la cause. Aussi les organisateurs du Séminaire savaient qu'ils ne trancheraient pas l'alternative : contraception/protection maternelle et infantile. Plus modestement, ils voulaient dresser un plan de recherches nouvelles à entreprendre comme d'ailleurs l'avait demandé la Commission de la population.*

4. *Les organisateurs ne partaient pas de zéro. Une abondante littérature existe déjà sur le sujet et des recherches prometteuses ont déjà été entreprises ou sont en cours. Un pays s'est particulièrement intéressé à la question: l'Inde. Aussi, avait-on pensé que ce pays pourrait accueillir le Séminaire. Monsieur A. Chandra Sekhar, alors Registrar General of India, accepta de mener les discussions avec son gouvernement et de se charger de l'organisation matérielle du Séminaire à New Delhi (Inde).*

Monsieur R.B. Chari, successeur de M. A. Chandra Sekhar au Registrar General prit le relais. Le Cicred se doit de les remercier tous les deux pour l'excellent travail de préparation qu'ils ont accompli.

5. *Mais c'était sans compter sur les aléas de la politique internationale. Entre temps l'Inde, pourtant connue pour sa grande libéralité, s'était vue contrainte de modifier sa politique d'accueil et il apparut au dernier moment que des difficultés de visas allaient être rencontrées. Le Cicred, de par sa vocation même, ne pouvait pas entrer dans le jeu des discriminations et on dut se résoudre à abandonner New Delhi.*

6. *La Commission Economique et Sociale pour l'Asie et le Pacifique (CESAP), informée de ces développements, proposa de faire du Séminaire une entreprise conjointe du Cicred et de la Commission. La crise était dénouée et c'est ainsi que la réunion s'est tenue à Bangkok. Il faut féliciter et remercier chaleureusement le Secrétaire exécutif de la Commission Monsieur J.B.P. Maramis d'avoir pris cette décision, sur les conseils de son collaborateur, M. Carl Frisen, directeur de la division de la population de la CESAP. C'est sur M. Frisen et son secrétariat qu'allait reposer la tâche difficile d'organiser matériellement le Séminaire et cela, dans un délai très court. Les séances ont eu lieu dans un hôtel de Bangkok : The First Hotel, la CESAP ayant obtenu de la direction de cet hôtel la mise à la disposition du Cicred, à titre gracieux, des salons de l'hôtel.*

7. *Les Centres membres du Cicred dans le pays hôte ont aussi participé activement à l'organisation matérielle du Séminaire. Comme pour les deux Séminaires précédents, le directeur d'un de ces centres a été pressenti pour occuper les fonctions de Directeur de Séminaire. Il s'agit de M. Visid Prachuabmoh, directeur de l'"Institute of Population Studies" de l'Université Chulalongkorn. C'est une tâche qui peut paraître de pure forme quand tout se déroule bien, mais au moindre incident, c'est le directeur qui doit intervenir et il faut remercier M. Visid Prachuabmoh d'avoir bien voulu accepter cette tâche.*

8. *M. Samuel H. Preston, du "Center for Studies in Demography and Ecology", de l'Université de Washington (Seattle), avait bien voulu accepter d'être le directeur technique du Séminaire. Il a eu la tâche de dresser un programme, de choisir les sujets des documents de base ainsi que leurs auteurs. A l'ouverture du Séminaire, il a présenté les sujets à discuter, dirigé les débats et, lors de la dernière réunion, il a enfin tenté de tirer les conclusions des débats. Ces conclusions ont été présentées par écrit et sont publiées à la fin de ce*

volume. Elles représentent en fait le document que le Séminaire avait pour objectif de rédiger. Il reste maintenant à convaincre les Centres de recherche démographique d'inclure les recherches proposées dans leur programme.

9. *Le père Francis C. Madigan, du "Mindanao Center for Population Studies", de l'Université "Xavier" (Philippines) a bien voulu accepter la tâche difficile de rédiger le rapport final du Séminaire donnant un résumé des discussions. Ce rapport a été adopté par les participants à la dernière séance.*

10. *Les dépenses du Séminaire ont été supportées par le Fonds des Nations-Unies pour les Activités en matière de Population (FNUAP). Il convient de remercier le directeur du Fonds, M.R. Salas d'avoir bien voulu accepter ce financement et aussi, les pays donateurs d'avoir suivi le directeur du Fonds dans le financement du projet qui aurait pu leur paraître en marge du mandat qu'ils entendaient donner au Fonds.*

11. *Voici quelle fut la participation des Centres au Séminaire :*

Continents, Régions, Pays	Centres de Recherche démographique et autres organismes	Nombre de personnes
Afrique	3	3
Amérique latine	3	3
Canada	1	1
Etats-Unis d'Amérique	5	5
Asie (excepté la Thaïlande)	22	23
Thaïlande	4	9
Australie	2	2
Europe	6	6
Total partiel	46	52
Organisations gouvernementales internationales	10	9
Autres organisations	3	0
Secrétariat de la Commission Economique et Sociale pour l'Asie et le Pacifique	1	14
Secrétariat du Cicred	1	4
Interprètes		6
Total général	61	85

12. *On trouvera en Annexe I la liste des participants, en Annexe II le programme du Séminaire avec mention des noms des présidents, aminateurs des discussions et rapporteurs de chaque séance. On y trouvera également le nom des auteurs de documents de base. Le directeur technique du Séminaire, M. Samuel H. Preston, avait demandé la rédaction de 12 documents de base. Ces documents sont publiés ici. Certains participants ont distribué d'eux-mêmes des communications. Certaines d'entre elles étaient fort intéressantes et il a été décidé de les publier. Elle font l'objet de l'Annexe III de ce livre.*

13. *Tous ces documents sont publiés ici dans la langue dans laquelle ils ont été écrits par leurs auteurs. Il n'a pas été possible de retenir la formule adoptée pour les deux séminaires précédents consistant à publier une version anglaise et une version française (1). Il s'écoule en général près de deux ans entre le moment où une requête est déposée auprès du Fonds des Nations Unies pour les Activités en matière de population et le moment où les manuscrits sont envoyés à l'imprimeur. L'augmentation des prix a été telle que le budget initial à prix constants s'est progressivement réduit au cours de ces deux dernières années et il s'en est fallu de peu que la dernière phase du projet – l'impression des actes du séminaire – ne soit impossible à réaliser.*

14. *Pour faciliter le travail du lecteur, les textes suivants sont toutefois publiés en anglais, français et espagnol : l'avant-propos du Président du Cicred, les remarques introductives de Samuel H. Preston, le rapport final de Fr. Madigan et les conclusions de Samuel H. Preston. Enfin, chaque document de base est précédé d'un résumé dans les trois langues.*

(1) Grâce à la générosité du CELADE, il avait été possible de publier une version espagnole des actes du séminaire sur la "Recherche démographique en liaison avec les objectifs de croissance d'une population".

15. *Le Séminaire a été inauguré par M. Nibhon Sasithorn, Ministre de l'Education du gouvernement thai. Le secrétaire exécutif de la CESAP, M. J.B.P. Maramis, prit ensuite la parole, suivi par M. Visid Prachuabmoh, le directeur du Séminaire. Madame Gwendolyn Johnson Acsadi, chef de la Section d'Etudes sur la Fécondité à la Division de la Population des Nations Unies, et qui représentait cette Division prononça une courte allocution. Enfin, M. Carl Frisen, directeur de la Division de la population de la CESAP et Jean Bourgeois-Pichat, Président du Cicred, donnèrent ensuite quelques informations d'ordre pratique. Après une brève interruption de séance, le Séminaire commença ses travaux par l'exposé introductif de M. Samuel H. Preston.*

PRESENTACION

por Jean BOURGEOIS PICHAT
Presidente del Cicred

1. *El tercer Seminario del Cicred se realizó en Bangkok (Tailandia) entre el 6 y el 12 de Mayo de 1975. El tema de la discusión fue "La mortalidad infantil en relación al nivel de la fecundidad".*

2. *Este es un tema que había despertado mucho interés a la Comisión de Población del Consejo Económico y Social de las Naciones Unidas, la que había solicitado en varias oportunidades que se iniciaran estudios tendientes a responder a la inquietud siguiente :*

Si se enseña a las madres a cuidar a sus hijos, ¿ se les proporciona al mismo tiempo el deseo de tener menos hijos ? O, a la inversa, si se permite a las mujeres tener menos hijos, ¿ se crean las condiciones para que los niños sean mejor cuidados ? Se comprende fácilmente que una respuesta a tal interrogante puede tener importantes consecuencias prácticas para orientar los programas de acción en materias de planificación familiar.

3. *El tema es difícil, y en su desarrollo resulta fácil confundir el efecto con la causa. Por lo tanto, los organizadores del Seminario sabían que no resolverían la alternativa : contracepción/ protección materna e infantil. Más modestamente, sólo desaban diseñar un nuevo programa de investigaciones enmarcado en los requerimientos de la Comisión de Población.*

4. *Los organizadores no partían de cero. Existe ya una abundante literatura sobre este tema, se han realizado algunas investigaciones muy interesantes sobre tópicos afines y hay otras actualmente en desarrollo. La India se ha destacado en este tipo de estudios. Por este motivo, se había pensado que este país podría acoger el Seminario. El señor A. Chandra Sekhar, Director General del Registro civil de la Inlia en ese momento, aceptó iniciar las gestiones ante su gobierno y encargarse de la organizacíon material del Seminario en Nueva Delhi.*

El señor R.B. Chari, sucesor del señor Chandra Sekhar en el cargo de Director General del Registro civil, continuó los esfuerzos en la preparación del Seminario. El Cicred agradece a ambos el excelente trabajo de preparación que realizaron.

5. *Pero no se contaba con las contingencias de la política internacional. Y ocurrió que en el intertanto, la India, que había ocupado un lugar señalado por su hospitalidad, modificó su política de acogida y en el último momento se hizo claro que habría dificultades en el otorgamiento de visas para algunos delegados. El Cicred, por su carácter mismo, no podía aceptar la discriminación en este campo y decidió desistir de Nueva Delhi como sede del Seminario.*

6. *La Comisión Económica y Social de Naciones Unidas para Asia y el Pacífico (CESAP), propuso al Cicred realizar el Seminario en forma colaborativa. De esta manera se resolvió la dificultad y el Seminario se realizó en Bangkok. Es necesario felicitar y agradecer cordialmente al Secretario Ejecutivo de la Comisión, señor J.B.P. Maramis y a su colaborador el señor Carl Frisen, Director de la División de Población de la CESAP, por haber tomado esta decisión. La tarea material de organizar el Seminario en un plazo muy corto recayó sobre el señor Frisen y su secretariado. Las sesiones se realizaron en un hotel de Bangkok, The First Hotel, cuyos salones fueron puestos a disposición del Cicred gracias a la gentil solicitud de la CESAP.*

7. *Los Centros miembros del Cicred existentes en Tailandia colaboraron activamente en la organización material del Seminario. Tal como en los dos Seminarios anteriores, el director de uno de estos centros fue designado para desempeñar las funciones de Director del Seminario. Se trata del señor Visid Prachuabmoch, director del Instituto de Estudios de Población de la Universidad de Chulalongkorn. Es preciso agradecer al senor Visid Prachuabmoch por haber aceptado este cargo, que aparentemente es una tarea puramente formal cuando todo se desenvuelve normalmente, pero cuyo papel decisivo se revela al ocurrir la menor dificultad, ya que en ese caso es el director el que debe resolverla.*

8. *El señor Samuel H. Preston, del Centro de Estudios de Demografía y Ecología de la Universidad de Washington, había tenido la gentileza de aceptar el cargo de director técnico del Seminario. Tuvo por misión*

elaborar un programa, seleccionar los temas de los documentos básicos y a sus autores respectivos. En la inauguración del Seminario indicó los temas que se iban a discutir, se preocupó en seguida de la dirección de los debates y después de la última sesión se encargó de extraer las conclusiones del torneo. Estas conclusiones se presentan al final de este volumen. Representan el documento que el Seminario tenía como objetivo producir. Sólo queda como tarea pendiente convencer a los Centros de investigación demográfica que incluyan en sus programas de estudios los temas de investigación propuestos.

9. *Al Padre Francis C. Madigan del "Centro de Estudios de Población de Mindanao" de la Universidad "Xavier", Filipinas, le correspondió la difícil labor de redactar el informe final del Seminario, dando un resumen de las discusiones. Este informe fue aprobado por los participantes, en la última sesión del Seminario.*

10. *Los gastos del Seminario fueron sufragados por el Fondo de Naciones Unidas para las actividades en materia de Población (FNUAP). Es necesario agradecer al Director de este Fondo, señor R. Salas, por haber aceptado este financiamiento, lo mismo que a los países patrocinadores que aceptaron que el Fondo financiara este proyecto que hubiera podido parecerles un poco ajeno a los objetivos que asignan al Fondo.*

11. *A continuación se señala la participación de los diferentes centros en el Seminario :*

Continentes, Regiones, Países	Centros de Investígacion Demográfica y otros organismos	Número de personas
Africa	3	3
América Latina	3	3
Canada	1	1
Estados Unidos	5	5
Asia (excepto Tailandia)	22	23
Tailandia	4	9
Australia	2	2
Europa	6	52
Total parcial	46	52
Organizaciones gubernamentales internacionales	10	0
Otras organizaciones	3	0
Secretariado de la Comisión Económica y Social para Asia y el Pacífico	1	14
Secretariado del Cicred	1	4
Intérpretes		6
Total general	61	85

12. *En el Anexo I se encontrará la lista de participantes, y en el Anexo II, el programa del Seminario con indicación del nombre de los presidentes de sesiones, directores de debates y relatores. En este último Anexo se encontrará también el nombre de los autores de los documentos básicos. El director técnico, señor Samuel H. Preston, había solicitado la redacción de 12 documentos básicos. Estos documentos se publican en este volumen. Algunos participantes distribuyeron sus colaboraciones en forma directa. Algunas de estas comunicaciones, por su interés relevante, se han incluído en el Anexo III de este libro.*

13. *Todos estos documentos se publican en el idioma en que han sido redactados por sus autores. No fue posible efectuar una versión en inglés y otra en francés como ocurrió en los dos Seminarios anteriores (1). En general transcurre alrededor de dos años entre el momento en que se presenta una solicitud de recursos al Fondo de Naciones Unidas para las Actividades en materia de Población y el momento en que los manuscritos son enviados a la imprenta. Debido al aumento de los precios, el presupuesto inicial queda reducido en el*

(1) Gracias a la generosidad de Celade, fue posible publicar una versión en español del Seminario sobre "Investigación Demográfica en Relación con los Objetivos del crecimiento de la Población".

curso de esos dos años a un nivel tal, que la última etapa del Seminario – la impresión de sus resultados – resulta casi imposible de efectuar.

14. *Para facilitar el trabajo del lector los siguientes textos son publicados en inglés, francés y español: la presentación del Presidente del Cicred, las notas introductorias de Samuel H. Preston, el informe final de Francis Madigan y las conclusiones del señor Preston. Por último, cada documento básico es precedido de un resumen en los tres idiomas.*

15. *El Seminario fue inaugurado por el señor Nibhon Sasithorn, Ministro de Educación del gobierno tailandés. A continuación hicieron uso de la palabra el señor J.B.P. Maramis, secretario ejecutivo de la CESAP, y el señor Visid Prachuabmoh, director del Seminario. La señora Gwendolyn Johnson Acsadi, jefe de la Sección de Estudios sobre la Fecundidad, de la División de Población de Naciones Unidas, pronunció una breve alocución en representación de esa división. Por último, los señores Carl Frisen, director de la División de Población de la CESAP, y Jean Bourgeois-Pichat, Presidente del Cicred, dieron algunas informaciones de orden práctico. Después de una breve interrupción de la sesión, el Seminario inició sus trabajos con una exposición del señor Samuel H. Preston.*

INTRODUCTION

by Samuel H. PRESTON
Center for Studies in Demography and Ecology
Department of Sociology
University of Washington

SUMMARY

The Seminar faces the critical questions, "How much do fertility rates change when mortality changes ? What conditions affect the responsiveness ? How rapid a response can be expected ? " Previous studies suggest that some fertility response is forthcoming in most populations, but evidence in support of any position has been weak. The Seminar background papers contribute to answering these questions primarily through detailed examination of family-level data in many different societies.

This paper reviews the background papers from the point of view of the growth-implications of the relationships they uncover. It concludes that mortality reduction in the vast majority of populations will result in increased rates of population growth over the near term. Some of the growth increment induced by mortality decline per se *can be expected to be offset by a variety of mechanisms linking mortality with fertility. Biological, replacement, insurance, and societal linkages are outlined and reviewed. The first two are mathematically incapable of producing a fully compensating change in fertility when mortality changes. The latter two may logically produce a fully compensating change but they have not been demonstrated to have done so. The need for additional work is greatest with respect to the latter two mechanisms.*

Introduction

Algebraically, birth rates and death rates interact in a transparently simple way to determine rates of population growth. But behind the simple identity lies a complex interplay of mortality and fertility that renders their analytic separation artificial and even misleading, despite its convenience. The Cicred Seminar on Infant Mortality in Relation to Level of Fertility was convened in order to consider in detail the extent and implications of this interplay in a variety of demographic settings.

At the outset it was decided to focus the Seminar on the influence of mortality on fertility rather than on the reverse on joint paths. This choice was made because of the seemingly greater demographic significance of the former relation. Death rates have fallen precipitously in the past half-century throughout most of the world, and there is a reasonably secure prospect of further decline. The growth implications of this reduction are enormous, but depend upon the extent to which it induces corresponding reduction in fertility. Thus, the critical questions facing the Seminar are, "How much do fertility rates change when mortality changes ? What conditions affect the responsiveness ? How rapid a response can be expected ? " The international and intertemporal evidence presented at the Seminar provides the most secure basis yet available for answering these questions.

The stage for this Seminar has been set by more than a century of research and theory related to the topic. Malthusian theory can be read as suggesting that populations simultaneously selected their mortality and fertility levels. Population growth was seen by Malthus as strictly constrained to a very low figure by the slow advance of technological means for material support. If a population accommodated itself to this constraint by preventative, fertility-reducing measures, it could enjoy lower mortality ; otherwise, both fertility and mortality would be high. A positive correlation between mortality and fertility across populations was thus predicted, operating through the pressure of population on the limited means of subsistence.

Rapid technological advance in much of the world during the nineteenth and twentieth centuries suspended whatever Malthusian mechanisms were operating. Demographic transition theory evolved under these new circumstances and it was rapidly accepted as a more accurate set of historical generalizations. In well-known versions of the theory appearing in 1945, Kingsley Davis and Frank Notestein in separate articles argued that mortality declines were an inevitable product of the application to human problems of the rational thought and improved social organization that were characteristic of the modern industrial state. Fertility rates would prove more resistant, in part because high rates of fertility had always been socially necessary to offset high mortality and because the reproductive institutions and norms that had evolved to secure this effect were slow to change. By implication, mortality decline would eventually remove the social underpinnings on which high fertility rested. More directly, lower mortality would mean that fewer births were required in order for individual parents to achieve a certain reproductive goal that was framed in terms of surviving children. In their restatement of the theory, Coale and Hoover (1958 : 17) urged caution on this point, noting that major mortality reductions in Ceylon and Taiwan had not to that point been accompanied by fertility reductions.

Ronald Freedman's massive review of literature on fertility in 1961 indicated general agreement that a secular decline in mortality must eventually produce a decline in fertility, but he commented that very little systematic empirical work had been done on the subject (1961/62 : 67). Two years later in a very influential article, Freedman argued that "known low mortality is one of the necessary conditions for an effective social policy for reducing fertility" (1963 : 164). Partial evidence for the claim was the statement that in almost every developed society, a substantial decline in mortality had preceded fertility decline (1963 : 167). Additional evidence of the importance of the relationships was forthcoming in cross-national regression analysis by Heer (1966), in which levels of infant mortality were shown to be among the strongest and most consistent predictors of fertility levels. The United Nations and World Health Organization lent authority to the suggested linkage in a variety of statements. According to the U.N. Department of Economic and Social Affairs (1972 : 84), "Evidence accumulates that the reduction of infant mortality may be a necessary prerequisite to the acceptance of family planning. Couples will not wish to prevent pregnancies until they have some assurance that the children they already have will survive." At the 21st World Health Assembly, the Director-General of the World Health Organization stated that, "A minimal level of health seems to be necessary for a family to realize that it can regulate its demographic behavior." (cited in International Planned Parenthood Federation, 1970, p.1 ; see also World Health Organization, 1972 : 74).

It is a short step from this conclusion to the recommendation that programs to reduce infant and child mortality should be undertaken *in order to* reduce fertility levels. Such a recommendation was offered forcefully by a committee of distinguished demographers under the auspices of the U.S. National Academy of Sciences in 1971. The Committee, chaired by Roger Revelle, suggested that "Policies and programs aimed at reducing infant and child mortality considerably below present levels, therefore, may be an essential underpinning of government programs for fertility control" (87), and considered that, "As death rates are brought below 10-15 per 1000 in present high-fertility, high-mortality countries, birth rates should be correspondingly reduced." (95). However, in a plenary session of the 1973 International Population Conference in Liege, Ansley Coale again offered a sobering note. Referring to the historical record newly emerging from the European Fertility Project of Princeton University, Coale noted that the time sequences of declines in infant mortality and fertility in European regions simply failed to support the notion that mortality change had been a broadly significant factor in fertility change in the majority of populations.

There is thus an uneasy consensus among demographers and demographic agencies that mortality levels influence fertility levels. The evidence offered in support of any position has been weak. Cross-sectional regressions are flawed by the existence of joint paths of influence between mortality and fertility, their mutual dependence on other variables, and by extreme problems of measurement error and of colinearity among independent variables. Evidence of an earlier decline in fertility than in mortality merely refutes the claim that mortality is the *only* influence on fertility, a position that few would embrace. As Brass and Cantrelle, et.al. point out in their papers for the Seminar, it is unrealistic to expect to be able to tease out of highly aggregated data the subtle relations that exist between mortality and fertility. Such data may be suggestive but they are rarely decisive. Not until demographers descended to the level of the family was much advance made on the question. It is here – at the level of the procreative couple – that the Seminar makes its largest contribution. The papers by Knodel, Lery and Vallin, Cantrelle, Ferry and Mondot, Chowdhury, Khan and Chen, Agrawal, Rutstein and Medica, and Heer and Wu summarize and expand knowledge of family-level relations between mortality and fertility in all major areas of the world. Papers by Brass, Retherford, and Venkatacharya do an admirable job of setting the stage for these results and aiding in their interpretation. Papers by Matthiessen and Lapham, Wright and Quandt are largely confined by design or by necessity to aggregate-level relations under different circumstances, and supplement in a number of useful ways the family-level results.

All of the papers recognize that mortality can affect fertility through four principal modes of influence : involuntary or biological mechanisms, operating largely through abbreviated breast-feeding and more rapid return of ovulation following an infant death ; volitional responses of individual families to mortality levels, wherein it is critical to distinguish between reaction to an actual child death (replacement motivation) and behavior that

attempts to anticipate subsequent child deaths (insurance motivation) ; and societal responses, social reorganizations induced by fertility decline that operate on fertility by changing the reproductive context faced by individual couples. In reality these mechanisms may operate in concert and in an inter-related way, but for analytic convenience they will for the most part be considered separately here.

Growth Consequences of Mortality Change

The remainder of this paper will attempt to indicate for each of these four modes of influences the growth implications of the relations uncovered in the background papers. The specific question that will serve to organize and integrate the findings is : in view of empirical relations uncovered, what is the likely impact of a permanent change in mortality on net reproduction rates ? That is, how much of the increase in long-term growth rates that is implied by a permanent reduction in mortality is likely to be offset by a reduction in fertility ? Instances of the maximal response of fertility to mortality will be emphasized in order to set lower limits on the growth-increment associated with mortality decline. Thus, we will ignore effects of improvements in adult mortality and health, improvements that would seem on net to induce an *increase* in fertility because of improved marital survivorship, decreased pregnancy wastage, increased fecundability, and an increase in the value of children in providing support during parents' older years (see Ridley, et.al., 1967 ; Ryder, 1955 ; Basavarajappa, 1962 ; Immerwahr, 1967). The possibility raised by Retherford that reduction in mortality will increase the desired number of surviving children because of the enhanced value of the stream of child services produced will also be disregarded for the same reason.

We will rely heavily upon the convenient approximation (Coale, 1972 : 18),

$$\mathrm{NRR} = p(30) \cdot \frac{\mathrm{TFR}}{1 + \mathrm{SRB}},$$

where : NRR = net reproduction rate

$p(30)$ = probability of a female newborn surviving to age 30

TFR = total fertility rate, or the average number of children ever born to a woman surviving to the end of her reproductive years

SRB = sex ratio at birth (males/females)

When the infant mortality rate changes by amount Δ IMR, with other death rates constant, $p(30)$ changes approximately by the factor, $1 - \Delta$ IMR. Thus, when the infant mortality rate falls from 200/1000 to 150/1000, $p(30)$ rises by approximately 5 %. Unless the average number of children born per woman falls by at least 5 %, as a result of the mortality decline, the net reproduction rate will rise.

1) Growth implications of mortality change in combination with involuntary mechanisms.

Mortality levels can have a pronounced influence on fertility levels even where the practice of birth control is absent. In populations where breast-feeding is common and extends for more than a few months, its ovulatory-suppressant effects result in longer average intervals to the next birth if the previous child survives the breast-feeding period than if it dies therein. Knodel shows that interval extension in pre-20th century populations ranged from .2 months in populations where breast-feeding was uncommon to 12.9 months if breast-feeding was commonly extended well into the child's second year. Estimates of the extension in areas of certain less developed countries place it at the upper end of this range : 12 months in Senegal according to Cantrelle, et al., and 13 months in Bangladesh according to Chowdhury, Khan and Chen. On the other hand, Rutstein and Medica show that the extension in rural and semi-urban areas of Peru, Colombia, Mexico, and Costa Rica is in the much lower range of 3.5 to 6.2 months. Breast-feeding appears from other evidence to be shorter in these populations.

These widely-noted extension of interbirth intervals resulting from child survival could be partially attributed to differences in residential arrangements, sleeping customs, intercourse frequency, and parental exhaustion resulting from the survival as opposed to the death of the child. They may even be partially contaminated by differential usage of contraception for spacing purposes, as appears to have occurred in the Punjab (Potter, et.al., 1965). However, the principal influence of child survival unquestionably works through the ovulatory-suppressant effect of lactation (Potter, et. al., 1965 : 379). To the extent that parents recognize this biological mechanism and extend breast-feeding specifically for contraceptive purposes, it is incorrect to label the mechanism "involuntary", and it would deserve treatment as a very special case of volitional responses.

Despite the major influence of child mortality on fertility in such populations, it is clearly impossible for fertility to make a fully-compensating response to variations in mortality. The interval to the next birth is shortened by a child death but it cannot be reduced to zero. Children cannot be instantaneously replaced because of the time required to become pregnant, the time required for gestation, and the possibility of fetal loss. The

amount of compensation can be estimated by modifying a model developed by Perrin and Sheps. In this model the average number of children born in the lifetime of a woman is viewed as the ratio of the length of her reproductive period (in months) to the mean number of months between births. Several components of the mean inter-birth interval are recognized : an average waiting time until conception for a woman in the susceptible state ; an average period of sterility during pregnancy ; and an average period of sterility following the termination of the pregnancy. We can introduce infant mortality into the model by allowing the sterile period following a live birth to vary according to whether or not the child survives its first year of life. The complete model is

$$TFR = \frac{N}{W + S_0 + IMR(S_1) + (1 - IMR)(S_2) + K(W + S_3)} ,$$

where : N = length of a woman's reproductive life

W = average waiting time until pregnancy for a woman in the susceptible state

S_0 = period of sterility during a pregnancy leading to a live birth

S_1 = period of sterility following a live birth that results in an infant death

S_2 = period of sterility following a live birth that results in a surviving infant

S_3 = period of sterility during and after a pregnancy resulting in a fetal death

IMR = infant mortality rate

K = ratio of chance of a fetal death to chance of a live birth

The sensitivity of fertility with respect to the infant mortality rate may be found by differentiating this latter expression with respect to IMR, a process that yields

$$\frac{d\,TFR}{TFR} = \frac{(S_2 - S_1)}{I} \, , \, d\,IMR \, ,$$

where I is the average length of the interbirth interval.

This expression is a very simple answer to our question. The proportionate change in fertility will equal the absolute change in infant mortality (which is equivalent to the proportionate change in p(30)) times the factor, $(S_2 - S_1)/I$. This latter factor is the difference between the sterile periods associated with a surviving as opposed to a dying infant as a proportion of the entire average interbirth interval. This factor must be less than unity ; it could equal unity only if the dead child could be instantaneously replaced by eliminating waiting times to conception and the period of pregnancy itself.

As noted above, the highest value of $(S_2 - S_1)$ for any population was uncovered by Chowdhury, Khan and Chen in Bangladesh, 13 months. Since a minimum average interbirth interval in a population with extended breast-feeding is surely no less than 26 months, it can be stated with confidence that 50 % is the maximum compensatory response of fertility to changes in infant mortality resulting from this mechanism. That is, it is conceivable that up to half of the increase in NRR resulting from a reduction in infant mortality could be eliminated by compensating reductions in fertility. A more likely level of response in populations with extended breast-feeding is indicated by Potter's analysis of birth intervals in the Punjab. $(S_2 - S_1)$ was 9 months and I was 30 months, a combination that would produce a compensatory response of 30 % (Potter, et.al., 1965 : 394). Judging from Rutstein and Medica's results a much smaller response is to be expected in Latin America.

It seems likely that the compensatory response would be greatest where nutritional levels of both the mother and child are poorest. The ovulatory-suppressant effects of lactation appear to be strongest in such populations, although results here are not yet conclusive (Salber, 1966 ; Chen, et.al., 1974 ; Chowdhury, Khan, and Chen). The effect may also be expected to be stronger among rural, illiterate, and older women, since as Cantrelle et.al. demonstrate for selective areas in Africa, breast-feeding itself tends to become shorter and less common during the course of modernization. But in no population can we expect a majority of the growth increment to be relieved by a reduction in fertility. The response of fertility to a permanent change in mortality from this mechanism should be quite rapid, occurring within the length of the average inter-birth interval, somewhere between 2 and 4 years.

2) Growth implications of mortality change in combination with volitional responses of individual couples

The previous section took no account of the possibility that couples practice contraception in order to achieve certain family size goals. The introduction of such goals and behavior immensely complicates the fertility-mortality interrelations. We will deal only with those couples whose family size desires are framed in terms of the number of children *surviving* to some point defined by the age of parents, which we will call the

"criterion age". If it is an age within the childbearing span itself, parents for the most part need only react to events of child death and survival within their family in order to pursue their family size goals. This condition will be analyzed under the term, "replacement effect". Where the criterion age is past the end of childbearing, however, uncertainty regarding the survivorship of children to that point is introduced. Foresight is required, and expectations regarding future child mortality presumably come to be based not only upon parent's own experience but also upon their perception of community levels of mortality. Because of this uncertainty, parents must attend to possible outcomes other than that which is most desired, and the shape of their entire preference function for surviving children becomes germane. This condition will be analyzed under the term, "insurance effect".

2a) Replacement effect

If parents aim to have a certain number of surviving children, C, at the end of their childbearing period, which is assumed to be known, and if they could bear and avoid bearing children at will, then they will most certainly have C living children at the end of their reproductive period. Each dying child would be "replaced" by a live birth. Surprisingly, even in this fictitious case, "complete" replacement will typically result in a rise in net reproduction rates when mortality falls. The reason is that the strategy secures the desired number of surviving children only up to the point where parents are aged 45 or so, at which time their children will perhaps be age 15, on average. But the age to which survivorship is pertinent for the NRR is much older than 15 (30 by the conventional approximation). Since an improved level of mortality tends to be associated with reduced death rates at all ages, the same number of 15-year olds results in more 30-year olds in a lower-mortality population. Hence, the mortality improvement produces a rise in the NRR. Using rough approximations, it can be shown that the net reproduction rate after a mortality decline will exceed the NRR before the decline by a factor equal approximately to the ratio of the new to the old probability of survival from age 15 to age 30. As mortality improves from a life expectancy at birth of 35 to one of 70, this factor is about 1.152 according to "average" life tables (Coale and Demeny's "West" female life tables, 1966 : 8 and 22). Even with complete replacement of dying children, a mortality improvement of this magnitude increases the net reproduction rate by 15 %. Since it would increase by approximately 104 % if no fertility adjustment occurred (based on a comparison of $p(30)$'s in *ibid.*), it is clear that the complete replacement mechanism eliminates about 85 % of the growth acceleration induced by mortality decline. Complete compensation would occur, of course, if the mortality improvement were restricted to infants.

It is unrealistic to expect women attempting to achieve a target number of living children by the end of childbearing to be able completely to replace those dying. By the time of the child's death, they may have lost a husband or become sub-fecund or sterile. More important in high fertility-goal countries, they may still be occupied with the bearing and nursing of children who would have been needed to reach the reproductive target even if the child had not died. Obviously, if the desired number of *surviving* children equals or exceeds the maximum number of *births* that can be produced during a woman's reproductive life, no replacement effect will be forthcoming. The size of the replacement effect should thus be influenced by family size goals and their determinants, such as woman's education and urban-rural residence. As an influence on fertility, mortality must logically be seen as *interacting with* these determinants, rather than as adding to them as a separate factor.

The effects of replacement motivation in the presence of these reproductive obstacles are too complex to be represented in simple analytic solutions. One is forced to use simulation. Venkatacharya is the first to examine a strategy close to what we have defined as replacement motivation in a full-blown model that accounts for declining fecundability with age, periods of sterility, and fetal mortality. Assuming that a couple procreates until one son reaches the age of 10, he shows that, under Indian conditions (simulation C_6), permanent reductions in mortality produce major increases in net reproduction rates. As female life expectancy increases from 35 years to 75 years, the NRR rises from 1.37 to 2.24, or by 64 % (Table 5). The total fertility rate falls by only 7 %, hardly sufficient to offset the effects of the major mortality improvement. Results are not substantially altered under similar strategies or under different levels of reproductive parameters.

As noted above, the amount of replacement should be higher in countries with lower family-size goals, where a child death would tend to occur earlier in a woman's reproductive life, allowing less opportunity for intervening reproductive obstacles to arise, and where the reproductive years would not be so completely occupied with the bearing of children needed to reach the target in any event. These expectations are verified in the background papers that report on the observed extent of replacement. A wide variety of measures were used to indicate the frequency and extent of replacement, and they are not strictly comparable across studies. Within studies, however, comparable measures were often used for different populations. In all cases the authors recognized the need to study the replacement effect prospectively from a certain point in women's reproductive cycle, in order to minimize the contaminating influence of fertility on mortality. They also recognized the need to eliminate the effects that work through the involuntary mechanism, although in practice the elimination was not always possible.

Knodel finds evidence of replacement motivation in various pre-20th century European populations by examining the length of interval between the second and third birth as a function of whether or not the first child died. The interval was generally somewhat shorter, on average, for women whose first child died, and the differential was larger in population known to be practising extensively birth control (i.e., in those where the potential replacement effect is largest). Brass points out that a possible source of bias in such results is varying fecundabilities among women. Highly fecund women would tend to have had short birth intervals, and short intervals typically result in a higher incidence of child mortality. Thus the apparent association between interval and mortality may be spurious, produced by their mutual dependence on fecundability. However, such bias should be greatest in populations exercising little control over births, whereas Knodel's results indicate that the effect on intervals is weakest here.

Knodel also compares parity progression ratios (the proportion of women who have achieved a certain parity who proceed to have a subsequent live birth) for women with differing incidence of child mortality prior to the attainment of that parity. Results generally support the interval analysis. Effets are strongest, in the expected direction, where family limitation was evident from other sources. Chowdhury, Khan, and Chen adopt a useful approach that combines the interval with the parity-progression measures. They compute life tables showing the proportion of women in Pakistan who have progressed from parity x to parity $x + 1$ by interval since the attainment of parity x. For women who had experienced a child death before attaining a parity between 2 and 5, the median interval to the next birth was shorter than for women with no child deaths before reaching that parity. Women with a child death occurring *after* the attainment of parity x were excluded from the table, so that results are not contaminated by positive correlation of infant death incidence over a woman's successive births. However, varying fecundability may still play a role. The median extension of the next interval resulting from having had no child deaths is quite short – a maximum of four months is observed at parity 4 (Table 6) – and even smaller differences are found in Bangladesh (Table 8). Consequently, Chowdhury, Khan, and Chen are inclined to interpret their results as reflecting no behavioral response to the death of a child. It is very clear from their results that the size of the replacement effect, if any, in Pakistan and Bangladesh ranks far below the involuntary mechanisms in order of quantitative importance.

The studies reported by Rutstein-Medica and Heer-Wu introduce, for purposes of statistical control, information on the socio-economic status of parents. They also examine other important dependent variables such as use of contraception and desired family size. The principal dependent variable is the parity progression ratio, adjusted for length of time since attainment of previous parity. The detail of Chowdhury and Khan's time-sequences is forfeited in order to observe the replacement effect in a comprehensive multivariate framework of fertility determinants. The studies are the most complex reported at the Seminar, and only a brief summary will be attempted. In general, the studies support the expectation that the replacement effect should be strongest in low fertility-goal populations. Heer finds in rural Taiwan that the death of one child of the first three births prior to a point one year after the third live birth results in .285 more children past the third than if none had died. However, there were fewer subsequent births if two died than if one died, and still fewer if three than two (p. 15). The replacement effect is apparently weak and even works in the wrong direction for deaths past the initial. The results must be interpreted cautiously because reproduction had not been completed by all women interviewed, and further replacement behavior was possible (nevertheless, the woman had a median of 11.9 years after the third birth in which to bear subsequent children (p. 12)). Moreover, some of the dying children may have already been "replaced" without a woman's progressing beyond the third parity. This could be the case only if a target surviving family size were one or two. It should be noted that Rutstein (1974), using a smaller but island-wide survey and a projective technique that attempts to carry women to the end of reproduction by the use of synthetic cohorts, finds a larger effect of child loss on subsequent fertility in Taiwan. However, the replacement effect is confounded with the involuntary mechanism in Rutstein's results, a confounding that Heer partially eliminates by controlling for the average length of lactation.

Replacement desires were stronger than replacement behavior among Heer and Wu's respondents. The death of one son in families that had born one or two produced an increase in the average desired number of additional births of .6 – .7 (p. 2), although a daughter's loss evoked a weaker effect. The disparity between the change in desires and the actual change in behavior may be attributed to factors mentioned earlier : the reduced chances for acting upon replacement desires in an otherwise cluttered reproductive life. Iskandar and Jones (1975) find similar effects in Indonesia. They show that, in virtually every region and at every parity women who have lost children are more likely to want additional children than women who have not.

Rutstein and Medica present the first evidence on the influence of child mortality experience on the childbearing of individual couples in Latin America. Applying identical techniques to CELADE survey data from rural and semi-urban areas of Colombia, Costa Rica, Mexico, and Peru, they are able to show that the replacement effect is everywhere substantially weaker than Rutstein's earlier results indicated for Taiwan. Costa Rica displays the largest replacement effects, ranging up to .39 additional births for women who had lost one as opposed to none of their first four births. Replacement effects in Mexico and Colombia were nil or

even slightly negative, a surprising result in view of the fact that the measured effect also comprises involuntary influences. Breast-feeding appears to be, on average, rather short in these areas, however. The area where breast-feeding is apparently most prolonged, Peru, shows the second largest replacement effect. Abstracting from this case, whose peculiarity seems plausibly explained, the results support the position that replacement effects are strongest in areas where fertility is lowest and use of contraception highest : Taiwan and Costa Rica. The exception that is not readily accounted for is urban Morocco, where Heer uncovers a replacement effect of .70 if one of the first three children died. The involuntary mechanism is not controlled here, but we have seen that it could not plausibly be responsible for an effect of greater than .35. Inter-woman variation in the duration of breast-feeding as well as in fecundability, is a potential contaminant, however. Women who breast-feed for short periods regardless of child survival are probably more likely to suffer a child death, but the extension of their susceptible period would be far greater than is implied merely by that death alone.

Finally, Lery and Vallin demonstrate the impact of infant mortality on subsequent fertility in a low fertility population, France. Employing a very large sample of women born 1892-1916, they convincingly demonstrate that progression ratios to the next parity are higher by 19-28 % when the child has died in infancy than when it survived to the time of survey in 1962. Essentially the same range of response is observed within classes of father's occupation. They also show that the death of a child in infancy accelerates the arrival of the next child by 6-12 months. Results suggest a vigorous response to child death, but the extent of replacement cannot be gauged from their figures.

In sum, no reported replacement effect was complete ; the effect tended to be stronger in countries of low fertility goals ; and even with complete replacement, the net reproduction rate would tend to increase as mortality falls. The absence of complete replacement can be attributed to many factors other than limited opportunities. Some of the conceptions resulting in dying children may have been "unwanted" in the first place ; a child's death may provide negative reinforcement for childbearing behavior ; and parents may lack family size goals that are framed in terms of surviving children.

When population mortality levels change, the replacement effect must modify fertility within a length of time equal to the reproductive span of women. The lag can be no longer than 30 years, and would presumably be shorter the smaller are fertility goals.

2b) Insurance effect

If parents aim at having a certain number of living children at some point past the end of their reproductive period, they must make a projection, however crude, of their children's subsequent death risks. Anticipation rather than reaction is required. To the extent that their anticipation is predicated on their own experience with child survival, its effects should be incorporated into the estimates of the replacement effect just reported. As we have seen, these reported effects are not nearly sufficient for complete replacement of dying children. However, parents' assessment of mortality risks may be more broadly based, founded on levels of mortality among friends or in the community at large.

Insurance motivation provides one of the few plausible pathways by which fertility compensation may be more than complete (Schultz, 1969 ; Preston, 1972). Since the future is uncertain, the number of children surviving to the criterion age cannot be predicted with perfect accuracy. Parents must therefore consider the attractiveness of outcomes other than that most desired, C. If outcomes above C are much more attractive than those at an equivalent distance below C, the greater variance in surviving numbers of children when mortality is high may interact with this preference function in such a way as to exaggerate the impact of mortality change.

This mechanism cannot work when parents' preference function for children has only one non-zero value, at C (in effect, can be represented by a spike). In this case it can be proven that the number of births, B, that maximizes the chance of reaching the target, C, if each child is subject to a probability, P, of surviving to the criterion age, is $B = C/P$.

Proportionate changes in mortality (P) would be exactly offset by proportionate changes in fertility. The net reproduction rate would be unaffected by mortality change except for the relatively minor mechanism noted in section 2a. If the criterion age were 60, then the NRR should be essentially unaffected ; if much above 60, it would typically respond *negatively* to a change in P.

In the more general and realistic case where non-zero values are attached to several outcomes, fertility can respond very vigorously or very lethargically to mortality change, depending on the shape of the preference function. To illustrate, we will use a preference function developed by Myers and Roberts (1968) for 18 Puerto Rican women who were asked to rank and scale relative preference for a particular family size in each of 1176 hypothetical pairs of girl-boy combinations. The average preference score attached to family size outcomes in order from zero to 12 children were : .64, .88, 1.62, 1.52, 1.56, 1.12, 1.02, .92, .92, .81, .81, .75, .76. Two was the most desirable outcome, but the distribution was clearly highly skewed to the right, with all other outcomes preferred to zero children. Given this function, and assuming that child survival

is a binonial process with a probability of success (survival to the criterion age) for each trial of P, we can ask what number of births would maximize the expected value of family size outcomes. When P = .5, the optimal number of births is 6. At P = .6, it is 5 ; at .7, .8, and .9 it is 4 ; and at 1.00 it is 2. The optimal number of births is fairly unresponsive until P exceeds .9, whereupon it responds very virogously to further declines in mortality. Overall, a doubling of survival chances reduces the optimal number of births by two-thirds. Ultimately, the fertility decline more than compensates for the mortality decline, but this effect is withheld until the range of lowest mortality is reached.

Simulation permits the abandonment of the unrealistic assumption that parents make point decisions on births. Heer and Smith (1968), by assuming that parents procreate until they are 95 % certain of having at least one son alive when the father is 65, have chosen a criterion age high enough that insurance motivation must have central importance. Moreover, their assumption about reproductive goals implies an asymmetric preference function wherein falling short of the goal is less highly valued than exceeding it. In short, their assumptions provide an opportunity for maximal response of fertility to mortality. As expected, the assumed strategy results in NRR's that fall as mortality improves beyond a female life expectancy of approximately 40 years. O'Hara (1972) introduces optimal spacing considerations into the Heer-Smith model with results that reduce in every case the level of NRR but leave unaltered its reaction to mortality change. Over the majority of the range of present human life expectancy, fertility overcompensates and the NRR falls when mortality improves. *The radical difference in the response of NRR to mortality change in the Heer-Smith simulation as opposed to that of Venkatacharya is ample evidence that the distinction between replacement and insurance motivation is fundamental.* In this case simulation, while not telling us how couples behave, has nevertheless identified a critical parameter of such behavior that warrants further empirical investigation.

It is clear that some notion of the shape of individual's preference maps for surviving children, as well as of the criterion age or age range, is essential in order to make predictions of the size of insurance effects. Myers and Roberts' maps for the Puerto Rican women are highly skewed to the right and this may be assumed to be the typical case in less developed countries. But much work needs to be done in this area. Scant evidence exists on the actual importance of insurance motivation. Heer and Wu's Taiwanese respondents were questioned regarding their perception of child survival. Holding constant the number of actual child deaths in the family, those who perceived the chances of a baby's surviving to age 15 to be less than .85 had .26 more additional children (beyond the third) than those who perceived the chances to be .95 or better. When the desired family size is clustered about 4, as in Taiwan, those with a subjective probability of .80 should have borne approximately one child more than those whose subjective probability is 1.00, ceteris paribus. The actual insurance effect is only one-quarter of this amount, indicating incomplete compensation for variation in survival perception. But in fact parents need not prepare for child mortality over the entire range of ages, since they have already observed the survivorship of certain of their children ; so it is difficult to develop a standard against which the completeness of compensation can be measured. Moreover, the reliability of responses to the survival question was quite low. Heer and Wu also show that in the higher mortality *region,* controlling for actual incidence of child death and measured perception of child survival, parents bore .35 more children after the third than in the low mortality region (p. 20). Whether or not this is "complete" compensation depends on differences between survival chances in the two areas, data not provided by Heer and Wu. Assuming a proportionate difference in $P(a^*)$ of .1, where a^* is the criterion age, the actual fertility difference with complete compensation should be .4 children where desired family size is 4. The actual response would thus represent almost complete compensation. Since the villages differed in respects other than mortality, it may be illegitimate to attribute the entire village effect to mortality differences. Nevertheless, most of the other pertinent variables affecting fertility were controlled at the individual level, and this result, combined with the survival perception effect, provides important evidence of the potential strength of the insurance effect. Rutstein (1974) constructs an index of fear of child mortality for Taiwanese respondents, which is shown to be positively related to parity progression ratios when actual experience of child mortality is controlled. The nature of the variable does not permit an assessment of whether such effects represent complete compensation. On the negative side, Heer and Wu find in Morocco that belief that child mortality has improved during the past generation is positively related to fertility performance.

Thus, there are theoretical reasons for believing that reproductive desires framed on the basis of surviving children to an age of parents beyond the end of childbearing might produce an overcompensatory reaction of fertility to mortality. The results available from Taiwan indicate that empirical effects may in fact be quite substantial. Unlike the previous mechanisms reviewed, limits to the lag in response of fertility are impossible to specify. The response time depends not on objective conditions but on perceptions of those conditions, which may adjust slowly or rapidly. A majority of respondents in several surveys taken in less developed countries showed an awareness that mortality conditions had recently improved (see Heer and Wu (Table 3)). Whether or not the response is rapid or apprehends the actual magnitude of change is unknown.

2c) Replacement combined with insurance effects

We have for analytic convenience separated replacement from insurance effects. But in fact they will

often act in concert. Even for couples whose reproductive goals are framed in terms of surviving children to some point during their reproductive cycle, knowledge that reproductive obstacles may arise before the end of that cycle, or that deaths may occur so rapidly as to preclude replacement, may produce insurance motivation. On the other hand, those with a criterion age well past the end of reproduction will in all cases have a chance to observe and react to the actual deaths that occur in pursuing their objectives. The higher the criterion age of parents the stronger should be the insurance effect relative to the replacement effect. Countries where the primary functions of offspring are support for parents in their older years, perpetuation of the family line through their own offspring, performance of ceremonial burial activities, etc., should show stronger relative insurance effects at the same level of mortality than countries where parents are more interested in children *qua* children (see Retherford).

It is reasonable to expect in all cases that variations in mortality affect fertility primarily through the replacement rather than through the insurance mechanism. The reason is the considerable concentration of child mortality in the very early ages. By the end of parent's childbearing period, children will be on average 10 – 15 years old. Very few will have to pass through the most hazardous first two years of life. Parents must anticipate child survival not through the entire age span to adulthood as in our simplified example, but in fact through what tend to be the ages of lowest mortality. Even though overcompensation may often occur for variation in mortality during this contracted age span, the response may imply incomplete compensation for the total change in infant and child mortality. Parents will have a chance to react to changes in mortality because the vast majority of deaths prior to the criterion age will have occurred during the reproductive cycle itself. For example, if 10 children are born at 2 year-intervals to women starting at age 20 in a population with life expectancy of 35, 74.5 % of the deaths those children will experience prior to age 30 will have occurred prior to the mother's attainment of age 40 ; at a life expectancy of 60, the figure is 68.3 % (compiled from Coale and Demeny, 1966 : 8 and 18).

3) Growth implications of mortality change in combination with societal mechanisms

The arguments of Notestein and Davis suggested that pre-industrial societies would, through one means or another, evolve normative practices that assured high average levels of fertility. Such levels would be needed to counteract high mortality ; without them, a society was doomed to extinction. The most important mechanism for ensuring demographic survival was the extended family system, which removed many of the costs of marriage from the partners and of childbearing from the parents (Davis, 1955). That birth rates must exceed death rates for demographic survival in a closed population is axiomatic ; that high fertility was required to this assumes that high mortality was a "given", largely unaffected by fertillity levels. Although this is certainly an over-simplification, and populations are perhaps most accurately viewed as adopting within limits their *combination* of fertility and mortality rates, it is surely true that the minimum fertility levels required for survival were much higher than those now required throughout much of the world.

What happens when the conditions requiring high birth rates disappear ? The selective advantage accruing to populations with high fertility disappears as well. But the evolutionary processes that would select those societies adapting most successfully to the new conditions presumably require millenia to work themselves out ; the optimal adaptation is not apparent, nor is rapid progression toward any particular one obvious today. In short, this perspective yields no useful prediction of events occurring within a practical time horizon after mortality reduction.

A more useful approach recognizes that preindustrial societies were faced not only with high mortality levels but also with highly variable mortality levels and with limits to group size. Since over-population could also pose a threat to group survival, and since mortality was highly unpredictable, it is reasonable to expect that many societies have evolved mechanisms by which fertility rates would vary directly with mortality. It is clear that biology provides some opportunity for such flexibility. The age patterns of fertility and mortality assured that dying is concentrated in the extremes of the life span and childbearing in the middle, so that, following a mortality crisis, the age distribution became unusually favorable to high birth rates and rapid recovery. The suppression of ovulation during lactation itself clearly contributed flexibility as well.

Among the social mechanisms that evolved with this effect, the best documented are probably those operating through age at marriage and proportions married, although extended separation of new mothers from their husbands and intercourse taboos during breastfeeding may be equally important. In Europe, the evolution and diffusion of the societal norm that a husband should himself be directly responsible for the support of his wife and children, combined with an agrarian mode of production in which the resources for such support – primarily, land – were strictly limited in the aggregate, provided the possibilities for major responses of fertility to mortality change. A mortality crisis would increase the number of new widows and widowers, heirs and heiresses, and increase the chances of marriage and parenthood for single people who survived. The key to the system was individual ownership of land, and Geertz (1968) demonstrates with evidence from Java that fertility cannot be expected to respond to mortality change where land is allotted at the village level on the basis of family "need". Friedlander (1969) points out that even where the European

marriage pattern was in effect, the relation between societal levels of fertility and mortality was attenuated where "safety valves" for population pressure exist. He suggests that the long lag between mortality and fertility declines in England is plausibly attributed to the simultaneous occurrence of industrialization and of the rural-urban migration possibilities that it offered. Overseas migration, geographic extension of the resource base, and labor-intensification of agriculture may under the right circumstances also offer safety valves. Some of these intervening responses can themselves affect fertility. For example, rural-urban migration exposes increasing proportions of the population to what is conventionally a lower fertility context.

The background papers do provide some new evidence on the strength of aggregate-level relations between mortality and fertility, although the relations necessarily comprise individual as well as societal factors. Matthiessen confirms that the time patterns of declines in mortality and fertility in 19th and early 20th century Europe are diverse and inconsistent from area to area. The diversity is sufficient to rule out mortality change as the only factor operating throughout Europe to cause a fertility reduction during the period. Cross-sectional relations are similarly varied. Scotland, France, Italy, Portugal and urban Germany show fairly strong positive cross-sectional relations between areal fertility and mortality levels in the 19th century, and these relations were maintained in areas where it was possible to control other variables such as literacy. However, England and Belgium show no such relation, and Lesthaeghe's (1974) analysis of the Belgian data is thorough and convincing.

Lapham, et.al. demonstrate the relatively strong, curvilinear relation that exists between crude birth rates and infant mortality rates in 74 less developed countries in the 1960's. Within nations and regions of tropical Africa, however, the zero-order cross-sectional relationship is *negative*, as Cantrelle, et.al. show. They point out, however, that variation in health conditions may affect both the extent of sterility and the rate of infant mortality in such a way as to produce a negative association. In Gabon, for example, the infant mortality rate is very high at 229/1000, but approximately a quarter of reproductive-age women have been rendered sterile, primarily by malaria, thereby reducing fertility levels. In India, on the other hand, Agrawal's figures on regional crude birth rates, total fertility rates and infant mortality rates suggest a strong positive association between mortality and fertility (Table 17). Based on data in this Table, the zero-order correlation between the total fertility rate and the infant mortality rate for 12 Indian states around 1970 can be computed as .560 ; for 17 states, the correlation between IMR and the crude birth rate was .654. Controlling for regional percent literate, the equivalent partial correlation coefficients are .340 and .520 ; controlling for percent rural, they are .597 and .668. All correlation coefficients except one are significant at 5 %. Evidently the aggregate-level relations are as diverse within groups of less developed countries today as they were in European countries a century ago. Positive and significant areal associations clearly predominate. But the causal inferences that can be drawn from such data are severely limited.

Mortality change can affect fertility at the societal level not only by changing the objective conditions under which reproduction occurs but also by changing the attitudes and mental sets with which individuals confront those conditions. It has been argued that fatalism – an attitude that events are outside of an individual's control – is a significant reason why many individuals fail to exercise control over their fertility. There is limited empirical evidence to support this point (Williamson, 1970). In a less developed country, one of the cheapest and most significant ways by which an individual's life can be altered is probably through health improvements. The demonstration that such changes are within reach may precipitate a psychological change that by itself makes the adoption of contraception more likely (Taylor, 1965 ; National Academy of Sciences, 1971). A related argument is that population pressure within the family and society must reach some critical minimum amount before innovation (contraception) will be considered. Once adopted, however, innovation will have snowballing "demonstration" effects both for the adopter and for others who observe or are persuaded. These arguments must be considered to be speculative until some careful empirical work is concluded.

Conclusion

Mortality decline is likely in all societies to increase rates of population growth. Some compensating fertility declines can be expected in most societies, but these declines will rarely be sufficient to completely offset the growth effects of mortality change. In populations not practising birth control, no more than a third of a mortality-induced increase in NRR will typically be offset through involuntary mechanisms that act to reduce fertility. In populations where birth control is widespread, even a regime in which parents replace each dying child will tend to produce a negative relation between levels of mortality and the net reproduction rate. Moreover, complete replacement is not to be expected and has not been observed. Replacement tends to be least complete in high fertility-goal populations, precisely where the social and economic effects of rapid population growth are often most severe.

Parental motivation to achieve a certain number of surviving children to some stage well past the end of the parents' reproductive period offers the one mechanism that might plausibly produce over-compensatory changes in fertility. However, in this case overcompensation logically applies only to mortality changes occurring

in a restricted age range, a range that effectively exludes the ages of maximal mortality change. An over-compensatory fertility response due to this effect depends on the existence of a preference function for children that is highly skewed toward large number of children, a shape that has received limited empirical validation. Moreover, the response may occur after a substantial delay because it depends upon perception by parents that mortality conditions have changed. Psychological changes, such as a reduction in fatalistic attitudes, that are produced by mortality decline might also engender over-compensatory changes in fertility. At the moment, this contention is highly speculative.

In sum, arguments in support of reduced mortality in order to reduce growth rates hang on slender threads of evidence and speculative lines of reasoning. There are, of course, many other reasons for pursuing such programs, and there are surely instances where more rapid growth is desired and mortality reduction programs would contribute positively to the achievement of such a demographic goal. Regardless of goal, the overwhelming evidence from the background papers as well as from the current rate of world population growth is that declines in mortality will tend to increase rates of population growth for at least several decades, and probably longer.

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INTRODUCTION

par Samuel H. PRESTON
Center for Studies in Demography and Ecology
Department of Sociology
University of Washington

RESUME

Le Séminaire doit répondre à des questions difficiles : "Dans quelle mesure les taux de fécondité changent-ils quand la mortalité change ? Quelles sont les conditions qui favorisent cette réaction ? Peut-on s'attendre à ce que celle-ci se fasse rapidement ? " Les études précédentes font penser qu'un changement de la fécondité est sur le point de se produire dans la plupart des populations mais les preuves en faveur de cette assertion ne sont guère convaincantes. Les rapports de base du Séminaire permettront de répondre à ces questions par un examen des données au niveau de la famille dans de nombreuses sociétés différentes.

Cet article présente un résumé des rapports de base en se plaçant du point de vue des possibilités de progrès qu'ils laissent entrevoir. Il conclut que le recul de la mortalité dans la plupart des populations amènera à court terme une plus forte croissance démographique. On peut s'attendre à ce qu'une partie de la croissance provoquée par le recul de la mortalité soit compensée par diverses relations qui existent entre la mortalité et la fécondité. On discutera ici ces relations qui tiennent à la biologie, au remplacement des générations, à l'assurance qu'ont les parents d'avoir des enfants qui leur survivent et aux facteurs sociaux. Les deux premières sortes de relations ne sauraient mathématiquement provoquer des changements de fécondité susceptibles de compenser ceux de la mortalité. Les autres relations peuvent logiquement provoquer un changement de cette espèce mais on n'a pu démontrer qu'elles y parvenaient en fait. C'est dans ce domaine que les recherches à venir doivent s'orienter.

Introduction

La natalité et la mortalité exercent l'une sur l'autre une action réciproque et déterminent ainsi de manière très simple les taux de croissance démographique. Mais cette identité extrêmement simple masque des réactions réciproques complexes entre la mortalité et la fécondité qui rendent leur distinction fort artificielle et même hasardeuse bien qu'elle soit très commode. Le Séminaire du Cicred sur la mortalité infantile en relation avec le niveau de fécondité s'est réuni pour étudier en détail l'étendue et les conséquences de cette action réciproque dans des conditions démographiques diverses.

Dès le départ, il a été décidé de concentrer les travaux de ce Séminaire sur l'influence exercée par la mortalité sur la fécondité plutôt que de celle de la fécondité sur la mortalité. Ce choix a été fait parce que la première de ces relations semble présenter une plus grande importance démographique. La mortalité a baissé de façon spectaculaire depuis un demi-siècle dans la plupart des pays et on peut prévoir sans trop craindre de se tromper, qu'elle continuera à baisser dans l'avenir. Les conséquences de cette baisse sur la croissance sont considérables mais elles dépendent de la répercussion que cette baisse aura sur l'évolution de la fécondité. C'est pourquoi les questions les plus importantes dont il doit s'agir dans le Séminaire sont les suivantes : "Dans quelle mesure la fécondité change lorsque change la mortalité ? Quelles conditions affectent les répercussions du changement de la mortalité sur la fécondité ? Peut-on s'attendre à ce que ces répercussions soient rapides ? " Les études se rapportant à diverses régions et à diverses époques présentées au Séminaire fournissent la base la plus solide dont on dispose jusqu'ici pour répondre à ces questions.

Plus d'un siècle de recherches et de théories relatives à ce sujet ont en quelque sorte servi de prélude au présent Séminaire. D'après les théories malthusiennes, les populations choisissaient pour ainsi dire leur niveau de mortalité et de fécondité. Malthus considérait que la croissance démographique devait rester très basse du fait de la lenteur du progrès de la technologie. Si une population s'adaptait à cette contrainte par des mesures susceptibles de réduire la fécondité, sa mortalité pouvait baisser ; autrement, tant la fécondité que la mortalité seraient fortes. Une corrélation positive entre mortalité et fécondité dans les populations pouvait donc être prédite du fait de la pression démographique sur des moyens limités de subsistance.

Le progrès rapide de la technologie dans la plus grande partie du monde au cours des dix neuvième et vingtième siècles ont rendu inopérants tous les mécanismes malthusiens. La théorie de la transition démographique, élaborée dans ces nouvelles circonstances, a été rapidement reconnue comme étant plus adaptée aux faits. Dans des exposés désormais classiques de cette théorie, publiés en 1945, Kingsley Davis et Frank Notestein, dans des articles séparés, ont montré que le déclin de la mortalité était la conséquence normale de l'application aux problèmes humains de la pensée rationnelle et de l'amélioration de l'organisation sociale qui caractérisent l'état industriel moderne. La fécondité était moins rapidement influencée, en partie parce qu'une forte fécondité a toujours été nécessaire pour compenser une forte mortalité et que les comportements et principes envers la reproduction qui s'étaient constitués pour y parvenir étaient lents à changer. Cependant, le déclin de la mortalité entraînerait, à longue échéance, l'abandon des structures sociales qui maintenaient une forte fécondité. De manière plus directe, la baisse de la mortalité signifiait qu'il fallait un nombre moins élevé de naissances pour que les parents parviennent au but qu'ils s'étaient fixé quant au nombre d'enfants survivants qu'ils se proposaient d'avoir. En exprimant de nouveau cette théorie, Coale et Hoover (1958 : 17) incitèrent à la prudence à cet égard en remarquant que la baisse de la mortalité, pourtant considérable, à Ceylan et à Formose ne s'était pas jusqu'alors accompagnée d'une diminution de la fécondité.

En 1961, Ronald Freedman fit un examen complet de tout ce qui avait été publié sur la fécondité. Il en résultait que le déclin séculaire de la mortalité devait bien amener éventuellement une baisse de la fécondité. Mais cet auteur notait que peu de recherches empiriques avaient été faites sur cette question (1961/62 : 67). Deux ans après, dans un article qui a eu beaucoup d'influence, Freedman déclara qu'"une mortalité peu élevée est une des conditions nécessaires pour que les mesures sociales pour faire diminuer la fécondité aient des résultats." (1963 : 164). Pour confirmer en partie cette opinion, on remarquait que dans presque toutes les sociétés développées, un déclin important de la mortalité avait précédé celui de la fécondité (1963 : 167). Des preuves montrant l'importance de ces relations devaient bientôt être apportées par l'analyse par régression faite pour divers pays par Heer en 1966. Selon ces études, le niveau de la mortalité infantile fournissait la meilleure manière de prédire celui de la fécondité. Les Nations Unies et l'Organisation Mondiale de la Santé apportèrent leur autorité à propos de cette relation dans diverses déclarations. Selon le Département des Affaires économiques et sociales des Nations Unies (1972 : 84), "il apparaît de plus en plus que la baisse de la mortalité infantile est une condition nécessaire à l'acceptation du plan familial. Les couples ne voudront empêcher les grossesses que quand ils auront l'assurance que les enfants qu'ils ont déjà survivront." A la 21e Assemblée de la Santé Mondiale, le Directeur Général de l'Organisation Mondiale de la Santé déclara qu'"un niveau minimal de santé semble nécessaire pour qu'une famille comprenne qu'elle peut régler son comportement démographique (cité dans la Fédération internationale de la famille planifiée, 1970, p. 1 voir également l'Organisation Mondiale de la Santé, 1972 : 74).

Il n'y a pas loin de cette conclusion à la recommandation selon laquelle les programmes pour faire diminuer la mortalité infantile et celle des enfants devraient être entrepris en vue de faire baisser la fécondité. Une recommandation de ce genre a été formulée avec une grande netteté par une commission de démographes fort distingués sous les auspices de l'Académie nationale américaine des sciences en 1971. La Commission présidée par Roger Revelle a exprimé l'avis que "les politiques et programmes visant à faire tomber la mortalité infantile et celle des enfants bien au dessous des niveaux actuels constituent un élément essentiel des programmes du gouvernement pour limiter la fécondité" (87). Il a déclaré également que "comme les taux de mortalité tombent au-dessous de 10 à 15 p. 1000 dans les pays caractérisés actuellement par une forte fécondité et une forte mortalité, les taux de natalité devraient diminuer en conséquence" (95). Cependant, dans une séance plénière de la Conférence internationale de la population qui s'est tenue à Liège en 1973, Ansley Coale, là encore, a quelque peu nuancé ces affirmations. A propos du passé de l'Europe, tel qu'il apparaît dans le projet sur la fécondité européenne organisé par l'Université de Princeton, Coale a remarqué que le déclin de la mortalité et celui de la fécondité dans les régions européennes ne prouvent nullement que le changement de la mortalité a exercé une influence importante sur la fécondité dans la plupart des populations.

Les démographes et les instituts de recherche démographique s'accordent donc plus ou moins sur le fait que la mortalité exerce une influence sur la fécondité. Les preuves données pour soutenir les diverses théories émises à ce sujet sont loin d'être concluantes. Les analyses par régression portant sur divers pays se heurtent à de sérieuses objections. La mortalité et la fécondité dépendent en effet l'une et l'autre d'autres variables. Il y a en outre des possibilités d'erreurs de mesure et les variables indépendantes peuvent évoluer de

manière colinéaire. Comme dans certains cas la fécondité a baissé avant la mortalité, il est évident que la mortalité n'est pas la seule influence qui s'exerce sur la fécondité. En fait rares sont les spécialistes qui soutiennent qu'il existe une relation directe entre elles. Ainsi que l'expriment Brass, Cantrelle et leurs collaborateurs dans la communication qu'ils ont faite pour le présent Séminaire, il ne serait guère réaliste de vouloir dégager de l'ensemble des données la relation subtile qui existe entre mortalité et fécondité. Des données de ce genre peuvent inciter à la recherche mais elles ne sauraient être décisives. Tant que les démographes ne sont pas descendus au niveau de la famille, les recherches sur ces questions n'ont guère progressé. C'est à ce niveau, c'est-à-dire à celui du couple procréateur, que le Séminaire apporte une contribution importante. Les communications de Knodel, Lery et Vallin, Cantrelle, Ferry et Mondot, Chowdhury, Khan et Chen, Agrawal, Rutstein et Medica, ainsi que celle de Heer et Wu résument et élargissent les connaissances que l'on a des relations qui existent au niveau de la famille entre la mortalité et la fécondité dans la plupart des régions du monde. Les communications de Brass, Retherford et Venkatacharya montrent admirablement comment ces résultats peuvent être élaborés et interprétés. Les communications de Matthiessen et Lapham, Wright et Quandt se limitent soit de propos délibéré soit par nécessité aux relations qui existent au niveau global, dans des circonstances différentes. Elles complètent à maints égards et de manière fort utile les résultats obtenus au niveau de la famille.

Tous ces travaux reconnaissent que la mortalité peut affecter la fécondité de quatre manières différentes :

– par des mécanismes involontaires ou biologiques du fait de l'interruption de la lactation qui suit un décès d'enfant, ce qui conduit à un retour plus rapide de l'ovulation.

– par un acte volontaire de la part des familles. Il est alors difficile de distinguer entre la réaction au décès de l'enfant (motivation de remplacement) et le comportement qui vise à prévoir les décès qui se produiront par la suite (motivation d'assurance).

– enfin il faut tenir compte des réponses de la société, c'est-à-dire de la réorganisation des structures sociales produites par le déclin de la fécondité. Ces influences s'exercent sur la fécondité par un changement de l'attitude de la société vis-à-vis de la reproduction et les couples en sont affectés. En réalité, ces mécanismes agissent tous ensemble et réagissent les uns sur les autres. C'est pour la clarté de l'analyse que nous les distinguerons et les présenterons séparément.

Conséquences de l'évolution de la mortalité sur la croissance

Dans les pages qui suivent, nous nous efforcerons d'indiquer pour chacune de ces quatre espèces d'influence les implications qu'ont sur la croissance les relations qui ont été mises en lumière par les travaux de base. La question spécifique qui nous aidera à organiser et à élaborer les résultats est la suivante : compte tenu des relations empiriques qui ont été établies, quelle peut-être l'influence que peut vraisemblablement exercer sur les taux nets de reproduction un changement permanent de la mortalité ? En d'autres termes, dans quelle mesure l'augmentation à long terme des taux d'accroissement qu'entraîne une baisse de la mortalité peut-elle être compensée par une diminution de la fécondité ? On présentera des cas extrêmes ou la fécondité est clairement déterminée par la mortalité afin de fixer les limites inférieures de l'augmentation de la croissance lorsque celle-ci est liée au déclin de la mortalité. Nous n'examinerons pas les effets de l'amélioration de la santé des adultes et du recul de leur mortalité. Ces progrès entraînent en effet une hausse de la fécondité du fait de l'augmentation de la proportion des femmes mariées qui survivent à la fin de la vie féconde, de la diminution du nombre des fausses couches, de l'augmentation de la fécondabilité et de celle de la valeur des enfants susceptibles de venir en aide à leurs parents sur leurs vieux jours (voir Ridley et autres, 1967 ; Ryder, 1955, Basavarajappa, 1962 ; Immerwahr, 1967). Pour la même raison, il ne sera pas question ici de la possibilité signalée par Retherford. Selon cet auteur, la baisse de la mortalité fait augmenter le nombre désiré d'enfants survivants car la quantité de services que ceux-ci peuvent rendre tend à s'accroître.

Nous utiliserons beaucoup une formule approximative mise au point par Coale (1972 : 18).

$$\mathrm{TNR} = p(30) \cdot \frac{\mathrm{ISF}}{1 - \mathrm{RMN}}$$

ou : TRR = Taux net de reproduction

$p(30)$ = probabilité de survivance des femmes à l'âge de 30 ans

ISF = Indice synthétique de fécondité : c'est-à-dire nombre moyen d'enfants mis au monde pour une femme qui atteint la fin de sa vie féconde

RMN = rapport de masculinité à la naissance $\left(\frac{\text{garçons}}{\text{filles}}\right)$

Quand le taux de mortalité infantile change d'une quantité Δ TMI et que les autres taux de mortalité restent constants, *p* (30) change approximativement d'une quantité égale à 1 – Δ TMI. Ainsi, quand le taux de mortalité infantile tombe de 200 p. 1000 à 150 p. 1000, *p* (30) augmente d'environ 5 %. A moins que le nombre moyen d'enfants par femme baisse d'au moins 5 %, le recul de la mortalité entraîne une augmentation du taux net de reproduction.

1) Conséquence du changement de la mortalité sur l'accroissement en combinaison avec les mécanismes involontaires.

La mortalité peut exercer une forte influence sur la fécondité même en l'absence de limitation des naissances. Dans les populations où l'allaitement est courant et où il est pratiqué pendant plus de quelques mois, l'effet d'inhibition qu'il exerce sur l'ovulation provoque un allongement de l'intervalle qui sépare la naissance précédente de la suivante si le dernier né dans le couple survit à la période d'allaitement. Knodel montre que la durée qui s'ajoutait à l'intervalle entre naissances dans les populations avant le 20e siècle allait de 0,2 mois dans celles où l'allaitement était peu pratiqué à 12,9 mois si l'allaitement était poursuivi jusqu'à une période postérieure au deuxième anniversaire de l'enfant. Les estimations de cette durée dans des régions de certains pays peu développés atteignent la limite supérieure indiquée ci-dessus ; il s'agit de 12 mois au Sénégal d'après Cantrelle et ses collaborateurs et de 13 mois au Bangladesh d'après Chowdhury, Khan et Chen. Par contre, Rutstein et Medica montrent que l'allongement de l'intervalle dans les régions rurales et semi-urbaines du Pérou, de la Colombie, du Mexique et du Costa Rica est proche de la limite inférieure puisqu'il n'est que de 3,5 à 6,2 mois. D'après d'autres indications, la durée de l'allaitement apparaît plus courte dans ces populations.

L'allongement bien connu des intervalles entre naissances qui provient de la survie d'un enfant pourrait être en partie attribué à des différences dans les conditions de logement, au fait que les époux dorment ou ne dorment pas ensemble, à la fréquence des rapports sexuels, à la fatigue des parents lorsqu'un enfant survit. L'usage de la contraception peut également jouer un rôle. C'est ce qui a été observé au Punjab (Potter et autres, 1965). Cependant, il est hors de doute que l'influence de la survie de l'enfant se fait surtout sentir par l'effet qu'exerce la lactation sur le retard de la reprise de l'ovulation (Potter et autres, 1965 : 379). Dans la mesure où les parents, conscients de ce mécanisme biologique, utilisent l'allaitement à des fins de contraception, il est inexact de parler de mécanisme "involontaire". Il vaudrait mieux considérer ce phénomène comme un cas particulier de réponse volitive.

Bien que la mortalité infantile ait un effet primordial sur la fécondité, il est manifestement impossible que l'évolution de la fécondité puisse tout à fait compenser celle de la mortalité. L'intervalle entre la dernière naissance et celle qui suit est raccourci par le décès d'un enfant mais il ne peut être réduit à zéro. Les enfants ne peuvent être remplacés instantanément du fait du temps qu'il faut pour qu'une femme soit enceinte, de celui nécessaire à la gestation et de la possibilité des fausses couches. On peut estimer l'importance de la compensation en modifiant un modèle mis au point par Perrin et Sheps. Dans ce modèle, le nombre moyen d'enfants nés au cours de la vie d'une femme est considéré comme le rapport de la durée de sa vie féconde, exprimée en mois, au nombre moyen de mois qui se sont écoulés entre les naissances. Plusieurs composantes de l'intervalle moyen entre naissances sont prises en compte :

– le temps moyen d'attente jusqu'à ce que survienne la conception pour une femme susceptible d'être fécondée

– la période moyenne de stérilité au cours de la grossesse

– et la période moyenne de stérilité qui fait suite à la fin de la grossesse. Nous pouvons faire intervenir la mortalité infantile dans le modèle en faisant varier la période de stérilité qui suit une naissance vivante selon que l'enfant survit ou non au cours de ses premières années.

Le modèle complet est le suivant :

$$ISF = \frac{N}{A + S_0 + TMI\,(S_1) + (1 - TMI)\,(S_2) + K\,(A + S_3)}$$

ou : N est la durée totale de la vie féconde de la femme

A = Le temps moyen d'attente avant une grossesse pour une femme susceptible d'être fécondée.

S_0 = La période de stérilité au cours d'une grossesse qui aboutit à une naissance vivante

S_1 = La période de stérilité après une naissance vivante suivie d'un décès d'enfant

S_2 = La période de stérilité après une naissance vivante suivie de la survie d'un enfant

S_3 = La période de stérilité pendant et après une grossesse aboutissant à un mort-né

TMI = Le taux de mortalité infantile

K = Le rapport de la probabilité d'avoir un mort-né à celle d'avoir un enfant né vivant.

L'influence de la mortalité infantile sur la fécondité peut être mise en lumière en faisant varier cette dernière expression par rapport à TMI ; on obtient de la sorte :

$$\frac{d\,\mathrm{ISF}}{\mathrm{ISF}} = \frac{(S_2 - S_1)}{I} \,.\, d\,\mathrm{TMI}$$

où I est la durée moyenne des intervalles entre naissances.

Cette expression répond de manière très simple à notre question. Le changement proportionnel de fécondité sera égal au changement de la mortalité infantile c'est-à-dire à l'équivalent du changement proportionnel de *p* (30) fois le facteur, $(S_2 - S_1)$ / I. Ce dernier facteur est la différence entre les périodes stériles associées à la naissance d'un enfant survivant en opposition à celle d'un enfant qui meurt exprimée sous forme de proportion par rapport à l'intervalle complet moyen entre naissances. Ce facteur doit être inférieur à l'unité : il ne pourrait égaler celle-ci que si l'enfant mort pouvait être remplacé instantanément en éliminant la période d'attente avant la nouvelle conception et la période de grossesse elle-même.

Ainsi qu'il a été indiqué plus haut, la valeur la plus élevée de $(S_2 - S_1)$ dans une population a été observée par Chowdhury, Khan et Chen au Bangladesh où elle atteint 13 mois. Comme l'intervalle minimal moyen entre naissances dans une population où l'allaitement est prolongé n'est certainement pas inférieur à 26 mois, on peut affirmer, en toute certitude, que la réponse maximale de la fécondité à la baisse de la mortalité infantile résultant de ce mécanisme est de 50 %. Ceci revient à dire qu'on peut concevoir que jusqu'à la moitié de l'accroissement du taux net de reproduction provenant d'une réduction de la mortalité infantile pourrait être éliminée par des réductions compensatrices de la fécondité. Un niveau plus probable de réponse dans des populations où l'allaitement prolongé est pratiqué est indiqué dans l'analyse de Potter sur les intervalles entre naissances au Punjab. $(S_2 - S_1)$ y était égal à 9 mois et I à 30 mois ; cette combinaison produirait une réponse compensatrice de 30 % (Potter et autres, 1965 : 394). A en juger par les résultats de Rutstein et de Medica, une réponse bien moindre pourrait être attendue en Amérique latine.

Il semblerait que la réponse compensatrice serait la plus forte là où les niveaux d'alimentation de la mère et de l'enfant sont le plus bas. Les effets d'inhibition de la lactation sur l'ovulation sont les plus forts dans ces populations, encore que les résultats sur ce point ne soient pas encore très concluants (Salber, 1966 ; Chen et autres, 1974 ; Chowdhury, Khan, et Chen). On peut s'attendre également à ce que l'effet soit plus fort parmi les paysannes illettrées et relativement âgées car, ainsi que le montrent Cantrelle et ses collaborateurs pour certaines régions d'Afrique, l'allaitement lui-même tend à être plus court et à devenir moins courant au cours du processus de modernisation. Mais pour aucune population on ne peut s'attendre à ce que la plus grande partie de l'augmentation de l'accroissement soit compensée par une baisse de la fécondité. La réponse de la fécondité à un changement permanent de la mortalité provenant de ces mécanismes devrait être rapide et survenir au cours de la durée moyenne de l'intervalle entre naissances, c'est-à-dire entre 2 et 4 ans.

2) Conséquences du changement de la mortalité sur l'accroissement en combinaison avec les réponses volitives des couples considérés séparément

La section précédente excluait l'éventualité où les couples pratiqueraient la contraception afin de parvenir à certains buts qu'ils s'étaient fixés quant à la dimension de la famille. Du fait de ces buts et de ces comportements, les interactions entre la fécondité et la mortalité se compliquent énormément. Nous ne traitons ici que des couples dont les désirs quant à la dimension de la famille sont exprimés par le nombre d'enfants survivants à un moment donné défini par l'âge des parents. C'est ce que nous appellerons "l'âge critère". Il s'agit d'un âge qui se situe à l'intérieur de la période féconde. La plupart du temps, les parents pour parvenir à la dimension de la famille qu'ils se sont fixée ne font autre chose que réagir d'une certaine façon lorsqu'un de leurs enfants meurt en bas âge ou survit. Nous analyserons cette condition en la désignant par le terme "effet de remplacement". Lorsque "l'âge critère" est situé au delà de la période féconde, quelque incertitude est introduite, cependant, quant à la survie des enfants. La prévoyance devient nécessaire et les idées que l'on se forme à l'égard de la mortalité des enfants dans les années à venir se fondent non seulement sur l'expérience des parents sur cette question mais aussi sur la manière dont ils perçoivent les niveaux de mortalité de la communauté. Du fait de cette incertitude, les parents doivent envisager des possibilités tout autres que celles qu'ils désirent le plus, ce qui affecte leur comportement. Nous analyserons cette condition en la désignant par le terme "effet d'assurance".

2a) Effet de remplacement

Si les parents se proposent d'avoir à la fin de leur vie féconde un certain nombre d'enfants survivants, C, que l'on suppose connu et s'ils pouvaient avoir et éviter des enfants à leur gré, ils auraient alors, de manière certaine, un nombre C d'enfants vivants à la fin de leur vie féconde. Chaque enfant décédé serait "remplacé" par une naissance vivante. Il est surprenant que, même dans ce cas imaginaire, le remplacement "complet" entraînera une augmentation des taux nets de reproduction à mesure que baisse la mortalité. La raison en est que les couples ne parviennent au nombre d'enfants désirés que tant que la femme n'a pas atteint 45 ans ou

environ. Les enfants auront alors 15 ans ou environ. Mais l'âge auquel le fait de survivre affecte le TNR est beaucoup plus élevé que 15 ans (on peut admettre 30 ans d'après les estimations les plus courantes). Comme le recul de la mortalité porte en général sur tous les groupes d'âge, un nombre égal de personnes de 15 ans produit un nombre relativement plus élevé de personnes de 30 ans dans une population où la mortalité est en baisse. C'est pourquoi le recul de la mortalité entraîne une augmentation du TNR. Très approximativement, on peut estimer que le taux net de reproduction après un déclin de la mortalité s'élèvera de manière proportionnelle au rapport entre la population des survivants à 30 ans et celle des survivants à 15 ans. Lorsque l'espérance de vie à la naissance passe de 35 à 70 ans, ce rapport est d'environ 1,152 selon les tables de mortalité "moyenne" (table de mortalité féminine, modèle Ouest de Coale et Demeny, 1966 : 8 et 22). Même si les enfants décédés sont complètement remplacés, un recul de la mortalité de cette importance augmente le taux net de reproduction de 15 %. Comme il augmenterait d'environ 104 %, si aucune adaptation de la fécondité ne se produisait (estimation fondée sur une comparaison de *p* (30) dans le même ouvrage), il apparaît clairement que le mécanisme du remplacement complet élimine environ 85 % de l'accélération de la fécondité provoquée par le déclin de la mortalité. Naturellement, la compensation serait complète, si le recul de la mortalité se limitait aux jeunes enfants.

On ne peut imaginer que les femmes cherchant à avoir un nombre donné d'enfants lors de la fin de leur période féconde puisse remplacer complètement ceux qui meurent. Lors du décès de leur enfant, elles peuvent avoir perdu leur mari ou être devenues peu fécondes ou stériles. Plus important encore, dans les pays où la fécondité désirée est forte, elles peuvent être encore occupées à mettre au monde et à élever les enfants qui auraient été nécessaires pour atteindre le but qu'on se proposait, même si l'enfant n'était pas mort. Manifestement, si le nombre désiré d'enfants survivants est égal ou supérieur au nombre maximal de naissances qui peuvent survenir au cours de la vie féconde d'une femme, il ne saurait y avoir d'effet de remplacement. L'importance de l'effet de remplacement devrait donc être influencée par les buts qu'on se propose quant à la dimension de la famille et par les causes qui déterminent ceux-ci, c'est-à-dire le niveau d'instruction de la femme et sa résidence urbaine ou rurale. Lorsqu'on considère l'influence qu'elle exerce sur la fécondité, la mortalité doit être examinée d'après l'interaction qu'elle a avec ces causes déterminantes et non comme un élément séparé qui vient s'ajouter à celles-ci.

Les effets de la motivation de remplacement en présence de ces obstacles à la reproduction sont trop complexes pour qu'on puisse les représenter sous forme de solutions simples. Il faut donc utiliser la simulation. Venkatacharya est le premier à avoir utilisé une stratégie qui se rapproche de celle que nous avons définie comme une motivation de remplacement dans un modèle très complet qui tient compte de la baisse de la fécondabilité avec l'âge, des périodes de stérilité et de la mortalité intrautérine. En supposant qu'un couple procrée jusqu'à ce qu'un fils atteigne l'âge de 10 ans, il montre que, dans les conditions qui prévalent en Inde (simulations C_6), les réductions permanentes de la mortalité produisent des augmentations plus importantes des taux nets de fécondité. Lorsque l'espérance de vie féminine passe de 35 à 75 ans, le TNR passe de 1,37 à 2,24, c'est-à-dire qu'il augmente de 64 % (Tableau 5). L'indice synthétique de fécondité ne baisse que de 7 % ce qui n'est guère suffisant pour compenser les effets du recul de la mortalité. Ces résultats ne changent pas de manière significative si on utilise des stratégies similaires ou si on se sert de niveaux différents pour les paramètres de la reproduction.

Comme il a été remarqué plus haut, l'importance du remplacement devrait être plus grande dans les pays où la dimension souhaitée de la famille est assez basse. Le décès d'un enfant tendrait à s'y produire relativement tôt dans la vie génésique des femmes. Les obstacles à la reproduction y seraient en outre moins courants. Enfin les années fécondes de la femme n'y seraient pas si complètement occupées à mettre au monde des enfants destinés à atteindre le but que se proposent les parents quant à la dimension de la famille. Ces prévisions se sont révélées exactes ainsi que le montrent les communications de base qui traitent de ce qui a été observé sur le remplacement des générations. Une grande variété de mesures ont été utilisées pour examiner de quelle façon le remplacement est assuré et elles ne sont pas parfaitement comparables entre ces diverses études. Dans tous les cas les auteurs ont reconnu la nécessité d'étudier l'effet de remplacement de manière prospective en se plaçant à une certaine période du cycle reproductif des femmes afin de réduire au minimum l'influence perturbatrice de la fécondité sur la mortalité. Ils ont aussi reconnu qu'il était nécessaire d'éliminer les effets qui se font sentir par l'intermédiaire du mécanisme involontaire, bien qu'en pratique cette élimination n'ait pas toujours été possible.

Knodel découvre des preuves de la motivation de remplacement en examinant la durée de l'intervalle entre la deuxième et la troisième naissance en fonction du décès ou de la survie du premier né. Cet intervalle était, en général, plus court chez les femmes dont le premier né était mort et la différence était plus importante dans les populations pour lesquelles on sait que la limitation des naissances était répandue (c'est-à-dire dans celles où l'effet du remplacement potentiel est le plus fort). Brass fait ressortir qu'un biais possible dans ces analyses tient aux variations de fécondabilité parmi les femmes. Les femmes très fécondes tendent à avoir des intervalles entre naissances courts et ces intervalles courts entraînent une plus forte incidence de la mortalité infantile. Ainsi donc, la corrélation apparente entre intervalles et mortalité peut être trompeuse car elle tiendrait au fait que ces deux phénomènes dépendent de la fécondabilité. Cependant, un biais de ce genre

devrait être à son maximum dans les populations où la limitation des naissances est peu répandue alors que les résultats de Knodel indiquent que c'est dans ces populations que l'effet sur les intervalles est le plus faible.

Knodel compare également la probabilité d'agrandissement des familles (c'est-à-dire la proportion des femmes qui, parvenues à un nombre déterminé d'enfants, ont une nouvelle naissance) chez les femmes, en fonction du nombre d'enfants qu'elles ont perdus avant d'atteindre une parité donnée. Les résultats confirment en général l'analyse des intervalles. Les effets sont le plus fort, dans le sens attendu, là où la limitation des naissances est solidement confirmée à partir d'autres sources. Chowdhury, Khan et Chen adoptent une approche intéressante qui combine les intervalles et la probabilité d'agrandissement des familles. Ils dressent des tables analogues aux tables de mortalité qui montrent la proportion des Pakistanaises qui sont passées de la parité x à la parité $x + 1$ selon les intervalles depuis que la parité x a été atteinte. Pour les femmes qui avaient perdu un enfant avant de parvenir à une parité allant de la 2e à la 5e , l'intervalle médian entre la naissance précédente et la suivante était plus court que chez les femmes n'ayant pas perdu d'enfants avant d'atteindre cette parité. Les femmes ayant perdu un enfant *après* avoir atteint la parité x étaient exclues de la table de sorte que les résultats ne sont pas affectés par la corrélation positive qui existe entre l'incidence des décès d'enfants et les naissances successives de la femme. Cependant, les variations de la fécondabilité peuvent encore jouer un rôle. L'allongement médian de l'intervalle suivant qui tient au fait qu'aucun enfant n'est mort est très court – on observe un maximum de 4 mois pour la 4e naissance (tableau 6) – et des différences encore plus faibles ont été calculées à partir des données provenant du Bangladesh (tableau 8). Par conséquent, Chowdhury, Khan et Chen sont tentés de voir dans ces résultats la preuve qu'il n'y a pas de changement de comportement en réponse au décès d'un enfant. Il apparaît très clairement d'après leurs résultats que l'importance quantitative de l'effet de remplacement, s'il existe au Pakistan et au Bangladesh, se classe loin derrière les mécanismes involontaires.

Les études dont traitent Rutstein – Medica et Heer – Wu introduisent, à des fins de contrôle statistique, des données portant sur la situation socio-économique des parents. Ils examinent également d'autres variables dépendantes telles que l'utilisation de la contraception et la dimension désirée de la famille. La variable dépendante est la probabilité d'agrandissement des familles ajustée pour tenir compte du temps écoulé depuis la dernière naissance. Le détail des séquences chronologiques de Chowdhury et Khan n'est guère valable pour observer l'effet de remplacement dans un cadre multivariate très complet des composantes de la fécondité. Ces études sont les plus complexes de celles qui ont été présentées dans ce Séminaire. Nous nous bornerons à en donner un bref résumé. En général les résultats de ces études sont conformes à l'attente. C'est bien, en effet, dans les populations où la dimension souhaitée de la famille est la plus faible que l'effet de remplacement est le plus fort. Heer trouve que, dans les campagnes de Formose, parmi les trois premières naissances le décès d'un enfant au cours d'une période allant jusqu'au 1er anniversaire du dernier de ces trois enfants entraîne 0,285 naissance de plus après la troisième naissance que si aucun décès ne s'était produit. Cependant les naissances ultérieures sont moins nombreuses si deux enfants sont morts et non un seul (p. 15). L'effet de remplacement est apparemment faible et se fait sentir à rebours pour les décès autres que celui du premier né. Les résultats doivent être interprétés avec prudence car les femmes interrogées n'étaient pas toutes parvenues au terme de leur vie féconde et elles pouvaient encore adopter un comportement favorable au remplacement (cependant, après la naissance d'un troisième enfant, ces femmes n'avaient plus qu'une durée médiane de 11,9 ans pour avoir d'autres enfants (p. 12). De plus quelques-uns des enfants décédés ou proches de la mort ont pu être déjà "remplacés" sans que la femme aille au delà d'une troisième naissance. Il pourrait en être ainsi seulement au cas où la dimension projetée de la famille est d'un ou deux enfants. Il convient de remarquer que, selon Rutstein (en 1974), qui utilise un échantillon plus petit mais représentatif de l'ensemble de l'île et une technique de projection destinée à suivre les femmes jusqu'à la fin de leur vie féconde au moyen de cohortes synthétiques, l'effet des décès d'enfants sur la fécondité ultérieure à Formose est plus important. Cependant, dans les résultats présentés par Rutstein, l'effet de remplacement est confondu avec le mécanisme involontaire. Heer élimine celui-ci en partie en tenant compte de la durée moyenne d'allaitement.

Les désirs de remplacement étaient plus importants que le comportement de remplacement parmi les personnes interrogées par Heer et Wu. Le décès d'un fils dans les familles qui en ont déjà eu un ou deux produit une augmentation du nombre moyen désiré de naissances complémentaires qui s'élève à 0,6 ou 0,7 (p. 24) alors que la perte d'une fille provoquait un effet moins fort. La disparité entre le changement de désir et le changement réel de comportement peut être attribuée à des facteurs qui ont été mentionnés plus haut : la réduction des probabilités d'action sur les désirs de remplacement dans une vie reproductive qui est déjà très chargée. Iskandar et Jones, en 1975, trouvent des effets analogues en Indonésie. Ils montrent que, dans presque toutes les régions et pour chaque parité, les femmes qui ont perdu des enfants auront probablement plus d'enfants que celles qui n'en ont pas perdu.

Rutstein et Medica examinent pour la première fois l'influence de la mortalité des enfants sur la fécondité au niveau des couples en Amérique latine. Appliquant des techniques analogues aux données de l'enquête du CELADE pour les zones rurales et semi-urbaines de la Colombie, du Costa Rica, du Mexique et du Pérou, ils peuvent montrer que l'effet de remplacement y est partout beaucoup plus faible que l'indiquaient les résultats antérieurs de Rutstein pour Formose. C'est au Costa Rica que les effets de

remplacement sont les plus importants, allant jusqu'à 0,39 naissance supplémentaire pour les femmes ayant perdu un enfant par comparaison à celles qui n'ont perdu aucun de leurs quatre premiers enfants. Au Mexique et en Colombie, les effets de remplacement étaient nuls ou même légèrement négatifs. C'est là un résultat surprenant car les effets mesurés comprennent aussi les influences involontaires. Dans ces régions cependant, la durée de l'allaitement semble assez courte. Le Pérou où elle est la plus prolongée, vient en seconde place pour l'effet de remplacement. En faisant abstraction de ce cas dont la particularité semble aisément explicable, les résultats confirment le fait que les effets de remplacement sont les plus forts dans les régions où la fécondité est faible et où l'usage de la contraception est répandu, c'est-à-dire Formose et le Costa Rica. Il existe cependant une exception qu'il n'est guère facile d'expliquer : le Maroc urbain. Heer y estime l'effet de remplacement à 0,70 si l'un des trois premiers enfants est mort. Dans son étude, on ne tient pas compte du mécanisme de remplacement mais nous avons vu qu'il ne pouvait pas expliquer un effet supérieur à 0,35. Toutefois, les variations de la durée d'allaitement, ainsi que celles de la fécondabilité peuvent jouer un certain rôle. Les femmes qui ont allaité pendant des périodes courtes sans tenir compte de la survie de l'enfant ont plus de probabilités de perdre un enfant mais l'allongement de la période où elles peuvent concevoir serait beaucoup plus important que ne l'implique ce décès.

Enfin, Lery et Vallin montrent l'influence de la mortalité infantile sur la fécondité ultérieure dans un pays de faible fécondité, la France. Utilisant un très vaste échantillon, celui des femmes nées de 1892 à 1916, ils démontrent, de manière très convaincante, que la probabilité d'agrandissement des familles est plus forte de 19 à 28 % quand l'enfant est mort en bas âge que s'il survivait lors de l'enquête en 1962. Ils montrent également que le décès d'un enfant en bas âge accélère la venue de l'enfant suivant de 6 à 12 mois. Ces résultats indiquent une réponse considérable au décès d'un enfant mais on ne peut estimer, d'après ces chiffres, l'importance du remplacement.

En somme, aucun effet de remplacement parmi tous les cas étudiés n'était complet ; cet effet tendait à être relativement fort dans les pays où la fécondité projetée par les couples était faible ; et même lorsque le remplacement est complet, le taux net de reproduction tend à augmenter à mesure que baisse la mortalité. L'absence de remplacement complet peut être attribuée à bien d'autres facteurs que le manque des possibilités. En premier lieu, quelques-unes des conceptions qui ont abouti à un décès d'enfant peuvent avoir été non désirées ; le décès d'un enfant peut provoquer une réaction négative à l'égard de la procréation ; d'autre part, les parents ne se sont peut-être pas fixé de but relativement à la dimension de la famille en termes d'enfants survivants.

Quand le niveau de la mortalité change, l'effet de remplacement doit modifier la fécondité dans une période de temps égale à la durée de vie féconde qui reste aux femmes. Le décalage ne peut excéder 30 ans et on peut présumer qu'il est d'autant plus court que la fécondité projetée par les couples est plus basse.

2b) Effet d'assurance

Si les parents se proposent d'avoir un certain nombre d'enfants vivants à un point donné qui soit postérieur à la fin de leur vie féconde, ils doivent faire une projection, même grossière, des risques de décès auxquels leurs enfants seront exposés. Il s'agit là d'une prévision plutôt que d'une réaction. Dans la mesure où leur prévision est fondée sur l'expérience qu'ils ont eue quant à la survie des enfants, ses effets devraient être pris en considération pour estimer les effets de remplacement dont il vient d'être question. Comme nous l'avons vu, ces effets ne peuvent suffire à assurer le remplacement des enfants qui meurent. Cependant, l'idée que les parents se font de la mortalité peut avoir des fondements plus solides en s'appuyant sur le niveau de mortalité qu'ils remarquent dans les familles de leurs amis ou dans celles qui prévalent dans le milieu où ils vivent.

La motivation d'assurance fournit l'un des cheminements par lequel la compensation de la fécondité peut être plus complète (Schultz, 1969 ; Preston, 1972). Comme l'avenir est incertain, le nombre d'enfants survivants à l'âge pris comme critère ne peut être prévu avec une parfaite exactitude. Les parents doivent donc considérer l'attrait de résultats autres que C ; c'est-à-dire celui qui est le plus désiré. Si les résultats supérieurs à C sont plus attrayants que ceux qui se situent à une distance équivalente au dessous de C, la plus grande variance du nombre d'enfants survivants lorsque la mortalité est forte peut exercer un effet réciproque sur cette fonction de préférence, de telle manière que l'influence du changement de mortalité s'en trouve exagéré.

Ce mécanisme ne peut jouer lorsque la fonction de préférence pour les enfants n'a qu'une valeur différente de O, au point C (en fait on peut la représenter par une pointe). Dans ce cas on peut prouver que le nombre de naissances, N, qui porte au maximum la possibilité d'atteindre le but, C, si chaque enfant est soumis à une probabilité P de survivre jusqu'à l'âge critère, est exprimé par la formule :

$$N = C/P.$$

Les changements proportionnels de la mortalité (P) seraient exactement compensés par ceux de la fécondité. Le taux net de reproduction ne serait pas affecté par le changement de la mortalité si l'on fait abstraction des mécanismes relativement peu importants notés dans la section 2a. Si l'âge-critère est 60 ans, le

TNR ne serait pour ainsi dire pas affecté ; s'il est bien supérieur à 60, il répondrait négativement à un changement de P.

Dans le cas plus général et plus réaliste où les valeurs différentes de zéro sont attachées à différents aboutissements, la fécondité peut répondre de manière très vive ou très molle à un changement de la mortalité. Tout dépend de l'allure de la fonction de préférence. Pour illustrer ce point, nous utiliserons une fonction de préférence mise au point par Myers et Roberts (en 1968) se rapportant à 18 Portoricaines auxquelles on demanda de classer leurs préférences relativement à la dimension de la famille dans 1176 paires hypothétiques de combinaisons garçon-fille. Le résultat moyen de la préférence relatif à la dimension de la famille achevée allant de 0 à 12 enfants était : 0,64, 0,88, 1,62, 1,52, 1,56, 1,12, 1,02, 0,92, 0,92, 0,81, 0,75, 0,76. L'aboutissement le plus désiré était 2 mais la distribution était clairement biaisée vers la droite et tous les autres résultats venaient avant O enfant. Etant donné cette fonction et en supposant que la survie d'un enfant est un processus binomial avec une probabilité de réussite (survie jusqu'à l'âge critère) pour chaque essai de P, nous pouvons demander quel serait le nombre de naissances qui porterait au maximum la valeur attendue de la dimension de la famille. Quand P = 0,5, le nombre optimal est 6. Pour P = 0,6, c'est 5 ; pour P = 0,7, 0,8, 0,9, c'est 4 et pour P = 1,00, c'est 2. Le nombre optimal de naissances n'est guère affecté tant que P n'atteint pas 0,9. Au-dessus de cette valeur il répond très vivement à une plus forte baisse de la mortalité. Dans l'ensemble, un doublement des chances de survie réduit le nombre optimal de naissances des deux tiers. Finalement le déclin de la fécondité fait plus que compenser celui de la mortalité mais cet effet est masqué tant qu'on ne parvient pas aux environs de la mortalité la plus basse.

La simulation permet d'abandonner les suppositions dénuées de réalisme selon lesquelles les parents décident exactement combien ils auront d'enfants. Heer et Smith (en 1968), en supposant que les parents ont des enfants jusqu'à ce qu'ils soient sûrs à 95 % d'avoir au moins un enfant vivant quand le père aura 65 ans ont choisi un âge critère suffisamment élevé pour avoir la certitude que la motivation d'assurance joue un rôle d'importance primordiale. De plus, leurs suppositions relatives au but qu'ils se fixent en matière de reproduction implique une fonction de préférence asymétrique pour laquelle on préfère aller au delà du but plutôt que de rester en deçà. En bref, leurs suppositions fournissent une possibilité d'avoir une réponse maximale de la fécondité à la mortalité. Conformément à l'attente, la stratégie supposée conduit à des taux nets de reproduction qui baissent dès que l'espérance de vie des femmes dépasse 40 ans environ. O'Hara (1972) introduit des considérations sur l'espacement optimal dans le modèle Heer-Smith et les résultats réduisent dans chaque cas le niveau du taux net de reproduction sans pour autant modifier la réaction au changement de la mortalité. Pour les niveaux actuels de l'espérance de vie, la réaction de la fécondité est plus que suffisante et le taux net de reproduction baisse lorsque la mortalité recule. La différence radicale de la réponse du taux net de reproduction au changement de la mortalité dans la simulation Heer-Smith par opposition aux résultats de Venkatacharya prouve abondamment que la distinction entre la motivation de remplacement et celle d'assurance est fondamentale. Dans ce cas, la simulation, bien qu'elle ne nous renseigne pas sur le comportement des couples, permet cependant d'identifier un paramètre qui dépend beaucoup de ce comportement et qui invite à poursuivre des recherches empiriques sur cette question.

Il est manifeste que pour pouvoir prédire l'importance des effets d'assurance, il faut avoir quelque idée sur les préférences des individus relativement au nombre d'enfants survivants ainsi que sur l'âge-critère et la gamme des âges. Les diagrammes faits par Myers et Roberts sur les Portoricaines sont fortement biaisés vers la droite et il y a lieu de penser que c'est là un trait typique des pays peu développés. Mais beaucoup reste à faire dans ce domaine et, dans l'ensemble, on est bien mal renseigné sur l'importance réelle de la motivation d'assurance. Les personnes interrogées à Formose par Heer et Wu ont répondu à des questions sur la conscience qu'ils avaient de la survie des enfants. Si on maintient constant le nombre de décès d'enfants dans la famille, les personnes qui estimaient que les probabilités qu'a un enfant d'atteindre l'âge de 15 ans sont inférieures à 85 % avaient 26 % d'enfants de plus (au delà du troisième) que ceux qui estimaient que cette probabilité était de 95 % ou davantage. Lorsque la dimension désirée de la famille est groupée autour de 4 enfants, comme c'est le cas à Formose, les personnes dont la probabilité subjective est de 80 % devraient avoir eu environ un enfant de plus que celles dont la probabilité est de 100 %, toutes choses étant égales d'ailleurs. L'effet réel d'assurance n'est que le quart de cette quantité ce qui indique une compensation incomplète pour la variation de la perception de la survie. Mais en fait les parents n'ont pas besoin de prévoir la mortalité des enfants pour tous les âges car ils savent déjà que certains d'entre eux ont survécu.

Il est donc difficile d'établir une norme qui permette de mesurer la totalité de l'effet de compensation. En outre, la fiabilité des réponses à la question relative à la survie était très faible. Heer et Wu montrent également que dans la zone de mortalité élevée, si on tient compte de l'influence du décès d'enfant et de la perception mesurée de la survie des enfants, les parents ont eu 0,35 enfant de plus après la 3e naissance que dans la zone de faible mortalité (p. 20). Pour savoir s'il s'agit d'une compensation complète, il faudrait connaître les différences de probabilités de survie entre les deux zones et ces données ne sont pas fournies par Heer et Wu. Si l'on suppose une différence proportionnelle de P (a^*) égale à 0,1, a^* étant l'âge critère, la différence réelle de fécondité avec la compensation complète devrait être de 0,4 enfant si la dimension désirée de la famille est de 4 enfants. La réponse réelle représenterait ainsi une compensation presque complète.

Comme les villages différaient à d'autres égards que la mortalité, il n'est peut être pas légitime d'attribuer l'effet du village entier à des différences de mortalité. Cependant on a tenu compte de la plupart des autres variables importantes au niveau de l'individu, et ce résultat, combiné avec l'effet de perception de la survie, fournit une preuve importante de la force potentielle de l'effet d'assurance. Rutstein (1974) met au point un indice de crainte de la mortalité des enfants pour les personnes interrogées à Formose et montre une corrélation positive entre cette crainte et la probabilité d'agrandissement des familles si on tient compte de l'expérience réelle relative à la mortalité des enfants. La nature de la variable ne permet pas d'estimer si ces effets représentent une compensation complète. Mais d'un autre côté, Heer et Wu ont trouvé qu'au Maroc l'impression que la mortalité des enfants avait reculé au cours de la dernière génération présente une corrélation positive avec le niveau de la fécondité.

Ainsi donc, il y a des raisons théoriques qui poussent à croire que lorsqu'elles dépendent du nombre d'enfants encore vivants lorsque les parents dépassent l'âge qui marque la fin de leur vie féconde, les intentions en matière de reproduction pourraient provoquer une réaction exagérée de la mortalité sur la fécondité. Les résultats dont on dispose pour Formose indiquent qu'en fait les effets empiriques peuvent être importants. A l'inverse des autres mécanismes dont il a été question, les limites du décalage de la réponse de la fécondité ne peuvent être fixées. Le temps de réponse ne dépend pas des conditions objectives mais de la perception de ces conditions et celle-ci peut survenir plus ou moins rapidement. La majorité des personnes interviewées dans diverses enquêtes faites dans des pays peu développés semblaient conscientes du recul récent de la mortalité. (Voir Heer et Wu, tableau 3). On ne peut savoir si la réponse est rapide et correspond à l'importance réelle du changement.

2c) Combinaison du remplacement avec les effets d'assurance

C'est pour plus de commodité pour l'analyse que nous avons séparé les effets de remplacement des effets d'assurance. Mais en fait, ils agissent souvent ensemble. Même pour les couples dont les buts de reproduction s'expriment par le nombre d'enfants survivants à quelque moment de leur vie féconde, une motivation d'assurance peut survenir s'ils savent que des obstacles à la reproduction peuvent se présenter avant la fin de la vie féconde ou qu'un décès peut se produire si inopinément qu'il empêchera le remplacement. D'un autre côté, les personnes dont l'âge critère se situe au delà de la fin de la vie féconde auront, en tous cas, la possibilité d'observer les décès qui se produisent alors qu'ils poursuivent leurs objectifs et d'y réagir. Plus l'âge critère des parents est élevé, plus l'effet d'assurance correspondant à l'effet de remplacement devrait être fort. Dans les pays où les fonctions primaires de la progéniture sont de fournir un soutien aux parents dans leur vieillesse, de perpétuer la lignée, de célébrer le culte funéraire, etc... les effets d'assurance devraient être relativement plus forts, pour un même niveau de mortalité que dans les pays où les parents ont des enfants pour des motifs désintéressés. (voir Retherford).

On peut s'attendre à ce qu'en tous cas les variations de la mortalité affectent la fécondité surtout du fait du mécanisme de remplacement plutôt que du fait du mécanisme d'assurance. La raison en est que la mortalité des enfants se produit surtout aux jeunes âges. A la fin de la vie féconde des parents, les enfants auront en moyenne de 10 à 15 ans. Ceux qui devront traverser les deux premières années de vie, de loin les plus dangereuses, seront relativement peu nombreux. Les parents doivent prévoir la survie des enfants non pas tout au cours de la période qui va de la naissance à l'âge adulte comme nous l'avons admis pour simplifier dans notre exemple mais au cours de la période où la mortalité est la plus faible. Même si une compensation trop forte se produit du fait des variations de la mortalité au cours de cette période relativement faible, la réponse peut entraîner une compensation incomplète par rapport au changement total de la mortalité infantile et de celle des enfants. Les parents pourront réagir aux changements de la mortalité parce que la grande majorité des décès antérieurs à l'âge critère se seront produits au cours de la vie féconde elle-même. Par exemple, si 10 enfants naissent à des intervalles de 2 ans à des femmes qui commencent à en avoir à l'âge de 20 ans dans une population où l'espérance de vie est de 35 ans, 74,5 % des décès qui se produiront parmi ces enfants avant 30 ans, surviendront avant que leur mère ait atteint 40 ans ; pour une espérance de vie de 60 ans, cette proportion est de 68,3 % (tiré de Coale et Demeny, 1966 : 8 et 18).

3) Conséquences sur la croissance du changement de la mortalité en combinaison avec d'autres mécanismes sociaux

Notestein et Davis estiment que dans les sociétés préindustrielles, d'une façon ou d'une autre, se forment des pratiques normatives qui assurent des niveaux moyens élevés de fécondité. Ces niveaux sont nécessaires pour contrebalancer une forte mortalité ; sans eux une société serait condamnée à l'extinction. Le mécanisme le plus important pour assurer la survie démographique est le système de la famille étendue qui décharge les époux du coût du mariage et les parents de celui des accouchements (Davis, 1955). C'est un truisme que de dire que la natalité doit être plus élevée que la mortalité pour que, dans une population fermée, la survie démographique soit assurée. Que pour y parvenir, une forte fécondité soit nécessaire suppose qu'une forte mortalité est chose naturelle qui n'est guère influencée par le niveau de la fécondité. Sans doute il s'agit là d'une simplification. Il est peut être plus exact de considérer que les populations adoptent, jusqu'à

un certain point la fécondité et la mortalité qui leur conviennent. Mais il n'en demeure pas moins que la fécondité minimale nécessaire à la survie était jadis beaucoup plus élevée que celle qui prévaut de nos jours dans la plupart des pays du monde.

Que se passe-t-il lorsque disparaissent les conditions qui nécessitent une forte natalité ? L'avantage sélectif dont bénéficient les populations ayant une forte fécondité disparaît également. Mais il faudrait des milliers d'années pour que les processus évolutifs qui sélectionnent les sociétés qui s'adaptent le mieux puissent jouer leur rôle ; l'adaptation optimale n'est pas apparente et la progression rapide vers quelque forme d'adaptation n'est guère évidente aujourd'hui. En bref, cette perspective ne nous permet de prédire utilement aucun événement qui se produirait dans un avenir pas trop éloigné du recul de la mortalité.

Une approche plus intéressante consiste à remarquer que les sociétés préindustrielles devaient faire face non seulement à une forte mortalité mais aussi à de grandes variations de mortalité et que les populations arrivaient très vite à leur effectif limite. Comme la surpopulation implique également une menace à la survie du groupe, et comme la mortalité était tout à fait imprévisible, on peut penser que, dans de nombreuses sociétés, des mécanismes se formèrent pour permettre à la fécondité de varier en même temps que la mortalité. Il est manifeste que cette adaptation est assurée par des mécanismes biologiques. La structure par âge de la fécondité et de la mortalité assurait une concentration des décès aux deux extrémités de la vie humaine, alors que la venue au monde des enfants se situait au milieu de la vie des femmes. Dans ces conditions, après une crise de mortalité, la structure par âge de la population devenait très favorable à une forte natalité et à une reprise rapide de la croissance démographique. La disparition de l'ovulation durant l'allaitement contribuait aussi à cette flexibilité.

Parmi les mécanismes sociaux de ce genre, les mieux connus sont probablement ceux qui ont trait à l'âge au mariage et à la proportion des personnes mariées. Mais la séparation des parents après une naissance et les tabous qui interdisent les relations sexuelles lors de l'allaitement peuvent aussi jouer un rôle important. En Europe s'implantèrent des normes sociales qui obligeaient le mari à pourvoir aux besoins de sa femme et de ses enfants. Ces coutumes allaient de pair avec un système agraire où les moyens de production, c'est-à-dire les terres, étaient dans l'ensemble très limités. C'est par ce système que les changements de la fécondité s'adaptaient à ceux de la mortalité. Une crise de mortalité augmentait le nombre des veufs et des veuves, des héritiers et héritières et les probabilités de se marier et d'avoir des enfants se trouvaient accrues pour les célibataires survivants. La clé du système était la propriété individuelle des terres et Greetz (1968) montre à partir de l'exemple de Java que l'on ne saurait espérer que la fécondité réponde au changement de la mortalité là où la terre est distribuée, entre tous les villageois, en tenant compte des besoins de la famille. Friedlander (1969) fait ressortir que, même lorsque le système matrimonial européen prévalait, la relation entre le niveau social de la fécondité et de la mortalité était atténuée là où il existait des "valves de sûreté" pour la pression démographique. Il estime que le long décalage observé entre le déclin de la mortalité et celui de la fécondité en Angleterre peut être attribué au fait qu'il y a eu simultanéité entre l'industrialisation et les possibilités de migration vers la ville qu'elle offrait. Les migrations transocéaniques, l'extension géographique de la base des ressources et l'intensification de la main-d'œuvre dans l'agriculture peuvent aussi, si les circonstances le permettent, offrir des valves de sûreté. Certaines de ces réponses peuvent elles-mêmes exercer une influence sur la fécondité. Par exemple, la migration des campagnes vers les villes expose une proportion croissante de la population à ce qui est d'ordinaire un contexte de basse fécondité.

Les communications de base fournissent de nouvelles preuves des relations qui existent, pour une population importante entre la mortalité et la fécondité bien que ces relations incluent nécessairement des facteurs individuels autant que sociaux. Matthiessen confirme le fait que l'évolution du déclin de la mortalité et de la fécondité en Europe au 19e et au 20e siècles présente de grandes particularités régionales. Cette diversité suffit à montrer que le recul de la mortalité ne fut pas la seule cause de la baisse de la fécondité au cours de cette longue période. Pour l'Ecosse, la France, l'Italie, le Portugal et l'Allemagne urbaine du 19e siècle, on observe de fortes relations transversales positives entre la fécondité régionale et les niveaux de mortalité. Ces relations demeurent même si on tient compte d'autres variables telles que l'alphabétisme. Cependant ces relations n'apparaissent pas pour l'Angleterre et la Belgique et l'analyse de Lesthaeghe (1974) à partir des données belges est sérieuse et probante.

Lapham et ses collaborateurs montrent la relation curvilinéaire et relativement forte qui existe entre le taux brut de natalité et la mortalité infantile dans 74 pays peu développés dans les années 60. A l'intérieur des pays et des régions de l'Afrique tropicale, cependant, la relation transversale de degré zéro est négative, comme le montrent Cantrelle et ses collaborateurs. Ils font ressortir, cependant, que les variations des conditions sanitaires peuvent exercer une influence sur la proportion des femmes stériles et sur la mortalité infantile de manière à produire une relation négative. Au Gabon, par exemple, la mortalité infantile est très élevée (229 p. 1000), mais un quart environ des femmes d'âge fécond sont devenues stériles, surtout du fait du paludisme. Il en résulte une baisse de la fécondité. En Inde au contraire, les chiffres d'Agrawal sur les taux bruts de natalité par région, l'indice synthétique de fécondité et la mortalité infantile indiquent qu'il existe une forte relation positive entre la mortalité et la fécondité (tableau 17). A partir des données qui figurent dans ce tableau,

le calcul de la corrélation de degré zéro entre l'indice synthétique de fécondité et la mortalité infantile, dans 12 états indiens vers 1970, donne une valeur de 0,560 ; pour 17 états, la corrélation entre la mortalité infantile et le taux brut de natalité est de 0.654. Si on tient compte de la proportion des illettrés par région, les coefficients correspondants de corrélation partielle sont de 0,340 et 0,520 ; si on tient compte de la proportion des personnes vivant en zone rurale, ils sont de 0,597 et 0,668. Tous les coefficients de corrélation, à une exception près, sont significatifs au seuil de 5 %. Manifestement, les relations au niveau global sont de nos jours aussi diverses dans les groupes de pays peu développés qu'ils l'étaient dans les pays européens au siècle dernier. Les relations régionales positives et significatives prédominent clairement. Mais les conclusions qu'on peut tirer de ces données relativement aux causes sont extrêmement limitées.

Le recul de la mortalité peut affecter la fécondité au niveau de la société non seulement en changeant les conditions objectives dans lesquelles se produit la reproduction mais aussi en changeant les attitudes et les mentalités. On a prétendu que le fatalisme – mentalité dans laquelle les événements ne dépendent pas de la volonté de l'individu – est le motif principal qui empêche de nombreux individus d'exercer un contrôle sur leur fécondité. Les preuves empiriques qui permettaient de justifier ce point de vue sont très limitées. (Williamson, 1970). Dans un pays peu développé, une des manières les moins coûteuses et les plus importantes pour transformer la vie d'un individu est l'amélioration de sa santé. Si l'on parvient à faire comprendre que ces changements sont réalisables, une modification psychologique peut se produire rapidement qui facilite l'adoption de la contraception. (Taylor, 1965 ; Académie nationale des sciences, 1971). Un argument du même genre consiste à dire que la pression démographique à l'intérieur de la famille et de la société doit atteindre un seuil critique pour que l'innovation, c'est-à-dire la contraception, soit acceptée. Une fois adoptée, l'innovation fera tache d'huile tant pour les personnes qui l'auront adoptée que pour ceux qui les observent ou qui seront persuadés par eux de sa valeur. Tant que des travaux de caractère empirique n'auront pas été faits sur ces questions, ces arguments relèveront du domaine de l'hypothèse.

Conclusion

Dans toutes les sociétés, il est probable que le recul de la mortalité fait augmenter le taux d'accroissement démographique. On peut s'attendre à un déclin de la fécondité de nature à le compenser dans la plupart des sociétés mais ce déclin suffira rarement à contrebalancer complètement l'accroissement provoqué par le recul de la mortalité. Dans les populations qui ne pratiquent pas la limitation des naissances, un tiers au maximum de l'augmentation du taux net de reproduction sera compensé par les mécanismes involontaires qui réduisent la fécondité. Dans les populations où la limitation des naissances est répandue, même si les parents remplacent chaque décès d'enfant, il y aura une relation négative entre la mortalité et le taux net de reproduction. De plus, on ne peut s'attendre à un remplacement complet, lequel d'ailleurs n'a jamais été observé. Le remplacement tend à être le moins complet dans les populations où la dimension idéale de la famille est élevée, c'est-à-dire justement là où les effets sociaux et économiques de l'accroissement rapide de la population se font le plus sentir.

La motivation qu'ont les parents de parvenir à un certain nombre d'enfants survivants à une époque postérieure à la fin de leur vie féconde présente le seul mécanisme vraiment susceptible de provoquer des changements de fécondité qui font plus que compenser la baisse de la mortalité. Cependant même dans ce cas, la surcompensation ne peut s'appliquer qu'à des changements de mortalité se limitant à certains groupes d'âge qui ne sont pas ceux où le recul de la mortalité est le plus fort. Une réponse de la fécondité qui tend à surcompenser le recul de la mortalité, dépend d'une fonction de préférence pour les enfants qui est fortement biaisée en faveur d'un nombre élevé d'enfants, et cette forme n'a pas été beaucoup plus confirmée par les résultats empiriques. De plus, cette réponse peut se produire après un délai important car il dépend de la conscience qu'ont les parents du recul de la mortalité. Les changements psychologiques, par exemple un recul des attitudes fatalistes produit par le déclin de la mortalité, peuvent également produire des changements propres à surcompenser ceux de la fécondité. Pour le moment la question reste largement ouverte.

En somme, lorsqu'on recommande la réduction de la mortalité pour faire baisser l'accroissement démographique, on ne s'appuie pas sur des faits irréfutables. Naturellement il y a beaucoup d'autres raisons pour poursuivre des programmes de ce genre et on pourrait certainement citer des cas où les programmes pour réduire la mortalité contribueraient à atteindre un tel but. Mais même si on fait abstraction de celui-ci, toute la documentation présentée dans les communications qui ont été faites et les tendances actuelles de l'accroissement démographique dans le monde indiquent que dans les décennies à venir et probablement pendant longtemps encore, le recul de la mortalité provoquera un accroissement plus rapide de la population.

Pour la bibliographie, voir le texte anglais

INTRODUCCION

par Samuel H. PRESTON
Center for Studies in Demography and Ecology
Department of Sociology
University of Washington

RESUMEN

El seminario abordó los siguientes interrogantes principales : ¿ En qué medida cambian las tasas de fecundidad cuando cambia la mortalidad ? ¿ Cuáles son las condiciones que afectan el proceso de cambio ? ¿ Cuánto demora la respuesta en hacerse presente ? Los estudios previos sugieren que en la mayoría de las poblaciones se espera una modificación de la fecundidad como consecuencia de los cambios de la mortalidad, pero las evidencias en apoyo de esta posición han sido débiles. Los documentos básicos del Seminario contribuyen a aclarar estas inquietudes, principalmente mediante el examen detallado de informaciones sobre el tamaño de la familia en diferentes sociedades.

Este trabajo revisa los documentos básicos del Seminario para destacar las más importantes relaciones que contienen. Se concluye que en los próximos años la baja de la mortalidad provocará un importante aumento de las tasas de crecimiento en la mayor parte de los países. Puede esperarse que parte del crecimiento demográfico inducido específicamente por la baja de la mortalidad, será compensado por una variedad de mecanismos que asocian la mortalidad con la fecundidad. Se revisan y comentan las asociaciones relativas a : los factores biológicos, de reemplazo, de seguridad y de implicaciones sociales. Los dos primeros factores no pueden, desde un punto de vista matemático, producir una compensación total en la fecundidad cuando cambia la mortalidad. Los dos ultimos podrían lograrlo, pero esto no está demostrado. Es en estos dos últimos campos donde deben centrarse los estudios del futuro.

Introducción

Las tasas de natalidad y de mortalidad se relacionan algebraicamente de una manera extraordinariamente simple para determinar las tasas de crecimiento de la población. Pero bajo la aparente simplicidad yace una compleja inter-relación entre la mortalidad y la fecundidad, por lo que, a pesar de sus ventajas, su separación para fines de análisis resulta artificial y a veces engañosa. El Seminario del Cicred sobre la Mortalidad Infantil en relación al Nivel de Fecundidad, fue concebido en la idea de examinar en detalle la amplitud e implicationes de estas inter-relaciones en una variedad de situaciones demográficas.

Desde la partida se decidió centrar el Seminario más en la influencia de la mortalidad sobre la fecundidad, que en la acción de la fecundidad sobre la mortalidad. Esta decisión se tomó atendiendo a que se consideró que la primera relación tenía una mayor significación demográfica. Las tasas de mortalidad han descendido de una manera impresionante en los últimos 50 años en la mayor parte de los países del mundo y existen razones suficientes para esperar nuevos descensos en el futuro. El crecimiento poblacional que provocarán estas reducciones de la mortalidad será enorme, pero puede ser moderado por la influencia que pueda tener en la reducción de la fecundidad. Así los problemas cruciales que abordó el Seminario fueron : ¿ En qué medida la fecundidad cambia como consecuencia del cambio de la mortalidad ? ¿ Cuáles son los condicionamientos de este proceso de cambio ? ¿ Con qué rapidez la fecundidad se modifica al variar la mortalidad ? Los estudios referidos a diferentes regiones y a diferentes épocas, presentados a este Seminario, proporcionan los antecedentes más serios de que se dispone actualmente para responder a estas interrogantes.

Este Seminario es la culminación de más de un siglo de investigaciones empíricas y de esfuerzos teóricos relativos al tema. La teoría Malthusiana puede interpretarse como que sugiere que las poblaciones seleccionan simultáneamente sus niveles de mortalidad y de fecundidad. El crecimiento demográfico, según Malthus, era obstaculizado por el lento avance de los medios tecnológicos necesarios para proporcionarle sustento material. Si una población se ajustaba a estos obstáculos mediante la prevención de los nacimientos y la correspondiente reducción de la fecundidad, disfrutaría también de una baja mortalidad ; si este ajuste no se producía, tanto la fecundidad como la mortalidad serían altas. Se predecía así una correlación positiva entre la mortalidad y la fecundidad, operando a través de la presión demográfica sobre los limitados medios de subsistencia.

El rápido avance tecnológico que se produjo en muchos países del mundo durante los siglos XIX y XX suspendió los mecanismos malthusianos donde quiera que operaban. La teoría de la transición demográfica se desarrolló en estas nuevas circunstancias y fue aceptada rápidamente como un conjunto de generalizaciones históricas, más adecuadas a los hechos . En artículos separados, que aparecieron en 1945, Kingsley Davis y Frank Notestein enunciaron sus conocidas versiones de la teoría de la transición demográfica y sostuvieron que la baja de la mortalidad era una consecuencia inevitable de la aplicación del pensamiento racional a los problemas humanos y del mejoramiento de la organización social, características ambas del moderno estado industrial. Las tasas de fertilidad se demostrarían ser más resistentes al cambio, debido en parte a que las altas tasas de fecundidad habían sido siempre socialmente necesarias para equilibrar la alta mortalidad y porque las instituciones relativas a la reproducción humana y las normas que se habían desarrollado para asegurar sus efectos, eran lentas en cambiar. Sin embargo, la baja de la mortalidad podría remover eventualmente los fundamentos sociales en que se sustentaban las altas tasas de fecundidad. Más directamente, la baja de la mortalidad podría significar que un número menor de nacimientos sería necesario, para asegurar la supervivencia de lo que los padres consideraban como su número ideal de hijos. Coale y Hoover (1958 : 17), en sus replanteamientos sobre la misma teoría, llamaron la atención sobre este punto, indicando que las grandes reducciones de la mortalidad que habían ocurrido en Ceylan y Taiwan, no habían sido acompañadas de una reducción de la fecundidad.

En su maciza revisión bibliográfica sobre la fecundidad, publicada en 1961, Ronald Freedman manifestaba su acuerdo general en que una secular reducción de la mortalidad podría eventualmente provocar una baja de la fecundidad, pero agregaba que eran muy escasos los estudios empíricos que se habían hecho sobre el tema (1961/62 :67). Dos años más tarde Freedman sostuvo, en un artículo que produjo un gran impacto, que "la conocida baja de la mortalidad es una de las condiciones necesarias para una política social efectiva tendiente a reducir la fecundidad". (1963 : 164). La evidencia parcial para esta afirmación era que en casi todas las sociedades desarrolladas, una importante baja de la mortalidad había precedido la reducción de la fecundidad (1963 : 167). Nuevas evidencias acerca de la importancia de estas relaciones fueron proporcionadas por el análisis por regresión de Heer (1966), quien sostuvo que los niveles de la mortalidad infantil aparecían como los medios más seguros y consistentes de predecir los niveles de la fecundidad. Las Naciones Unidas y la Organización Mundial de la Salud sancionaron esta relación así sugerida, en numerosas oportunidades. El Departamento de Asuntos Económicos y Sociales de las Naciones Unidas sostuvo que : "Se ha acumulado bastante evidencia en el sentido que la baja de la mortalidad infantil puede ser un pre-requisito necesario para la aceptación de la planificación familiar. Las parejas no desearán prevenir los embarazos hasta no tener alguna seguridad de que el hijo que ya tienen sobrevivirá" (1972 : 84). En la 21ª Asamblea Mundial de la Salud, el Director General de la Organización Mundial de la Salud sostuvo que : "Un nivel mínimo de salud parece ser necesario para que una familia comprenda que puede regular su conducta demográfica". (citado en : International Planned Parenthood Federation, 1970, p. 1 ; ver también World Health Organization, 1972 : 74).

Desde esta conclusión, hasta la recomendación de que los programas para reducir la mortalidad infantil y de la niñez deben ser previos a los destinados a reducir los niveles de la fecundidad, no hay sino un solo paso. Tal recomendación fue vigorosamente aprobada por un comité de distinguidos demógrafos reunidos bajo los auspicios de la Academia Nacional de Ciencias de Estados Unidos en 1971. Ese comité, presidido por Roger Revelle, sugirió que " las políticas y programas tendientes a reducir la mortalidad infantil y de la niñez a niveles considerablemente más bajos que los actuales, deben ser los fundamentos de los programas gubernamentales de control de la fecundidad" (87), y consideró que, "Cuando las tasas de mortalidad de los países que actualmente tienen altas tasas de fecundidad y altas de mortalidad, sean reducidas a niveles inferiores a 10-15 por 1000, entonces las tasas de natalidad podrían experimentar una considerable reducción". (95) Sin embargo, en una sesión plenaria de la Conferencia Mundial de Población realizada en Lieja en 1973, Ansley Coale hizo algunas observaciones acerca de este planteamiento. Basándose en el registro histórico que se está estudiando a través del Estudio de la Fecundidad Europea organizado por la Universidad de Princeton, Coale notó que las asociaciones entre la reducción de la mortalidad infantil y la fecundidad en las regiones europeas, no apoyaban la idea de que el cambio de la mortalidad había sido un factor de alta significación en el cambio de la fecundidad en la mayor parte de las poblaciones.

No existe así un consenso entre los demógrafos y las agencias de población en el sentido de que los niveles de mortalidad influencian los niveles de fecundidad. La evidencia en favor de cualquiera de las

posiciones planteadas ha sido débil. Los cálculos de regresión han sido invalidados por la existencia de factores comunes que influencian tanto a la mortalidad como a la fecundidad ; por su dependencia mutua de otras variables y por los difíciles problemas de calcular el error entre las variables independientes. La evidencia de que existe una disminución de la fecundidad anterior a la baja de la mortalidad sólo invalida la afirmación de que la mortalidad es el único factor que influencia a la fecundidad, posición que pocos se atreverían a sostener. Brass y Cantrelle, en sendos documentos presentados a este Seminario, señalan que no es razonable esperar que de la abigarrada cantidad de información existente, pueda ser posible extraer las sutiles relaciones que existen entre la mortalidad y la fecundidad. Tales datos son sugerentes, pero escasamente decisivos. No se hizo mucho avance en el tema sino hasta que los demógrafos descendieron a nivel de los estudios de familia. Es aquí- en el nivel de la pareja procreadora- que el Seminario hizo su contribución mayor. Los documentos de Knodel, Lery y Vallin, Cantrelle, Ferry y Mondot, Chowdhury, Khan y Chen, Agrawal, Rutstein y Médica, y, Heer y Wu, sintetizan y expanden el conocimiento de las relaciones entre la mortalidad y la fecundidad al nivel del grupo familiar, en todas las regiones del mundo. Los documentos de Brass, Retherford y Venkatacharya cumplen la admirable tarea de montar el escenario para la presentación de esos resultados y ayudar así a su interpretación. Los documentos de Matthiessen y Lapham, Wright y Quandt se refieren a la necesidad de estudiar estas relaciones en diferentes circunstancias y complementar en una variedad de formas útiles, los resultados logrados al nivel familiar.

Todos los documentos reconocen que la mortalidad puede afectar a la fecundidad a través de cuatro formas principales de acción : – mecanismos involuntarios o biológicos, que operan ampliamente como consecuencia del acortamiento del período de lactancia y del más rápido retorno de la ovulación después de la muerte de un niño ; – respuestas voluntarias de familias a las condiciones de mortalidad, aunque es difícil distinguir entre la reacción ante un hijo actualmente muerto (motivos de reemplazo) y el comportamiento que intenta anticipar las siguientes muertes infantiles (motivos de prevención) ; – respuestas a nivel de la sociedad, y disposiciones sociales inducidas por la baja de la fecundidad tendientes a influír sobre la fecundidad, cambiando el contexto reproductivo que enfrentan las parejas. En realidad estos mecanismos pueden operar conjuntamente y de una manera inter-relacionada, pero para los fines del análisis serán considerados aisladamente en este estudio.

Consecuencias de los cambios de la mortalidad en el crecimiento de la población

En el resto de este trabajo trataremos de señalar las implicaciones que tienen para el crecimiento de la población, las relaciones presentadas por los autores de los distintos documentos y de acuerdo con los cuatro modos de influenciar este crecimiento que ya se han descrito. La pregunta específica que servirá para organizar y integrar los resultados es : considerando las relaciones empíricas estudiadas, ¿ cuál es el impacto probable sobre las tasas netas de reproducción de un cambio permanente en la mortalidad ? Es decir, ¿ qué parte del incremento de las tasas de crecimiento de la población, a largo plazo, que es una consecuencia de la permanente disminución de la mortalidad, es probable que sea compensada por una reducción de la fecundidad ? Serán destacados los casos extremos en que la respuesta de la fecundidad a los cambios de la mortalidad fue máxima, para obtener los límites inferiores del incremento de la tasa de crecimiento asociados con la baja de la mortalidad. De esta manera, ignoraremos los efectos de los mejoramientos en la salud de los adultos, mejoramientos que parecerían claramente inducir un aumento en la fecundidad debido a la mayor supervivencia marital, a la disminución de las pérdidas fetales, al aumento de la fecondabilidad, y a un aumento de la estimación de los hijos como apoyo de sus padres en la vejez. (Ver Ridley y col., 1967 ; Ryder, 1955 ; Basavarajappa, 1962 ; Immerwahr, 1967). Por las mismas razones, no será considerado el planteamiento hecho por Retherford de que la reducción de la mortalidad aumentaría el número deseado de niños sobrevivientes debido al aumento de los servicios que estos niños producen.

La siguiente fórmula aproximativa fue propuesta por Coale, (1972 : 18),

$$\mathrm{TNR} = p(30) \cdot \frac{\mathrm{TTF}}{1 + \mathrm{RM}} ,$$

en que : TNR = tasa neta de reproducción

$p(30)$ = probabilidad de que una niña reción nacida sobreviva hasta los 30 años

TTF = tasa total de fecundidad, o el numero promedio de hijos tenidos por una mujer que haya sobrevivido hasta el final de su vida reproductiva

RM = razón de masculinadad al nacer

Cuando la mortalidad infantil cambia en una cantidad Δ TMI, manteniéndose constantes las demás tasas de mortalidad, p (30) cambia aproximadamente en el factor 1 $- \Delta$ TMI. Así, cuando la tasa de mortalidad infantil baja de 200 por 1000 a 150 por 1000, p (30) aumenta en approximadamente 5 %. A menos que el

número promedio de hijos por mujer baje en un 5 %, la tasa neta de reproducción aumentará como consecuencia de la baja de la mortalidad.

1) Implicaciones del cambio de la mortalidad en el crecimiento de la población en conexión con mecanismos involuntarios

Los niveles de la mortalidad pueden tener una profunda influencia en los niveles de la fecundidad incluso cuando no se practica la contracepción. En las poblaciones en las cuales la lactancia materna es frecuente y se extiende por muchos meses, el efecto que tiene de inhibir la ovulación se traduce en intervalos intergenésicos mayores cuando el hijo anterior sebrevive todo el período de lactancia materna, que cuando este niño fallece antes. Knodel muestra que el aumento de este intervalo puede alcanzar 0,2 meses en poblaciones que vivían con anterioridad al siglo XX, cuando la lactancia materna era escasamente de 12,9 meses y se extendía hasta que el niño cumpliera su segundo año de vida. Las estimaciones de la duración de la lactancia en regiones en desarrollo alcanzan un máximo de 12 meses para Senegal según Cantrelle y col. y 13 meses en Bangladesh de acuerdo on Chowdhury, Khan y Chen. En el otro extremo, los valores mínimos de 3,5 a 6,2 meses han sido encontrados por Rutstein y Medica en las zonas rurales y semi-urbanas de Perú, Colombia, Méjico y Costa Rica. De acuerdo con otras informaciones la alimentación por pecho materno es de menor duración en estas últimas poblaciones.

Este aumento de la duración de los intervalos intergenésicos, como resultado de la supervivencia del niño, podría ser atribuída parcialmente a diferencias en características de la vivienda, hábitos de dormir, frecuencia de coitos y agotamiento de los padres como resultado de la supervivencia del niño. Puede haber sido parcialmente influída por el uso de la contracepción con fines de espaciamiento de los hijos, como parece haber sido el caso en Punjab (Potter y col., 1965). Sin embargo, la influencia principal de la supervivencia del niño opera a través del efecto inhibidor de la ovulación debido a la lactancia (Potter y col., 1965 : 379). En la medida en que los padres se den cuenta de este efecto biológico y extiendan la lactancia con propósitos contraceptivos, es incorrecto denominar a este mecanismo como "involuntario" y se considerará como un caso muy especial de reacción voluntaria.

A pesar de la gran influencia de la mortalidad infantil en la fecundidad en tales poblaciones, es claramente imposible para la fecundidad compensar totalmente las reducciones de la mortalidad. Ya que el intervalo entre el último nacimiento y hasta el próximo, puede ser acortado por una defunción infantil pero no puede ser reducido a cero. Los niños no pueden ser reemplazados instantáneamente, debido al tiempo requerido para obtener un nuevo embarazo, el tiempo necesario para la gestación y por la posibilidad de una pérdida fetal. El monto de la compensación puede ser estimado a través de la modificación de un modelo desarrollado por Perrin y Sheps. En este modelo el número promedio de hijos nacidos durante el período reproductivo de una mujer es representado como la razón entre la duración de su vida reproductiva (medida en meses) y el número medio de meses de los intervalos entre nacimientos. Varios componentes del intervalo intergenésico medio son conocidos : el tiempo medio que demora en concebir una mujer expuesta al riesgo, el tiempo medio de esterilidad durante el embarazo y el tiempo medio de esterilidad a continuación del término del embarazo. Podemos introducir la mortalidad infantil en el modelo haciendo variar el período de esterilidad que se produce a continuación de un nacido vivo según si el niño sobrevive o no su primer año de vida. El modelo completo es :

$$TFR = \frac{N}{W + S_0 + TMI\,(S_1) + (1 - TMI)\,(S_2) + K\,(W + S_3)}$$

donde : N = duración de la vida reproductiva de una mujer

W = tiempo promedio que demora en quedar embarazada una mujer expuesta al riesgo

S_0 = período de esterilidad durante un embarazo conducente a un nacido vivo

S_1 = período de esterilidad que sigue a un nacido vivo que muere durante su primer año de vida

S_2 = período de esterilidad que sigue a un nacido vivo que sobrevive todo su primer año de vida

S_3 = período de esterilidad durante y después de un embarazo que termina en una muerte fetal

TMI = tasa de mortalidad infantil

K = razón entre la probabilidad de tener una muerte fetal y la de tener un nacido vivo.

La sensibilidad de la fecundidad con respecto a la tasa de mortalidad infantil puede ser encontrada diferenciando esta última expresión con respecto a la TMI, lo que da :

$$\frac{d\,TFR}{TFR} = \frac{(S_2 - S_1)}{I} \,.\, d\,TMI\ ,$$

donde I es la duración promedio de los intervalos entre nacimientos.

Esta expresión es una respuesta muy simple a nuestra interrogante. El cambio proporcional de la fecundidad será igual al producto del cambio absoluto de la mortalidad infantil (que es equivalente al cambio proporcional en p (30)) por el factor $(S_2 - S_1)/I$. Este último factor es la diferencia entre los períodos estériles referidos a un niño que sobrevive en relación a otro que muere durante ese primer año, como una proporción del intervalo medio entre nacimientos. Este factor debe ser menor que la unidad ; puede ser igual a la unidad solamente si una muerte infantil pudiera ser reemplazada instantáneamente eliminando el tiempo de espera de la concepción y el tiempo del embarazo.

Como ya fue señalado, el mayor valor para $(S_2 - S_1)$ ha sido mostrado por Chowdhury, Khan y Chen en Bangladesh, 13 meses. Si se considera que el menor intervalo medio entre nacimientos, en poblaciones de elevada lactancia materna, casi con toda seguridad no es inferior a 26 meses, puede establecerse con confianza que 50 % es la respuesta compensatoria máxima de la fecundidad a los cambios de la mortalidad infantil resultante de este mecanismo. Esto es, puede pensarse que cerca de la mitad del aumento de la tasa neta de reproducción, resultante de la reducción de la mortalidad infantil, puede ser eliminado mediante equivalentes reducciones de la fecundidad. Un nivel muy parecido de respuesta en poblaciones con lactancia materna extendida, es indicado por el análisis de Potter para los intervalos entre nacimientos en Punjab. $(S_2 - S_1)$ era de 9 meses e I era de 30 meses, una combinación que produciría una respuesta compensatoria de un 30 % (Potter y col., 1965 : 394). A juzgar por los resultados presentados por Rutstein y Médica, una respuesta mucho menor debe esperarse en América Latina.

Parecería que la respuesta compensatoria sería mayor cuando los niveles nutricionales, tanto de la madre como del niño, son más bajos. El efecto inhibidor de la ovulación, que provoca la lactancia materna, parece ser mayor en tales poblaciones, aunque los resultados sobre este aspecto no son todavía concluyentes (Salber, 1966 ; Chen y col., 1974 ; Chowdhury, Khan y Chen). Tal como lo señalan Cantrelle y col. para algunas regiones seleccionadas de Africa, el efecto esperado puede ser mayor en mujeres de áreas rurales, analfabetas y de edad avanzada, ya que la lactancia materna tiende a ser más corta y menos frecuente cuando se inicia el proceso de modernización. Pero en ninguna población podemos esperar que la mayor parte del aumento de la tasa de crecimiento sea aliviado por una reducción en la fecundidad. La respuesta de la fecundidad a un permanente cambio en la mortalidad, en este mecanismo, debería ser completamente rápida, ocurrir durante el tiempo correspondiente al intervalo medio entre nacimientos, es decir entre 2 y 4 años.

2) Efecto combinado del cambio de la mortalidad y de las acciones voluntarias de las parejas, sobre el crecimiento de la población

La sección anterior no tomó en cuenta la posibilidad que las parejas practicaran la contracepción, para lograr un tamaño esperado de la familia. La introducción de tales metas y conductas complica enormemente las inter-relaciones entre fecundidad y mortalidad. Trataremos sólo de aquellas parejas en las cuales el tamaño deseado de la familia es planteado en término del número de niños *sobrevivientes* hasta cierta edad de los padres, que definiremos como la edad crítica. Si es una edad situada dentro del período fértil, la mayor parte de los padres sólo necesitan continuar sus esfuerzos por alcanzar el número deseado de hijos, cuando ocurre la muerte de un hijo.

En el período de crianza de los hijos, la mayor parte de los padres reacciona frente a la muerte o supervivencia de los niños, continuando sus esfuerzos por alcanzar el tamaño deseado de la familia. Esta condición será analizada bajo la acepción "efecto de reemplazo". Cuando la edad crítica es posterior al fin de la edad de crianza de los hijos, se introduce, sin embargo, la incertidumbre acerca de la sobrevivencia de los niños hasta tal edad. Entonces es necesario prevenir y las expextativas referentes a la mortalidad futura de los niños pueden basarse no sólo en la propia experiencia de los padres, sino que también en la forma en que ellos perciben los niveles de la mortalidad propios de su comunidad.

Debido a esta incertidumbre, los padres pueden esperar un número diferente de hijos al que desean, y se complica el esquema de tamaños preferidos de hijos supervivientes. Esta condición será analizada bajo el nombre de "efecto de seguridad".

2a) Efecto de reemplazo

Si los padres desean tener un cierto número de hijos sobrevivientes C, al término de su período de crianza de los niños, que se presume conocido, y si ellos pueden tener o no tener hijos a voluntad, entonces lo más probable es que tendrán C hijos que estén vivos al término de su vida reproductiva. Cada niño que muera será "reemplazado" por un nacido vivo. Sorprendentemente, aún en este caso ficticio, el reemplazo "completo" originará un aumento de la tasa neta de reproducción cuando baja la mortalidad. La razón reside en que esta estrategia asegura el número deseado de hijos sólo hasta el punto en que los padres tienen 45 años o algo así, edad a la cual sus hijos tendrán tal vez 15 años, en promedio. Pero la edad hasta la cual la sobrevivencia es pertinente, para el cálculo de la tasa neta de reproducción, es mucho mayor que 15 años (30 en una aproximación convencional). Como la reducción de la mortalidad afecta a todos los grupos de edad, un mismo número de personas de 15 años originará un número mayor de personas de 30 años de edad en una

población en la cual la mortalidad es más baja. Aquí la baja de la mortalidad produce un aumento de la tasa neta de reproducción. Mediante cálculos aproximados, puede mostrarse que el nivel de la tasa neta de reproducción, después de una reducción de la mortalidad, excederá al valor que tenía esta tasa antes de esa baja, en un factor aproximadamente igual a la razón entre la nueva y la antigua probabilidad de sobrevivir desde los 15 hasta los 30 años de edad. Cuando la mortalidad pasa desde una esperanza de vida al nacer de 35 años a una de 70, este factor es aproximadamente 1,152 de acuerdo con las tablas de vida "promediadas" de Coale y Demeny (Tablas de vida para mujeres modelo "Oeste" 1966 : 8 y 22). Siempre con un reemplazo total de los niños muertos, un mejoramiento de la mortalidad de la magnitud señalada, produce un aumento de la tasa neta de reproducción de alrededor de un 15 %. Desde que la tasa neta de reproducción podría aumentar en aproximadamente 104 %, si no se producen ajustes en la fecundidad (basado en una comparación de las probabilidades de sobrevivir a los 30 años, en las tablas de mortalidad ya citadas), es claro que el mecanismo de reemplazo completo elimina cerca del 85 % de la aceleración inducida por la baja de la mortalidad. La compensación completa ocurriría, por supuesto, si el mejoramiento de la mortalidad fuera circunscrito sólo a los niños.

No es realista esperar que las mujeres que intentan completar un número deseado de hijos, sobrevivientes al fin de su período de crianza, puedan reemplazar completamente a los niños que se mueren. Ya que en la época en que el niño muere, pueden haber perdido a sus maridos, pueden estar menos fecundas o estériles. Más importante aún, en los países de alta fecundidad, pueden estar aún ocupadas en el cuidado y crianza de los niños, que habrían sido necesarios para alcanzar la meta reproductiva si el niño no hubiera muerto. Obviamente, si el número deseado de niños sobrevivientes iguala o excede al número máximo de nacimientos que pueden producirse durante la vida reproductiva de una mujer, no podrá producirse ningún efecto de reemplazo. La magnitud del efecto de reemplazo sería influenciada así por el tamaño deseado de la familia y sus determinantes, tales como la educación de la mujer y la residencia urbano-rural. La mortalidad debe, lógicamente, ser considerada más como un factor condicionante que interactúa con estos determinantes, que como un factor separado.

Los efectos de estas motivaciones de reemplazo en presencia de estos obstáculos a la reproducción, son demasiado complejos como para ser representados en soluciones analíticas simples. Venkatacharya es el primero en examinar una estrategia próxima a la que hemos definido como motivación de reemplazo, en un modelo abierto que toma en cuenta la baja de la fecundabilidad con la edad, los períodos de esterilidad y la mortalidad fetal. Suponiendo que una pareja procree hasta que un hijo alcance la edad de 10 años, muestra que, en las condiciones de las parejas de la India (simulación C6), las permanentes reducciones en la mortalidad producen más altos aumentos en las tasas netas de reproducción. Con un aumento en la esperanza de vida al nacer desde 35 a 75 años, la tasa neta de reproducción sube de 1,37 a 2,24, es decir, en 64 % (Tabla n° 5). La *tasa total de fecundidad* disminuye sólo en un 7 %, baja insuficiente para compensar los efectos del mayor mejoramiento de la mortalidad. Los resultados no son alterados substancialmente bajo estrategias similares o bajo diferentes modelos de parámetros reproductivos. Tal como ya ha sido dicho, la magnitud del reemplazo podría ser más alta en países con bajos tamaños deseados de la familia, en los cuales la muerte de un niño tenderá a ocurrir tempranamente en la vida reproductiva de una mujer. En este caso quedan menos oportunidades para que intervengan los obstáculos a la reproducción, y el período reproductivo no está tan completamente ocupado en la crianza de los niños necesarios para alcanzar el tamaño deseado. Estas expectativas son verificadas en los documentos básicos que informan sobre la extensión observada del reemplazo. Una amplia variedad de medidas fue usada para indicar la frecuencia y extensión del reemplazo y ellas no son estrictamente comparables en los distintos estudios. Sin embargo, en algunos casos, se utilizaron medidas comparables para fines internos. En todos los casos los autores reconocen la necesidad de estudiar el efecto de reemplazo prospectivamente, desde un cierto momento del ciclo reproductivo femenino, para reducir al mínimo la influencia perturbadora de la fecundidad sobre la mortalidad. Reconocen también la necesidad de eliminar los efectos que actúan a través de mecanismos involuntarios, aunque en la práctica esta eliminación no es siempre posible.

Knodel ha encontrado evidencias de la motivación de reemplazo en varias poblaciones europeas anteriores al siglo XX, examinando la duración del intervalo entre el segundo y el tercer nacimiento, en relación a la muerte o sobrevivencia del primer hijo. El intervalo era generalmente algo más corto, en promedio, en las mujeres cuyo primer hijo había muerto, y la diferencia fue mayor en poblaciones en las cuales se practicaba extensamente la contracepción (es decir, en aquellas en que el efecto de reemplazo potencial es mayor). Brass sostiene, que una fuente posible de error en tales resultados, es la variación de la fecundabilidad entre las mujeres. Las mujeres altamente fecundas tenderían a tener cortos intervalos entre nacimientos y los intervalos cortos, resultan típicamente, en una alta incidencia de la mortalidad infantil. Así la asociación aparente entre intervalo y mortalidad puede ser falsa y producida en realidad por su dependencia mutua de la fecundabilidad. Sin embargo, tales errores serían mayores en poblaciones donde existe menor control de la natalidad, ya que los resultados encontrados por Knodel, indican que el efecto sobre los intervalos es menor en estos casos.

Knodel compara también la probabilidad de agrandamiento de la familia (la proporción de mujeres que han alcanzado un nivel determinado de paridez y que proceden a tener un nuevo nacido vivo) para las mujeres con diferente incidencia de la mortalidad infantil, previa al logro de tal paridez. En general los resultados apoyan el análisis de intervalos. Los efectos son más fuertes en la dirección esperada cuando, de acuerdo con la información de otras fuentes, la limitación de la familia era evidente. Chowdhury, Khan y Chen adoptan un enfoque muy útil que combina el intervalo con las medidas de la probabilidad de agrandamiento de la familia. Han calculado tablas de vida que muestran la proporción de mujeres (en Pakistán) que han progresado desde la paridez x a la paridez x + 1, por intervalos posteriores a aquél en que se alcanzó la paridez x. Para las mujeres que habían perdido un niño antes de lograr una paridez entre 2 y 5, el intervalo medio en relación al próximo nacimiento fue más corto que para las mujeres que nos habían tenido una muerte infantil antes de alcanzar tal paridez. Las mujeres que habían perdido un niño después de alcanzar la paridez x fueron excluídas de la tabla, por lo tanto los resultados no están contaminados por la correlación positiva entre la incidencia de la muerte de un niño y los nacimientos sucesivos de una mujer. Sin embargo, las variaciones de la fecundabilidad pueden aún jugar un papel. La duración mediana del intervalo siguiente, en el grupo de mujeres que no tuvieron una defunción infantil, es mucho más corto- un máximo de 4 meses cuando la paridez observada es 4 (Tabla N° 6)- y se encuentran diferencias aún más pequeñas en Bangladesh (Tabla 8). Por consiguiente Chowdhury, Khan y Chen se inclinan a pensar que no hay un cambio en la conducta como respuesta ante la muerte de un niño. Es muy claro, a partir de estos resultados, que la magnitud del efecto de reemplazo, si es que existe, en Pakistán y Bangladesh, se ubica mucho más bajo que los mecanismos involuntarios.

Los estudios presentados por Rutstein-Medica y Heer-Wu incluyen, para propósitos de control estadístico, información sobre el status socio-económico de los padres. Ellos examinan también otras importantes variables dependientes, tales como el uso de la contracepción y el tamaño deseado de la familia. La variable dependiente principal es la probabilidad de agrandamiento de la familia, según la duración del período a partir del momento en que se logró la paridez previa. El desarrollo de las series de Chowdhury y Khan no sirve para describir el efecto de reemplazo, en un marco de análisis multivariado, de los determinantes de la fecundidad. Estos estudios son los más complejos de los presentados al Seminario y de ellos sólo intentaremos un breve resumen. En general, estos estudios apoyan el resultado esperado, de que el efecto de reemplazo debería ser mayor en poblaciones con bajas metas de fecundidad. Heer encuentra en la zona rural de Taiwán, que la muerte de un niño, perteneciente a los tres primeros nacimientos, anterior a una fecha posterior en un año al tercer nacido vivo, da 0,285 más niño después del tercero, que si ninguno hubiera muerto. Sin embargo, habrán menos nacimientos subsiguientes si mueren dos en lugar de uno, y aún menos si mueren tres en lugar de dos (pagina 15). El efecto de reemplazo es aparentemente débil y aún actúa en sentido contrario, cuando la muerte ocurre pasado el primer nacimiento. Los resultados deben ser interpretados de una manera cautelosa, debido a que la reproducción no ha sido completada por todas las mujeres interrogadas y a que todavía era posible un reemplazo posterior, (la mujer tenía todavía un lapso mediano de 11,9 años después del tercer nacimiento en el cual podría tener niños (p. 12). Más aún, algunos de los niños muertos pueden haber sido ya reemplazados, sin que la mujer progrese más allá de la tercera paridez. Esto podría ser solamente en el caso que el tamaño deseado de la familia final fuera uno o dos hijos. Es necesario tomar en cuenta que Rutstein (1974), mediante una muestra más pequeña pero más amplia, realizada en Taiwan, y un método de proyección que le permitió llevar a las mujeres hasta el final de su período reproductivo, usando cohortes sintéticas, encontró un efecto mayor de la pérdida de un niño, sobre los nacimientos subsiguientes. Sin embargo, el efecto de reemplazo se confunde con los mecanismos involuntarios, en los resultados presentados por Rutstein, una confusión que Heer elimina parcialmente controlando la duración media de la lactación materna.

Entre las mujeres estudiadas por Heer y Wu, el deseo de reemplazo era mayor que la conducta correspondiente. La muerte de un hijo en las familias en las que ya habían nacido uno o dos, producía un aumento en el número medio deseado de nacimientos adicionales de un 0,6 a 0,7 (p. 24). En cambio, la pérdida de una hija tenía un efecto menor. La diferencia entre el reemplazo deseado y la conducta efectiva puede atribuirse a los factores mencionados al comienzo : las escasas probabilidades de actuar sobre los deseos de reemplazo, en una vida reproductiva ordenada de otra manera. Iskandar y Jones (1975) encuentran efectos similares en Indonesia. Ellos señalan que, en todas las regiones y en todos los niveles de paridez, las mujeres que habían perdido un hijo eran más propensas a desear otros niños adicionales, que las mujeres que no habían perdido ninguno.

Rutstein y Medica presentan la primera evidencia sobre la influencia de la mortalidad infantil en la crianza de los niños, en las parejas individuales en América Latina. Aplicando técnicas semejantes, a los datos obtenidos mediante la encuesta de fecundidad de CELADE, en áreas rurales y semi-urbanas de Colombia, Costa Rica, Méjico y Perú, mostraron que el efecto de reemplazo es mucho más bajo que el encontrado anteriormente por Rutstein en Taiwán. Costa Rica presenta los mayores efectos de reemplazo, que alcanzan hasta 0,39 nacimientos adicionales por mujer que había perdido un hijo en comparación a aquellas que no han perdido ninguno de sus cuatro primeros hijos. El reemplazo en Méjico y Colombia fue nulo e incluso levemente negativo. Este es un resultado sorprendente, ya que el efecto medido, incluía también influencias

involuntarias. Sin embargo, la lactancia materna parece ser, en promedio, mas bien corta en estas areas. El area en que la lactancia es aparentemente mas larga, Perú, se ubica en segundo lugar en cuanto a la duración del efecto de reemplazo. Si se hace abstracción de este caso, cuya peculiaridad parece plausiblemente explicada, los resultados apoyan el planteamiento de que el efecto reemplazo es más fuerte en las regiones en que la fecundidad es más baja y el uso de anticonceptivos más alto : Taiwán y Costa Rica. La excepción, que no se tomó en cuenta, es la zona urbana de Marruecos, donde Heer encontró un efecto de reemplazo de 0,70, si uno de los tres primeros hijos moría. El mecanismo involuntario ne fue controlada en este caso, pero como hemos ya visto, este mecanismo no es verosimilmente responsable de un efecto mayor de 0,35. Sin embargo, las variaciones en la duración de la lactancia materna y en la fecundabilidad son factores contaminantes potenciales. Las mujeres que alimentan de pecho por períodos cortos, independientemente de la sobrevivencia del niño, son probablemente más propensas a experimentar la muerte de un niño, pero la extensión de su período susceptible, puede ser mucho mayor que el determinado por la exclusiva muerte del niño.

Por último, Lery y Vallin muestran el impacto de la mortalidad infantil en la fecundidad subsiguiente, en una población de baja fecundidad, Francia. Utilizando una muestra muy grande, de mujeres nacidas entre 1892 a 1916, demuestran que la probabilidades de agrandamiento de la familia son mayores en un 19 a 28 % cuando el niño murió en la infancia, que cuando sobrevivió hasta la época de la encuesta, en 1962. En esencia, se encuentran los mismos resultados, cuando el nivel de respuesta se clasifica por ocupación del padre. Muestran también, que la muerte de un niño en la infancia acelera el nacimiento del próximo en 6 a 12 meses. Estos resultados sugieren una vigorosa respuesta ante la muerte de un niño, pero la extensión del efecto reemplazo no puede ser medida a partir de los datos que poseen.

Resumiendo, no fue detectado ningún reemplazo completo. El efecto tiende a ser mayor en los países con bajas metas en cuanto a la fecundidad, e incluso, con un reemplazo completo, la tasa de reproducción tiende a aumentar cuando la mortalidad baja. La ausencia de reemplazo completo puede ser atribuída a muchos factores diferentes que a la falta de oportunidades. Algunas de las concepciones que terminan en un niño muerto pueden haber sido, en primer lugar, concepciones no deseadas ; la muerte de un niño puede desanimar la conducta reproductiva ; puede ocurrir que los padres no tengan metas en cuanto al tamaño de la familia, medido en términos de niños sobrevivientes.

Cuando cambian los niveles de mortalidad, el efecto reemplazo debe modificar la fecundidad, en un lapso igual a la duración de la vida reproductiva de la mujer. La duración puede ser no mayor de 30 años y presumiblemente será más corta mientras más pequeño sea al tamaño de la familia deseada.

2b) El efecto seguridad

Si les padres desean tener un cierto número de hijos vivos en alguna edad posterior al término de su vida reproductiva, deben hacer una proyección, aunque sea muy estimativa, de los posibles riesgos de morir de sus hijos. En la medida en que su previsión es referida a su propia experiencia, en cuanto a los hijos sobrevivientes, sus consecuencias deberían ser incorporadas a la estimación del efecto reemplazo ya descrito. Como hemos visto, estos efectos no son suficientes, para completar el reemplazo de los niños muertos. Sin embargo, la apreciación de los padres acerca del riesgo de muerte de sus hijos puede estar basada en un contexto más amplio, como por ejemplo, en los niveles de mortalidad que observan entre sus amigos o en la comunidad total.

Los motivos de seguridad proporcionan una de las pocas pistas plausibles, mediante las cuales, la compensación de la fecundidad puede ser más que completa (Schultz, 1969 ; Preston, 1972). Debido a que el futuro es incierto, el número de hijos sobrevivientes hasta la edad crítica no puede ser previsto con entera exactitud. Los padres pueden, sin embargo, considerar la ventaja de tener un número de hijos mayor que el más deseado por ellos, C.

Si las preferencias marcadas por un número de hijos mayor que C son más atractivas que por un número de hijos a igual distancia, pero bajo C, la mayor varianza en el número de hijos sobrevivientes, cuando la mortalidad es alta, puede interactuar por esta preferencia, exagerando el impacto del cambio de la mortalidad.

Este mecanismo no puede actuar sino que cuando la función de la preferencia por el número de hijos, tiene un valor diferente a cero en el punto C. (En efecto, puede ser representado por un vértice). En este caso puede probarse que el número de nacimientos B, que maximiza la probabilidad de alcanzar la meta C, si cada niño está sujeto a la probabilidad P de sobrevivir hasta la edad crítica es

$$B = \frac{C}{P}$$

La proporción de los cambios en la mortalidad (P) será exactamente equilibrada por la proporción de los cambios en la fecundidad. La tasa neta de reproducción no sería afectada por el cambio de la mortalidad, sino que por el efecto del mecanismo menor, expuesto en la sección 2a. Si la edad crítica fuera 60, entonces la tasa neta de reproducción no sería fundamentalmente afectada ; si es muy superior a 60, respondería típicamente de una manera negativa a un cambio en P.

En el caso más general y realista, cuando los valores diferentes a cero en la función de preferencia son adscritos a varias opciones, la fecundidad puede responder o muy vigorosamente, o de una manera muy suave al cambio de la mortalidad, dependiendo de la forma de la curva de la función de preferencia. Para ilustrar esto, usaremos una función de preferencia desarrollada por Myers y Roberts (1968) para 18 mujeres de Puerto Rico. A estas mujeres se les interrogó sobre su preferencia en cuanto a rango y escala relativa para un tamaño de la familia específico, en cada uno de 1176 pares hipotéticos de combinaciones niña-niño. Las preferencias en promedio, asignadas a los tamaños de familia, desde cero hasta 12 fueron : 0,64 ; 0,88 ; 1,62 ; 1,52 ; 1,56 ; 1,12 ; 1,02 ; 0,92 ; 0,81 ; 0,81 ; 0,75 y 0,76. El número más deseado fue dos, pero la distribución estaba claramente sesgada hacia la derecha, con todas las demás preferencias sobre cero hijos. Dada esta función y suponiendo que el niño sobreviviente es un proceso binomial, con una probabilidad P de niños sobrevivientes hasta la edad crítica, en cada oportunidad podemos calcular el número de nacimientos que maximizara el valor esperado de posibles tamaños de la familia. Cuando P = 0,5, el número óptimo de nacimientos es 6. Para P igual a 0,6 es 5. Para P igual a 0,7, 0,8, y 0,9 este tamaño es 4 y para P igual a 1,0 el tamaño óptimo es 2. El número óptimo de nacimientos no tiene una respuesta muy efectiva hasta que P sobrepasa 0,9, valor sobre el cual las respuestas son muy sensibles a las ulteriores reducciones de la mortalidad. Sobretodo, una duplicación de las probabilidades de sobrevivencia, reduce en dos tercios el número óptimo de nacimientos. Al final, la baja de la fecundidad compensa con creces la reducción de la mortalidad, pero este efecto es frenado hasta que es alcanzado el nivel más bajo de la mortalidad.

Los modelos de simulación permiten obviar los supuestos menos realistas, en cuanto a decisiones extremas de los padres sobre el número de sus hijos. Heer y Smith (1968) formularon el supuesto de que los padres procrearán hasta tener una certeza de un 95 %, de tener por lo menos un hijo vivo, cuando el padre llega a los 65 años de edad. Y eligieron una edad crítica lo suficientemente elevada como para que los motivos de seguridad tuvieran una importancia principal. Sin embargo, sus suposiciones acerca de las metas reproductivas están asociadas a una función de preferencia de forma asimétrica, en la cual los puntos inferiores a la meta están menos valorados que los superiores a la misma. En resumen, sus suposiciones proporcionan una oportunidad para calcular la máxima respuesta de la fecundidad a los cambios de la mortalidad. Como se esperaba, la estrategia seguida conduce a que la tasa neta de reproducción disminuye mientras la esperanza de vida al nacer de las mujeres aumenta, hasta un nivel aproximado de 40 años. O'Hara (1972) introduce consideraciones sobre los espaciamientos óptimos en el modelo de Heer-Smith, con resultados que reducen en cada caso el nivel de la tasa neta de reproducción, pero dejan inalterada su reacción ante el cambio de la mortalidad. Para la mayoría de los actuales niveles de mortalidad, la fecundidad se compensa y la tasa neta de reproducción baja, cuando el nivel de la mortalidad mejora. La diferencia sustancial en el caso de la tasa neta de reproducción ante los cambios en la mortalidad, en el modelo de simulación de Heer-Smith, en relación al de Venkatacharya, es la amplia evidencia de que las diferencias entre el efecto reemplazo y los motivos de seguridad son fundamentales. En este caso la simulación, aunque no nos dice en qué forma proceden las parejas, ha identificado sin embargo un parámetro crítico de tal conducta que autoriza futuras investigaciones empíricas.

Es claro que alguna noción acerca de la forma de la curva de las preferencias individuales, acerca de la sobrevivencia de los hijos, tanto como el criterio acerca de la edad a la cual se asocia, es esencial para formular cualquier previsión sobre la magnitud de los efectos de la motivación de seguridad. Los esquemas de Myers y Roberts sobre las mujeres de Puerto Rico, están sesgados hacia la derecha y puede suponerse que este es el caso típico de los países menos desarrollados. Pero es necesario trabajar mucho, en este aspecto, todavía. Existe muy escasa evidencia acerca de la importancia actual de las motivaciones de seguridad. Las mujeres entrevistadas por Heer y Wu en Taiwán, fueron interrogadas acerca de como percibián la sobrevivencia de sus hijos. Si se mantenía constante el número observado de nacidos muertos por familia, aquellas mujeres que percibían una probabilidad inferior a 0,85, de que sus niños llegaran hasta los 15 años, tenían 0,26 más hijos adicionales que aquellas que percibían una probabilidad de 0,95 o más. Cuando el tamaño deseado de la familia se centra en alrededor de 4, como era el caso de Taiwan, aquellas mujeres que mostraban una probabilidad subjetiva de 0,80, tendían a tener aproximadamente un hijo más que aquellas mujeres que vislumbraban una probabilidad subjetiva de 1,0, conservando las demás condiciones aproximadamente iguales. El efecto actual de la motivación de seguridad es sólo una cuarta parte de esta magnitud, lo que indica una compensación incompleta para las variaciones de la percepción de sobrevivencia. Pero de hecho los padres no necesitan prepararse en todos los niveles de la mortalidad de sus hijos, cuando han observado la sobrevivencia de algunos de ellos ; es decir, es difícil elaborar una norma en relación a la cual pueda ser medida la cabalidad del efecto de compensación. Más aún, la confiabilidad de las respuestas a las preguntas sobre la sobrevivencia de los hijos, era muy baja. Heer y Wu muestran también, que en las regiones de alta mortalidad, si se controla la incidencia actual de la mortalidad infantil y la percepción medida acerca de la sobrevivencia de los hijos, los padres tienen 0,35 más hijos después del tercero que en las regiones de baja mortalidad, (p. 20). Los datos de Heer y Wu no permiten, sin embargo, distinguir si esta compensación "completa" depende o no de las diferentes probabilidades de sobrevivir en las dos regiones. Suponiendo una diferencia proporcional en P (a^*) de 0,1, donde a^* es la edad crítica, la diferencia en la fecundidad real con compensación completa, será de 0,4 niños cuando el tamaño deseado de la familia es 4. La respuesta real

representa así una compensación casi completa. Debido a que las aldeas defieren en muchos otros aspectos, además de la mortalidad, no es adecuado atribuír el efecto total de las diferencias exclusivamente a la mortalidad. Sin embargo, la mayoría de las demás variables concernientes a la fecundidad, fueron controladas en el nivel individual, y este resultado, combinado con la percepción del efecto de sobrevivencia, proporciona importantes indicios acerca de la fuerza potencial del efecto de motivación de seguridad. Rutstein (1974) construyó un índice acerca del miedo a la mortalidad de sus hijos con las respuestas de las mujeres entrevistadas en Taiwan, este índice se mostró correlacionado positivamente con la serie de probabilidades de agrandamiento de la familia, cuando se controla la situación actual de la mortalidad infantil. La naturaleza de la variable no permite afirmar cuales o tales efectos representan una compensación completa. En el aspecto negativo, Heer y Wu encuentran en Marruecos, que la creencia de que la mortalidad infantil ha mejorado en la generación pasada, está correlacionada positivamente con la evolución de la fecundidad.

Así, existen razones teóricas para pensar que los deseos reproductivos, formados sobre la base de los niños sobrevivientes hasta una edad de los padres, más allá del término de la vida reproductiva, podrían producir una reacción de compensación en exceso de la fecundidad sobre la mortalidad. Los resultados disponibles para Taiwan indican que los efectos empíricos pueden en realidad ser completamente decisivos. A diferencia de los mecanismos que se han revisado previamente, los límites de la falta de respuesta de la fecundidad, en el caso de la motivación de seguridad, son imposibles de determinar. El tiempo de respuesta depende no de condiciones objetivas, sino que de percepciones subjetivas acerca de tales condiciones, que pueden ajustarse lenta o rápidamente. La mayoría de las mujeres entrevistadas, en muchas encuestas realizadas en países menos desarrollados, indican que las mujeres perciben que las condiciones de la mortalidad han mejorado recientemente (Ver Heer y Wu, Tabla n° 3). Se desconoce, sin embargo, si las respuestas indican la rapidez y magnitud del cambio.

2c) Efectos de reemplazo combinados con efectos de motivación de seguridad

Por motivos de análisis hemos separado los efectos de reemplazo de los efectos de seguridad. Pero en la realidad actúan a menudo en coordinación. Incluso en las parejas cuyas metas reproductivas son elaboradas en términos de hijos sobrevivientes hasta alguna edad comprendida en el período reproductivo, pueden producirse motivaciones de seguridad si saben que los obstáculos a la reproducción pueden intervenir antes del término de su vida fértil. Lo mismo puede ocurrir si se cree que la mortalidad puede amenazar el reemplazo. Por otro lado, aquellas que han fijado una edad crítica bien posterior al término del período de vida reproductiva, tendrán en todos los casos la oportunidad de observar y de reaccionar ante la mortalidad, continuando la prosecución de sus objetivos. Mientras más alta sea la edad crítica de los padres, mayor será el efecto de motivación de seguridad en relación al efecto de reemplazo. En los países donde las funciones primarias de la progenie son mantener a los padres en su vejez, perpetuar el propio linaje, realizar cultos funerarios, etc. los efectos de seguridad deben ser relativamente más intensos en niveles de mortalidad similares, que en los países donde los padres quieren tener hijos por motivos desinteresados (ver Retherford).

La razón reside en la considerable concentración de la mortalidad infantil en las edades jóvenes. Al término del período de vida reproductiva de los padres, los niños tendrán en promedio 10 a 15 años de edad. Los primeros dos años de vida habrán sido los más duros. Los padres pueden prever la sobrevivencia de sus hijos, no a través del entero transcurso de su vida hasta la edad adulta, como ocurre en nuestro ejemplo simplificado, sino que en realidad a través de las edades de más baja mortalidad. Incluso cuando una fuerte compensación pueda ocurrir, a menudo, por la variación de la mortalidad, durante este estrecho período de la vida, esta compensación puede ser incompleta en relación al cambio total de la mortalidad infantil y de la niñez. Los padres pueden tener una oportunidad de reaccionar ante los cambios en la mortalidad, debido a que la mayor parte de las muertes anteriores a la edad crítica, habrán ocurrido durante el ciclo reproductivo mismo. Por ejemplo, si 10 niños nacen con dos años de intervalo en mujeres que han iniciado su vida reproductiva a los 20 años, en una población con una esperanza de vida al nacer de 35 años ; entonces el 74 % de las muertes que ocurrirán en estos niños, antes de que ellos alcancen los 30 años de edad, habrán ocurrido antes de que la madre alcance la edad de 40 años ; a una esperanza de vida al nacer de 60 años, la proporción de 68,3 %, (tomado de Coale y Demeny, 1966 : 8 y 18).

3) Implicaciones para el crecimiento de la población, de cambios en la mortalidad en combinación con mecanismos sociales

Los argumentos de Notestein y Davis sugieren que las sociedades pre-industriales tenderían, a través de diversos medios, a desenvolver prácticas normativas que le aseguraran altos niveles de fecundidad. Tales niveles serían necesarios para contrarrestar la alta mortalidad ; sin ellos, una sociedad estaría condenada a la extinción. El mecanismo más importante para asegurar la sobrevivencia demográfica era el sistema de la familia extendida, que procuraba el ahorro de muchos de los gastos del matrimonio para las parejas y de la crianza de los niños para los padres (Davis, 1955). Por axioma, en una población cerrada, las tasas de natalidad deben ser mayores que las de mortalidad, para asegurar la sobrevivencia demográfica ; el hecho de que para asegurar esta

sobrevivencia se requería una alta fecundidad suponía que la alta mortalidad era un "factor dado", independiente en gran medida, de los niveles de fecundidad. Aunque esto es indudablemente una super-simplificación y tal vez la visión de las poblaciones, adoptando tasas combinadas de fecundidad y mortalidad dentro de ciertos límites, sea demasiado refinada ; con toda verosimilitud los menores niveles de fecundidad requeridos para asegurar la sobrevivencia, eran mucho más altos que los requeridos actualmente en la mayor parte de las regiones del mundo.

¿ Qué pasó cuando las condiciones que hacían necesaria una alta fecundidad desaparecieron ? También desaparecieron las ventajas selectivas propias de las poblaciones con alta fecundidad. Pero el proceso evolucionista de selección, que necesitaron esas sociedades para adaptarse más exitosamente a las nuevas condiciones, presumiblemente demoró milenios en consumarse ; la adaptación óptima no es aparentemente la rápida progresión hacia una situación específica, tan obvia actualmente. Es decir, esta perspectiva no permite fundamentar previsiones útiles de los acontecimientos que pueden ocurrir en plazos limitados después que ocurrió la reducción de la mortalidad.

Un enfoque más útil considera que las sociedades preindustriales estaban enfrentadas no sólo a los problemas de los altos niveles de la mortalidad sino que también con la extraordonaria variación de esos niveles y con los límites del tamaño del grupo. Desde que la sobre-población puede también plantear una amenaza a la sobrevivencia del grupo, y debido a que las previsiones sobre los cambios de la mortalidad eran impracticables, es razonable pensar que muchas sociedades generaron mecanismos mediante los cuales la fecundidad variaba en relación directa a los cambios de la mortalidad. Es claro que la biología permite la posibilidad de tales cambios. Las estructuras de la fecundidad y mortalidad por edad aseguraban que la muerte estaba concentrada en los extremos de la vida y la procreación en el centro, de tal manera que, después de una crisis en que aumentaba la mortalidad, la distribución por edades de la población sobreviviente se hacia ocasionalmente favorable a una tasa de natalidad y a una rápida recuperación. La supresión de la ovulación durante el período de lactancia, contribuía también a hacer flexible este proceso.

Entre los mecanismos sociales que evolucionaron con este efecto, los mejores documentados son probablemente aquellos que operaban a través de la edad al casarse y de la proporción de la población casada, aunque la extendida separación de los padres después de un nacimiento y los tabúes referidos a las relaciones sexuales durante el amamantamiento de los hijos, pueden haber sido igualmente importantes. En Europa, la evolución y difusión de la norma de que el marido debería ser directamente responsable de la mantención de su esposa e hijos, combinado con un modo de producción agrario en el cual los recursos para tal mantenimiento en primer lugar la tierra- estaban estrictamente delimitados en el grupo, proporcionaban mayores oportunidades de un cambio en la fecundidad como respuesta a los cambios de la mortalidad. Una crisis de mortalidad aumentaría el número de viudos y viudas, herederos y herederas, y aumentaría también las posibilidades de matrimonio y paternidad entre los sobrevivientes solteros. La clave del sistema era la propiedad individual de la tierra y Geertz (1968) demuestra sobre la base de estudios realizados en Java que se producen reacciones de la fecundidad como respuesta a cambios en la mortalidad, cuando la tierra ha sido distribuída en las aldeas de acuerdo a las "necesidades" de la familia. Friedlander (1969) ha encontrado en estudios realizados sobre los hábitos matrimoniales en Europa, que las relacioes entre la fecundidad y la mortalidad se atenúan cuando existen "válvulas de seguridad" para la presión demográfica. Sugiere, además, que es posible que, en el caso de Inglaterra, la larga separación entre la baja de la mortalidad y la reducción de la natalidad, pueda encontrar una explicación satisfactoria en el efecto simultáneo del proceso de industralización y de las posibilidades de emigración rural-urbana que este proceso facilitó. Las migraciones a ultramar, las extensiones geográficas de los recursos básicos y la intensificación de los cultivos agrícolas, constituyen también válvulas de seguridad en determinadas circunstancias. Algunos de estos factores pueden afectar la fecundidad. Por ejemplo, las migraciones de las áreas rurales a las urbanas exponen a una proporción creciente de la población, a la influencia de un contexto convencional de baja fecundidad.

Los documentos básicos suministran algunas evidencias nuevas acerca de la intensidad del conjunto de relaciones entre la mortalidad y la fecundidad, relaciones que incluyen factores tanto individuales como sociales. Matthiessen confirma que los esquemas temporales de reducción de la mortalidad y de la fecundidad en los siglos XIX y comienzos del XX, son diferentes e inconsistentes de región a región. La diversidad es de una naturaleza suficiente como para rechazar la posibilidad de que el cambio en la mortalidad sea el único factor causante de reducción de la fecundidad en Europa en este período. Los resultados de correlaciones transversales son igualmente variadas. Escocia, Francia, Italia Portugal y la parte urbana de Alemania muestran fuertes correlaciones cruzadas positivas entre fecundidad y mortalidad por regiones en el siglo XIX y estas correlaciones se mantuvieron en otras áreas donde fue posible controlar otras variables como el analfabetismo. Sin embargo, en Inglaterra y Bélgica no se presenta esta conclusión y el estudio de Lesthaege (1974) sobre los datos de Bélgica es serio y convincente al respecto.

Lapham y colaboradores mostraron la relación relativamente estrecha y curvilínea que existe entre las tasas crudas de natalidad y las tasas de mortalidad infantil, que existían en 74 países en desarrollo, alrededor de 1960. Sin embargo, Cantrelle y colaboradores mostraron que la correlación transversal de orden cero era

negativa entre naciones y regiones de Africa tropical. Ellos señalan también, que las variaciones en las condiciones de salud pueden afectar tanto la incidencia de la esterilidad como la mortalidad infantil hasta el grado de producir esta correlación negativa.

En Gabón, por ejemplo, la tasa de mortalidad infantil es muy alta, del orden de 229 por 1000, pero aproximadamente la cuarta parte del período reproductivo de la mujeres ha sido perdido por la esterilidad provocada principalmente por la malaria, hecho que ha ocasionado una reducción de los niveles de fecundidad. Por otra parte en la India, las cifras de Agrawal sobre las tasas regionales de natalidad, tasas totales de fecundidad y tasas de mortalidad infantil, sugieren una intensa asociación entre mortalidad y fecundidad (tabla 17). Si se toman como base los datos de esta tabla, la correlación de orden cero entre la tasa total de fecundidad y la mortalidad infantil en 12 estados de la India alreador de 1970, puede ser calculada en 0,560 ; en 17 estados la correlación entre la tasa de mortalidad infantil y la tasa cruda de natalidad fue 0,654. Si se controla la proporción de población alfabeta por regiones, los coeficientes de correlación parcial, equivalentes, fueron 0,340 y 0,520 ; si se controla la proporción de población rural, estos coeficientes son 0,597 y 0,668. Todos los coeficientes de correlación calculados con la excepción de uno fueron significativos en el nivel del 5 %. Evidentemente las correlaciones entre estas características en los países menos desarrollados de la hora actual son tan diferentes como lo eran entre los países de Europa de hace aproximademente un siglo atrás. Predominan las correlaciones positivas y significativas. Pero las inferencias causales que se pueden inducir de estos datos son estremadamente limitadas.

El cambio en la mortalidad puede afectar el nivel de la fecundidad en el contexto social, no sólo cambiando las condiciones objetivas en las cuales se produce la reproducción, sino que también cambiando las actitudes y disposiciones mentales con que los individuos enfrentan tales situaciones. Se ha sostenido que el fatalismo- una actitud que implica creer que los acontecimientos están fuera del control del individuo- es una razón significativa por la cual muchos individuos no ejercen control sobre su propia fecundidad. Pero hay escasa evidencia empírica en apoyo de este punto (Williamson, 1970). En los países menos desarrollados, una de las formas más baratas y más significativas mediante la cual puede cambiarse la vida de un individuo es probablemente a través de los mejoramientos de la salud. La demostración de que tales cambios están al alcance de los individuos puede provocar cambios de actitud psicológica que hagan más aceptable la contracepción (Taylor, 1965 ; National Academy of Sciences, 1971). Un argumento del mismo tipo sostiene que la presión de la población en la familia y en la sociedad debe alcanzar cierto límite crítico antes que se acepte la innovación (uso de contraceptivos). Sin embargo, una vez que este uso es aceptado, se producirá un efecto de bola de nieve, tanto sobre el aceptante como por parte de los observantes convencidos. Pero este argumento debe ser considerado puramente especulativo hasta que se concluya un estudio empírico más detenido.

Conclusión

En casi todas las sociedades la baja de la mortalidad parece aumentar las tasas de crecimiento de la población. El descenso de la fecundidad compensará en parte este efecto ; pero estas reducciones de la fecundidad difícilmente podrán compensar todo el aumento provocado por la declinación de la mortalidad. En las poblaciones que no practican el control de la natalidad, a lo más la tercera parte del aumento de la tasa neta de reproducción, inducido por la baja de la mortalidad, puede ser compensado por los mecanismos involuntarios que actúan reduciendo la fecundidad. En las poblaciones donde el control de la natalidad está difundido ampliamente, incluso el reemplazo de cada hijo que muere tenderá a producir una relación negativa entre los niveles de la mortalidad y la tasa neta de reproducción. Sin embargo no se espera un reemplazo completo, y este no ha sido observado jamás. El reemplazo tiende a ser mínimo en las poblaciones con altos ideales de fecundidad, es decir, precisamente en aquellas en que los efectos económicos y sociales del rápido crecimiento demográfico son a menudo más intensos.

Las motivaciones de los padres para tener un cierto número de niños sobrevivientes, hasta una edad posterior al término de su vida reproductiva, parece ser el único mecanismo capaz de producir una sobre compensación mediante el cambio de la fecundidad. Sin embargo, la sobrecompensación, en este caso, se aplica lógicamente sólo en los cambios de la mortalidad que ocurren en un intervalo de edad muy limitado, intervalo que no incluye precisamente las edades de máxima reducción de la mortalidad. La sobrecompensación de la fecundidad debida a estas motivaciones depende de la forma de la curva de preferencia, la que debe tener un marcado sesgo hacia el lado del mayor número de hijos, forma que ha tenido muy poca validación empírica. Sin embargo, la respuesta puede ocurrir después de una importante demora, porque depende de la percepción, por parte de los padres, de que se ha producido un cambio en la mortalidad. Los cambios de la mentalidad, como por ejemplo el abandono de actitudes fatalistas, que son provocadas por la baja de la mortalidad, puede también generar modificaciones compensatorias en la fecundidad. Pero, por el momento, este tipo de planteamientos tiene una fuerte dosis de especulación.

En resumen, la argumentación en favor de la reducción de la mortalidad como una forma de disminuír las tasas de crecimiento, descansa en bases muy débiles y en razonamientos muy especulativos. Hay, sin embargo, muchas otras razones para proseguir tales programas, y hay seguramente casos en que se desea lograr un aumento del crecimiento. En tales casos los programas de reducción de la mortalidad contribuíran muy positivamente al logro de tal objetivo. Independientemente del objetivo deseado, la conclusión más evidente que se desprende tanto de los documentos presentados, como de las actuales tasas de crecimiento de la población mundial, es que las futuras reducciones de la mortalidad tenderán a aumentar el ritmo de crecimiento de la población por lo menos durante varias décadas, o aún por períodos más extensos.

(Para los detalles de la bibliografía, ver el texto en inglés).

THE MEASUREMENT OF FERTILITY AND CHILD MORTALITY TO INVESTIGATE THEIR RELATIONSHIP IN STUDIES OF AGGREGATE AND FAMILY DATA

W. BRASS
Professor of Medical Demography,
Department of Medical Statistics and Epidemiology,
London School of Hygiene and Tropical Medicine
and J. C. BARRETT
Senior Lecturer in Medical Demography,
London School of Hygiene and Tropical Medicine

SUMMARY

There are many ways in which fertility and child mortality are related. The problem with which this paper is concerned is the separation out of the effects which give primary evidence that the child mortality level is a direct determinant contributing to the fertility level. This requires decisions about types of measurement and the organisation of these measurements.

Briefly, relations may exist because of : –

a) heterogeneity of populations (e.g., socio-economic sub-groups with systematic differentials in both fertility and mortality) ;

b) spurious artifacts due to the collection of data and specification of measures so that chance factors are correlated with the significant indices ;

c) factors which influence both fertility and mortality but which are not affected by them ;

d) reflections of the converse relation, that is, effects of fertility on mortality appearing as the reverse ;

e) non-volitional factors, e.g., operating through the shortening of post-partum amenorrhoea when a child dies ;

f) data errors through omissions or wrong timing of events which induce false correlations ;

g) Biases which arise in the attempt to detect volitional effects in the required direction in the presence of some of the other relations are considered.

In aggregate studies, groups of families in communities are investigated through average measures (for districts, regions and even countries). The relations sought will combine family and community or societal influences. The problems of choice of measure are often solved by the availability of data which usually come from vital registration and census. Since child mortality after age three is low and that before three, due to similar influences over a short age interval, it seems likely that any convenient measure such as $_2q_0$, $_5q_0$, *or* $_5m_0$ *will do equally well, but it may be useful to distinguish neo-natal deaths. Age standardized fertility and marital*

fertility rates such as used in the Princeton European Fertility Transition programme are appropriate measures.

Special problems arise in developing countries where series of rates are obtained from retrospective reports of children born and died. The use of the multiplier techniques (Brass, Sullivan, Trussel) to estimate child mortality seems satisfactory but methods of calculating fertility mainly average over long time periods, depend on the child mortality or both. The P/F ratio method or the direct use of P_2 or P_3 may be most appropriate. Similar problems arise in estimating series of rates from maternity histories ; the difficulties are acute and have been little explored.

The major hindrance, however, in aggregate analysis is the need for replication in space and time to separate the fortuitous from the systematic effects. Time lag influences may dominate, there is a need for multiple time series with short intervals. These are hard to find and the analysis in the presence of high auto-correlations is formidable.

Analysis of family data can be more incisive, since its aims are specific although limited and measures can be manipulated more freely. However, biases from the "nuisance" factors which are not relevant to the mortality-fertility volitional path may be considerable. A computer simulation programme, developed to examine these, is described in the Appendix. Since no volitional effects of mortality on fertility are put into the simulation, any relations which appear are due to bias in the present sense.

Stochastic influences are illustrated in tables 1 to 3. They show the dangers of relating total births and child deaths and the need to measure births subsequent to a specified child death experience, with control of parity.

In tables 4 and 5, biases which arise from the post-partum infertility variation with child survival are examined. With parity control, the bias may be as much as one third of a child with a movement from no child deaths to a substantial number. With parity and exposure to risk control, the bias in the mean subsequent births seems to disappear for long follow-up periods but not for short ones.

For the simulations in Tables 7 and 8, a variation in child mortality with birth concentration is introduced of a size which fits with empirical knowledge. With parity control, the bias in mean subsequent births goes up to one half or two thirds of a child, for the same other conditions as in Table 4. The addition of the control for exposure to risk gives what at first seems a puzzling result since the mean subsequent births now show a downwards bias with a rise in child deaths. The apparent explanation is that for nominal exposure held constant for women with a given parity, the real exposure goes up with more child deaths. The women with child deaths are therefore, actually and potentially, less fertile.

RÉSUMÉ

La mortalité de l'enfant et la fécondité de la mère peuvent être liées de bien des façons. Parmi toutes ces liaisons possibles, ce document a choisi d'étudier les faits montrant à l'évidence que la mortalité de l'enfant contribue à déterminer directement la fécondité de la mère. Cette façon d'aborder le problème entraîne le choix de certains indices.

En bref, les relations entre les deux phénomènes peuvent exister pour les raisons suivantes :

a) La population est hétérogène (c'est-à-dire qu'elle est composée de sous-groupes économiques présentant systématiquement des différences de mortalité et de fécondité).

b) De fausses apparences sont observées, dues à la façon de rassembler les données et aux instruments de mesures utilisés, si bien que les variations aléatoires sont en corrélation avec les indices choisis.

c) La fécondité et la mortalité sont toutes les deux influencées par certains facteurs sur lesquels elles n'ont pas d'influence.

d) La fécondité agit sur la mortalité et la relation est interprétée à l'envers.

e) Il existe des facteurs non volontaires diminuant l'aménorrhée puerpérale quand l'enfant meurt.

f) Il y a des erreurs dans les données, dues à des omissions d'événements ou à leur mauvaise datation, ce qui fait apparaître de fausses corrélations.

g) Des erreurs de jugement peuvent se produire quand on cherche à mettre en évidence des effets volontaires dans la direction souhaitée aussitôt que certaines des autres relations mentionnées ci-dessus existent.

Dans des études utilisant des données d'ensemble, des groupes de familles appartenant à des communautés sont étudiés à l'aide d'indices moyens (par district, par région ou même par pays). La relation cherchée est une combinaison des influences de la famille, de la communauté et de la société. Le choix des indices de mesure est souvent dicté par la disponibilité des données qui, en général, proviennent des recensements et des statistiques de l'Etat civil. Du fait que la mortalité des enfants après trois ans est faible et qu'avant trois ans, elle reflète des influences qui sont très semblables à tous les âges sur un si petit intervalle d'âge, n'importe lequel des indices comme $_2q_0$, $_5q_0$ *ou* $_5m_0$ *conviendra parfaitement. Il peut toutefois être utile de distinguer la mortalité néo-natale.*

Des taux comparatifs de fécondité ou des taux de fécondité légitime comme ceux qui sont utilisés dans l'étude de la transition démographique en Europe par l'Université de Princeton sont des indices appropriés.

Les pays en développement dans lesquels des séries de taux sont obtenues par des enquêtes rétrospectives sur les enfants nés et morts présentent des problèmes particuliers. La technique des multiplicateurs (Brass, Sullivan, Trussel) utilisée pour estimer la mortalité des enfants semble satisfaisante, mais les méthodes de calcul de la fécondité, surtout des moyennes sur de longues périodes, donnent des résultats qui dépendent de la mortalité des enfants, la relation inverse pouvant d'ailleurs aussi exister. La méthode du rapport P/F ou l'utilisation directe de P_2 *ou* P_3 *peut être la plus appropriée. Des problèmes analogues se présentent quand on cherche à estimer une série de taux à partir d'histoires génésiques. Les difficultés sont réelles et ont été jusqu'ici peu étudiées.*

Toutefois l'obstacle principal dans les analyses d'ensemble vient du fait que les conditions de temps et d'espace doivent être les mêmes pour séparer ce qui est fortuit et systématique dans les observations.

Des décalages dans le temps peuvent aussi avoir une influence déterminante et il faut alors de nombreuses séries temporelles portant sur des intervalles courts. Il est difficile de les trouver et leur analyse présente de sérieuses difficultés quand on se trouve en présence de fortes auto-corrélations.

L'analyse des données familiales permet d'aller beaucoup plus loin, ses objectifs étant spécifiques bien que limités. De plus, les problèmes de mesure peuvent être résolus plus facilement. Toutefois les facteurs "perturbateurs" indépendants de la relation volontaire qui lie la mortalité et la fécondité peuvent introduire des erreurs de jugement considérables. Un modèle de simulation sur ordinateur, dont la description figure en annexe, a été construit pour examiner ces effets perturbateurs. Puisqu'aucune relation volontaire entre la mortalité et la fécondité n'existe dans le modèle, toute relation apparaissant entre ces deux phénomènes est due aux effets perturbateurs qu'on vient de mentionner.

Les tableaux 1 à 3 mettent en évidence les effets stochastiques. Ils montrent combien il est dangereux de rapprocher un total de naissances du total de décès d'enfants et que toute mesure fondée sur les naissances qui se produisent après la mort d'un enfant doit tenir compte de la parité de cet enfant.

Les tableaux 4 et 5 examinent les erreurs de jugement qui peuvent se produire quand on étudie les variations de l'infécondité liée à la période postpartum en fonction de la survie de l'enfant.

Si l'on tient compte de la parité, en passant d'une situation sans décès d'enfants à une situation avec une proportion importante de décès, l'erreur de

jugement peut atteindre un tiers d'enfant.

Si l'on tient compte à la fois de la parité et du temps d'exposition au risque de conception, l'erreur de jugement sur la moyenne des naissances à venir semble disparaître sur une longue période d'observation, mais pas sur une courte période.

Dans les tableaux 7 et 8, la variation de la mortalité des enfants est associée à une concentration des naissances correspondant à ce que l'expérience nous enseigne. En tenant compte de la parité, l'erreur de jugement sur la moyenne des naissances à venir s'élève à 1/2 ou 2/3 d'un enfant et cela pour des conditions analogues à celles du tableau 4. Si l'on tient compte en plus du temps d'exposition au risque de conception, le résultat obtenu paraît curieux. En effet, l'erreur de jugement sur la moyenne des naissances à venir diminue quand la mortalité augmente. L'explication vient sans doute du fait que pour une parité donnée, si l'on maintient la même durée nominale d'exposition au risque, on suppose en réalité une durée d'exposition qui augmente quand la mortalité des enfants s'accroît. Les femmes dont les enfants meurent sont donc, présentement et potentiellement, moins fécondes.

RESUMEN

Existen diversas formas de inter-relación entre la fecundidad y la mortalidad de la niñez. En este documento se trata de dar importancia primordial a la detección de los efectos que indican que el nivel de la mortalidad de la niñez es un factor que contribuye directamente a la determinación del nivel de la fecundidad. Esto requiere una decisión acerca del tipo de medidas a emplear y acerca de como calcularlas.

Resumiento, las relaciones pueden deberse a :

a) el carácter heterogéneo de las poblaciones (por ejemplo, la existencia de subgrupos socio-económicos con diferencias sistemáticas tanto en la mortalidad como en la fecundidad.) ;

b) relaciones espureas debidas a que la recolección de los datos y la definición de las medidas se ha hecho de tel manera que los factores aleatorios estén correlacionados con los índices significativos ;

c) factores que influencian tanto a la fecundidad como a la mortalidad pero que son independientes de estas características ;

d) efectos reflejos de relaciones recíprocas, es decir, efectos de la fecundidad sobre la mortalidad que aparecen de una manera inversa ;

e) factores no-volitivos, por ejemplo, aquellos que operan a través del acortamiento del período de amenorrea post-partum cuando muere un niño ;

f) errores de los datos debidos a omisiones o fechas equivocadas de los acontecimientos que inducen falsas correlaciones ;

g) sesgos que aparecen cuando se intenta detectar efectos volitivos en la dirección exigida por la presencia de algunas de las demás relaciones.

En los estudios globales se investigan grupos de familias en comunidades a través de medidas promedios (por ejemplo distritos, regiones e incluso países). Las influencias familiares, de la comunidad y de carácter social, aparecen combinadas en las relaciones que se investigan. La disponibilidad de los datos decide a veces el problema de seleccionar las medidas a utilizar. Los datos proceden generalmente de los registros civiles y de los censos. Es recomendable calcular medidas tales como $_2q_0$, $_5q_0$ *o* $_5m_0$, *ya que la mortalidad sobre los tres años de edad es mas baja que antes de esa edad. Sin embargo puede ser muy útil diferenciar la mortalidad neo-natal. Puede agregarse que algunas medidas utilizadas en el Programa de Estudio de la Fecundidad Europea de la Universidad de Princeton son también recomendables, entre ellas las tasas de fecundidad tipificadas por edad y las tasas de fecundidad según estado civil.*

En los países en desarrollo se presentan problemas especiales cuando las series de tasas se obtienen mediante métodos retrospectivos sobre los niños nacidos vivos y muertos. El uso de la técnica de los multiplicadores (Brass, Sullivan, Trussel) para estimar la mortalidad de la niñez, parece ser satisfactoria ; pero los métodos para calcular la fecundidad media en largos periodos depende de la mortalidad de la niñez o de ambas. El método de la razón P/F o el uso directo de P_2 o de P_3 puede ser más adecuado. Problemas similares se presentan en la estimación de series de tasas sobre la base de historias maternales ; estas dificultades son bastante agudas y han sido poco exploradas.

Sin embargo, la dificultad mayor en el análisis de datos globales, es la necesidad de distinguir los efectos aleatorios de los sistemáticos en las respuestas de contenido espacial y temporal. Las series cronológicas múltiples, con intervalos pequeños, pueden ser necesarias para evitar los problemas de desfase. Estos son difíciles de encontrar y el problema para el análisis cuando existen altas auto-correlaciones es extraordinario.

El análisis de los datos a nivel familiar puede ser más productivo, ya que sus propósitos son específicos aunque limitados, y las medidas pueden ser manejadas con más libertad. Sin embargo, los sesgos provenientes de los factores "parásitos" impropios de las relaciones volitivas entre la mortalidad y la fecundidad, pueden ser muy grandes. En el Apéndice se expone un programa de simulación para computadores, útil para estudiar estos problemas. En este sentido, si los efectos no-volitivos de la mortalidad sobre la fecundidad son incluídos en el modelo de simulación, cualquier relación que aparezca puede ser atribuída a sesgos.

Las influencias estocásticas son ilustradas en las tablas 1 y 3. Ellas muestran los riesgos de relacionar los totales de los nacimientos y de las defunciones de niños y la necesidad de medir los nacimientos subsiguientes a la experiencia de la defunción de un niño. incluyendo control de paridad.

En las tablas 4 y 5 se examinan los sesgos que provienen de la variación del período de esterilidad post-partum en relación a la sobrevivencia del niño. Si se realiza control de paridad, el sesgo puede ser tan alto acomo un tercio de niño, con una variación que va de los casos en que no hay defunciones de niños hasta aquellos en que hay varias. Mediante control de paridad y de exposición al riesgo, el sesgo en el promedio de los nacimientos subsiguientes parece desaparecer en períodos de seguimiento largos, pero no en los cortos.

La variación de la mortalidad de la niñez en relación con la concentración de los nacimientos, en los modelos de simulación de las tablas 7 y 8, es presentada para una magnitud que puede ser ajustada a los datos empíricos. Con control de paridad, el sesgo en el promedio de los nacimientos subsiguientes va desde un medio hasta dos tercios de un niño, manteniendo las demás condiciones como las de la tabla 4. Si se agrega el control por exposición al riesgo se encuentra lo que a primera vista parece ser un embrollo, ya que el promedio de los nacimientos subsiguientes muestra ahora un sesgo descendente a medida que aumentan las muertes de los niños. La explicación aparente es que si la exposición nominal se mantiene constante en las mujeres según una paridad dada, la exposición real aumenta a medida que aumentan las defunciones de niños. Por lo tanto las mujeres que han experimentado defundiones de sus hijos, son al presente y potencialmente, menos fecundas.

1. Introduction

Fertility and child mortality are related in many different ways. There is seldom any need to establish this. The relevant issue is the interpretation of the interactions. In particular the topic of the seminar (the consideration of how the level of child mortality and changes in it may affect fertility) requires an understanding of how this particular form of relation can be detected in the presence of others. The purpose of this paper is to outline the main problems of establishing the relevant effects and the possible methods of approach. It is intended to serve as a framework for discussion and not as a definitive study. With our present knowledge and stock of observations it would be premature to attempt the latter ; this indeed is one of the main reasons for the Seminar.

2. Classification of Relations

A brief indication of the types of mortality-fertility relation which may exist is necessary to clarify the subsequent arguments. Firstly there are several ways in which statistical correlations can arise without any meaningful association. The most elementary are artifacts due to the variability in the characteristics and the nature of the data collection. There are a number of "chance" factors which affect the size of families such as age at sterility of the woman. Since the probability of a child death varies with the length of exposure to risk and many other features such as the age of the mother and the parity of the birth, the "chance" variation is not neutral with respect to the relation of interest. As will be demonstrated later these artificial interactions can operate in complex ways. Another kind of interference comes from heterogeneity of the population. For example, if both fertility and child mortality decrease with rising income, then there will be an association between the two characteristics which does not come from any influence of one on the other. From the present viewpoint the relationship is irrelevant or spurious. A slightly different but similar effect is that of coincidence when time series are being compared ; some factor or factors may cause systematic changes in both fertility and child mortality so that there is a positive or negative correlation between them. Of course, such nuisance effects through mediating variables are a difficulty in all studies of relations from observational data. There is no logical method of avoiding them. But the dangers in the present context are particularly great and methods for reducing or assessing their impact of primary importance.

The associations of direct determination may be in either direction. That the level of fertility can have an effect on child mortality is well-established. Probabilities of survival are poorer for births to older women and/or of higher parities ; obviously these tend to be in larger families. In abstract theoretical terms this might be a reverse reflection of a making-up of births by couples whose children are subject to a high mortality but there is a large weight of evidence that the more obvious explanation is the true one. To argue this fully would require a paper on its own but it is here accepted as true. Thus in any analysis which shows a decrease in fertility with lowered child mortality the possibility that the effect is from former to latter must be considered.

Within the category of influences, which are directed from the child mortality to fertility several sub-classes need to be specified. The process may be volitional or non-volitional. Of the latter kind the most obvious and discussed example is the effect of an infant death on the post-partum infertility period of the mother. The expected waiting time until the resumption of fecundity is lessened, in whole or in part through the reduced length of lactation. Other things being equal the exposure to risk period is shortened less for a child dying young than for one which survives. There is thus compensation acting through a bio-social mechanism and not through any consciously or unconsciously motivated activity. There are other possibilities for non-volitional effects although less is known about these. Thus, if the nutritional level and health of the woman are factors in the age at menopause (there is some data to support the idea), early child deaths may reduce the burden on the mother and increase the total period of exposure to the risk of conception.

Volitional effects of child mortality on fertility are also conveniently sub-divided into two classes which may be labelled family and community. In the former case the deaths of children to a couple are a determining factor on the attempts to produce subsequent children. This may operate through the use of family planning when the desired number of surviving children (or an upper risk limit for that number) is achieved or through less closely controlled means such as frequency of intercourse and separations of husband and wife. Community effects come from a broad recognition by the couples in a population that the mean family size should be related to the average incidence of child mortality to meet the needs for survivors ; in particular they imply that if child mortality falls fewer births are required. Although there is no certain link between family and community effects it seems unlikely that the latter would occur without the former : the converse proposition is not so plausible. The separation of community and family components of variation is a difficult task for any demographic phenomena and little progress has been made in the topic. To undertake the separation for the fertility-mortality relation would require a range and detail of data in addition to a sophistication of analysis which is at present beyond our resources. The problem will not be considered here.

The strategy for the detection and verification of the volitional influence of child mortality on fertility is easy to define if difficult to apply. Firstly those measures must be chosen which can plausibly be expected to display particular patterns if the volitional hypothesis is valid and which are insensitive to the influences of the other "nuisance" interactions ; the possible quantitative biases from the latter must be assessed and eliminated where practicable. The strength of the case will increase with the variety and precision of the patterns postulated since the possible interference of uncontrolled "nuisance" factors will then be less likely.

3. Aggregate Studies

In aggregate studies the mortality and fertility measures analysed are for groups of families. These are usually large groups, for example countries, regions or districts, mainly because of the nature of the data

available. There are, in fact, some possible advantages of large groups if these are culturally and socially homogeneous since the pattern of interaction may then be easier to discern but smaller units in bigger numbers supply more repetition of similar basic measures in different conditions. The effects sought must be from the mixture of family and community factors which combine in the overall indices. The analysis may be cross-sectional, that is of aggregates at a given period, serial over time, or both. Commonly, in cross-sectional studies child mortality is one of a number of variables which are used to "explain" fertility by regression techniques. However, the possibility of interference from the sources described in section 2 is so great and the scope for eliminating these so small that the approach is not promising. The interpretation of time series for a single aggregate is only slightly less forbidding. There is an important extra advantage from the fact that the time dimension gives some guidance on the direction of the effects (changes in child mortality can be related to later fertility movements) but this is offset by the severe statistical problems of auto-correlation.

The investigation of time series for a number of aggregates which share the wider socio-economic influences but with variations in impact and tempo is more attractive (for example regions or districts within a country). If there is good vital registration and adequate estimates of populations at risk the choice of demographic measures is not critical. Child mortality is heavily concentrated in the first three years after birth. There is little gain in going beyond that interval in terms of extra numbers and considerable advantage in the concentration of the measure over a short age range for time specificity. The common division of mortality under one year from that in the second and third has little to recommend it in biological or social terms ; if a separation is to be made it would be better of deaths under one month from the remainder. In practice one index of mortality such as ${}_2q_0$, ${}_5q_0$ (probabilities of dying by 2 or 5 years) or ${}_5m_0$ (death rate in first five years) seems sufficient.

For fertility there is the important distinction between general and marital rates and the need to apply some kind of age standardization. There is good reason to believe that changes in marriage patterns are caused by different factors than those affecting family size and it does not seem likely that child mortality is an influence on the former. The study should then be of age standardized marital fertility. The Princeton programme on the European fertility transition used indirect standardization based on the rates of married Hutterites but there are a variety of approaches which would be equally valid. In practice, the decisions are determined by the data available. The use of cruder measures such as the marital or general fertility, or even the crude birth rate will not necessarily lead to serious distortions, compared with the uncontrolled variation, over periods when age and marriage patterns are altering little (for example in many historical studies).

A theoretical case can be made for the use of cohort rather than time-period measures. Clearly this is unimportant for early childhood mortality but it might be speculated that any influence of this would operate through the subsequent actions of the cohorts of women who experienced a particular infant death incidence around their ages of greatest fertility. However, community effects could have a quite different time lag and variability of response tempo would blur the sharpness of any impact. It seems unlikely that much is to be gained by the use of cohort methods at the present stage of knowledge and the appropriate data are seldom available.

The general points above apply also when good registration statistics and population at risk estimates are not obtainable and substitute methods are required to derive the necessary measures. Further issues arise from the nature of the indirect techniques. Usually, the attempt will be to derive fertility and child mortality measures from data collected at Censuses or large scale demographic enquiries for sub-aggregates (districts for example). The only satisfactory source of information for the mortality estimates is of total children born and died to the younger women. There are reliable means for turning the proportion of children dead by age of mother into conventional indices, developed by Brass (see The Demography of Tropical Africa and elsewhere) and elaborated by Sullivan (Population Studies 26(1)) and Trussel (to appear in Population Studies). These give convenient measures of child mortality for the present purpose ; in particular an estimate of ${}_2q_0$ for the births in the few years previous to the enquiry is obtained from the reports on child deaths by women ages 20-24 years. The bias that exists because of the exclusion of higher parity births to older mothers may actually be an advantage here since the corresponding mortality can hardly have a family influence on fertility.

The derivation of an appropriate fertility index is not so straightforward. It might seem that the obvious measure was the mean completed family size of married women from the Census or Survey. But older women often understate the number of children born to them and the error may vary in ways which distort the relations sought. Again much of the child-bearing of these women will have taken place *before* the period to which the child mortality applies. The use of estimates from population age distributions and stable models also has this latter disadvantage. In addition the results are critically dependant on the level of child mortality assumed which may introduce serious biases into the analysis of the interactions. Reverse survival procedures are even more sensitive to the same problem. The technique for adjusting reported births in the previous year (or a recent period) to be consistent with the mean children born to the younger women is independent of the incidence of child deaths and gives a fertility level for about the same time as the mortality estimates. Where this method works it is probably the most satisfactory for the present purpose but it can be badly

distorted by age reporting errors. (See for example The Demography of Tropical Africa). A decision on the best measurement must depend on particular circumstances. For example the "own child" version of reverse survivorship can give satisfactory values for very recent fertility if completeness of coverage and age reporting are good for young children. The measures are dependent on the child mortality estimates but the effects of the resulting biases vary with the levels and differentials in the two sets of indices. They may not be critical. In practice the final estimates of fertility levels are often arrived at after comparison and assessment of values found by different techniques. The averaging, time-diffuse nature of the operation is obviously a serious limitation in any attempt to relate secular trends in fertility to those of child mortality.

4. Family Studies

In family studies attempts are made to examine the relation between the deaths of children and the total numbers of births. This could, in theory, be done for couples but more commonly the observations are from maternity histories of women. The specificity of the hypothesis and data give wider scope for the exclusion of nuisance factors in the interpretation of patterns but the danger of artificial and irrelevant interactions is greater than for aggregates. Although there is an important practical distinction between prospective maternal history studies (where subsequent additional births are recorded after a base-line survey) and retrospective (where the records are entirely from statements about past events) the conceptual difference is small. If the existence and timing of events were reported accurately the retrospective data could be put in a prospective form, apart from the women who disappeared from the population by death or movement. The latter effect is unlikely to be critical for the analysis of the mortality-fertility relations. Omissions and wrong timing of events (which may easily vary with family size and child deaths) are, however, a common feature of retrospective surveys and these could seriously hamper the search for significant results.

In the discussion of measurement problems the development will be from the less to the more detailed investigations. Reference will be made to a programme of computer simulation research into biases which is being undertaken by the authors. The basic simulation system of reproductive histories of women has been described and applied elsewhere (most recently in Population Studies, 28(3)). To it has been added provision for deaths of children at ages up to 11/2 years, with appropriate effects of deaths in any month on the distribution of the post-partum infertility period. Because birth spacing is one of the factors being studied single child families were omitted. A brief outline of the simulation model is given in the Appendix. The investigation is at an early stage and only the simpler simulations have so far been completed.

It is sufficiently obvious that no sound conclusions can be reached on the implications of the mortality-fertility correlations from a general sample of maternity histories without some control of the length of exposure to risk since variations in this for individuals will dominate the associations. The most obvious way of doing this is by length of marriage (or union). This will not entirely remove the nuisance effects of heterogeneity of exposure since women married at different ages will be included for periods of their life over which fertility rates and the incidence of child mortality both vary. There is also the linked problem of sterility which may be associated with high child mortality and the numbers of children. In countries where age at marriage has a small variance it seems likely that allowance for this factor would be very small ; in these circumstances control either through length of marriage or age should be adequate. However this needs further investigation as does the possible sterility interactions about which hardly anything is known. In these instances as in others there is an advantage in keeping the age interval of child mortality short to avoid problems of biases in the exposure to the risk of death. The arguments for the aggregate situation also apply here.

For a fixed exposure to risk the number of births per woman varies because of chance as well as systematic factors. The more children there are the larger the numbers who would be expected to die, other things being equal. That the pattern is not a simple one is illustrated by the computer simulation results below for women of completed fertility, married at age 20 years. Child mortality was kept constant for all birth

TABLE 1 – WOMEN OF COMPLETED FERTILITY MARRIED AT 20 YEARS : CONSTANT CHILD MORTALITY. MEAN BIRTHS BY CHILD DEATHS

Child Deaths	No. of Women	Mean Births	Additional Births
0	430	5.91	5.91
1	750	7.61	6.61
2	685	9.16	7.16
3	502	10.46	7.46
4	254	11.13	7.13
5 and over	138	12.20	6.80

orders and ages of mothers with an 0.22 probability of dying by 11/2 years. The peculiar shape of the additional birth measures (that is excluding the child deaths) indicates that chance artifacts are operating.

It might seem intuitively more satisfactory to examine child mortality rates in relation to mean family sizes but when this is done for the same simulation data the outcome appears even more puzzling.

TABLE 2 – WOMEN OF COMPLETED FERTILITY MARRIED AT 20 YEARS : CONSTANT CHILD MORTALITY. MEAN BIRTHS BY PROPORTIONS OF CHILDREN DEAD

Child Death Rate	No. of Women	Mean Births
Less than 25 %	1 577	8.81
25 % to less than 50 %	1 017	9.30
50 % and over	165	5.82

Here the mean births go down for families where the proportion of deaths is high although child mortality was kept constant in the model. A detailed examination shows that this is a chance artifact. In the conditions a very high incidence of child deaths comes from chance variation about the expected value but this is more likely to happen when there is a small number of births than a large. An extremely low incidence (for example zero) is also more likely to happen in small families and this accounts for the lower mean births in the group with mortality less than 25 %. There are other possible biases, not built into this model, which could be considered but the chance artifact influences are clearly too great for a direct attack through first order associations in the total data to be promising.

The question remains of whether the second order features of the observations, that is the form of the joint distribution of child births and deaths can aid the interpretation of the relation. Analyses of this nature have commonly been used in population genetics, for example to investigate family influences in spontaneous abortions. If a hypothesis that there is a volitional effect of child mortality on fertility implies a different type of distribution of deaths by births, appropriate tests may be developed. Approaches of this kind deserve study. In the computer simulation model used for illustration the distribution of the number of child deaths over families of a fixed size is binomial. If there was a volitional mortality influence, the variance of the distribution would be reduced ; presumably the reduction would be absent or small for family sizes of two or three and become progressively larger with greater numbers of births. Although in observations there would be many more complications, due to the influences of fertility characteristics on child mortality (age of mother, order, spacing), as compared with the model these might not be critical. Further gains could come from the examination of the distributional patterns for different lengths of exposure to risk, using data for cohorts of incomplete fertility at the time of the retrospective enquiry, since the volitional effects would be expected to have the biggest impact at the larger exposures.

When the births and child deaths to each woman can be arranged as a dated series of events in whole or in part, there are further analysis options. Such data are obtained from detailed maternity histories or prospective follow-up studies of subsequent births in a period to women whose previous birth and child death experience has been determined. It is now possible to eliminate the first order interference of chance correlations by relating child mortality up to some marker with subsequent fertility. This marker may be a fixed exposure to risk (as measured by length of marriage or, less satisfactorily, age) or an achieved family size, that is parity. In the former case not all the chance association is removed. Thus families with the highest proportion of deaths for a fixed exposure will tend to be concentrated where the births are small in number ; this may imply sub-fertility or even sterility.

For example Table 3 shows for the same model the results of a prospective (or quasi-prospective) study, in which women, married at age 20, are classified at age 30 by the mortality of their children and their subsequent births recorded.

TABLE 3 – WOMEN AGED 30 MARRIED AT 20 YEARS : CONSTANT CHILD MORTALITY. MEAN SUBSEQUENT BIRTHS BY PROPORTIONS OF CHILDREN DEAD

Child Death Rate	No. of Women	Mean Subsequent Births
Zero	1 117	3.97
Over zero to less than 25 %	520	5.04
25 % to less than 50 %	843	4.55
50 % and over	327	3.92

Here the chance concentration of low and high proportions of children dying in small families is reflected in the subsequent births through the correlation of reduced fertility in the first ten years of marriage

with the later experience. If number of births is taken as the marker so that comparisons are by subsequent fertility according to children surviving infancy for fixed parities there are still possible biases through heterogeneity of the exposure to risk interval. For example at lower parities there could be a tendency for the higher child mortalities to occur either to women marrying late or to those with short exposure intervals with highly concentrated births at the time of the enquiry ; in either case there would be a subsequent exposure to risk biased downwards. It would seem necessary, therefore, to make allowance for both exposure interval and parity in the analysis although the former might be less critical. In particular if the measurements studied were parity progression ratios it might be sufficient to eliminate these women whose exposure following a birth of the relevant order was severely truncated.

With the reservations above about some control of exposure, the most effective use of the data might be the calculation of the proportions of women with *n* children, *r* of whom died before some early age, who subsequently had another birth. If the enquiry was confined to women of completed fertility the outcome would be a straightforward study of parity progression ratios, sub-divided by previous child mortality. More commonly in developing countries women of incomplete fertility would be included to improve the quality of the reporting and give more weight to events nearer in time ; volitional effects might be suspected to be of recent origin. In these circumstances the calculations would give measures which were composites over cohorts of a particular kind, depending on the distribution of women by exposure to the risk of child-bearing and the degree of truncation of her subsequent recorded experience. Although the levels of the proportions proceeding to a further birth would have no absolute meaning this is unimportant for the present purpose where it is the comparisons by fixed parity and varying child deaths that matter. The addition over cohorts could introduce biases in theory through trends in either fertility and/or child mortality. For example falling incidences of deaths would mean for a given parity a smaller subsequent exposure to risk of fertility for women with low child mortality because these would be overweighted by the younger cohorts. Such biases, however, are likely to be very small and in general would not justify the more elaborate statistical methods which could be used to eliminate time-period trends.

Although the analysis procedure outlined would reduce the nuisance interference of some fertility-child mortality interactions, others remain. The most obvious are probably the non-volitional, physiological and social factors. Following a birth there is a period within which the probability of a further conception is reduced ; the size of the effect varies greatly among women and is strongly associated with the length of breastfeeding. In several studies of populations where children are breast-fed for 18 months or more the average interval before full fecundity is effectively resumed has been about 11 months.

However, there are at least two enquiries which give delays of 18 months. There is some doubt whether this longer interval is a purely physiological phenomenon, perhaps due to poor maternal nutrition, or whether social customs of reduced cohabitation of partners when the woman is lactating have also contributed. Whatever the exact causes, the evidence is overwhelming that when a child dies young the delay to the resumption of full fecundity is correspondingly less. If the death is in the first few weeks after birth the average reduction in the post-partum infertility delay may be more than one year.

It is obvious that these interactions pose serious difficulties for the isolation of volitional effects

TABLE 4 – WOMEN OF COMPLETED FERTILITY, MARRIED AT DIFFERENT AGES : CONSTANT CHILD MORTALITY. MEAN SUBSEQUENT BIRTHS BY DEATHS IN FIRST *r*

r / Child deaths	3		4		5		6	
	No. of women	Mean subse't births	No. of women	Mean subse't births	No. of women	Mean subse't births	No. of women	Mean subse't births
				Age 15 at marriage				
0	1 350	7.99	996	7.14	778	6.39	570	5,64
1	1 146	8.01	1 172	7.16	1 080	6.27	1 000	5.49
2+	310	8.34	569	7.59	799	6.79	995	5.93
				Age 20 at marriage				
0	1 251	5.90	889	5.22	665	4.47	480	3.74
1	1 092	6.06	1 102	5.20	963	4.55	840	3.84
2+	341	6.21	584	5.45	808	4.65	961	3.96
				Age 25 at marriage				
0	1 198	4.12	854	3.43	586	2.83	393	2.21
1	933	4.24	928	3.57	823	2.88	675	2.32
2+	310	4.26	485	4.85	646	2.90	720	2.33

whatever the method of analysis used. In particular concern here is with the parity progression approach. The higher the number of child deaths for a given parity the greater the reduction in average birth interval and also in the probability that the last child has failed to survive. The effective subsequent exposure to risk thus increases with the incidence of child deaths for a given parity. It may be speculated that such effects could be appreciable for short follow-up periods, that is in prospective type enquiries where women are asked about additions to their families after an interval, following the determination of their demographic characteristics by a base-line survey. With long intervals, such as those automatically provided by surveys of cohorts of completed fertility the interference from this source may not be of great importance particularly at lower parities. In "all cohort" analyses the situation is still more complex particularly when, as suggested, women with shorter intervals of exposure after the given parity are excluded.

The computer simulation model has been used to explore the possible sizes of the biases arising from post-partum infertility in parity and exposure controlled analyses. Table 4 shows a selection of results for cohorts of women of completed fertility, married at different ages. The mean births, following the child mortality experience of the first *r* born are shown.

TABLE 5 – WOMEN OF VARIOUS AGES MARRIED AT 20 YEARS : CONSTANT CHILD MORTALITY. PROPORTION HAVING FURTHER BIRTH BY TIME INTERVALS AND MEAN SUBSEQUENT BIRTHS BY DEATHS IN FIRST *r*

r	Age 25					
	1		2		3	
Child deaths	0	1	0	1-2	0	1-3
Interval, yrs. 1	53	57	44	52	22	31
2	74	77	77	80	67	75
3	83	83	91	93	87	90
5	88	87	96	96	96	97
No. of women	540	111	1083	493	220	290
Mean subse't births	5.75	6.39	7.09	6.93	7.50	7.41

r	Age 30										
	3		4			5			6		
Child deaths	0	1-3	0	1	2-4	0	1	2-5	0	1	2-6
Interval 1	37	37	41	43	54	41	41	51	31	35	41
2	62	56	68	72	79	70	75	75	69	73	76
3	70	66	79	84	89	86	89	86	86	88	86
5	77	72	87	90	91	95	94	92	91	93	94
No. of women	198	189	315	302	124	246	356	285	94	181	188
Mean subse't births	3.31	3.10	4.26	4.52	4.42	5.07	4.83	4.70	5.12	5.12	5.16

r	Age 35											
	5			6			7			8		
Child deaths	0	1	2-5	0	1	2-6	0	1	2-7	0	1	2-8
Interval yrs. 1	25	19	29	30	28	36	37	34	37	41	35	34
2	43	42	40	52	43	55	66	60	64	65	62	66
3	50	47	48	61	53	66	78	72	72	83	79	81
5	58	54	51	70	65	71	85	79	82	91	87	88
No. of women	96	109	86	142	182	172	91	225	296	69	144	312
Mean subse't births	1.46	1.41	1.45	2.15	1.99	2.13	2.68	2.61	2.72	3.36	2.97	2.98

Despite the substantial sampling fluctuations it is clear that the mean subsequent births increase appreciably with the number of children dead for a fixed parity. The rise is of about one third of a child for a movement from no deaths to the highest mortality groups for which there are sufficient numbers at risk for estimates to be reasonable. The model samples are not large enough for the variation to be specified in detail by parity and age at marriage of the women. In real populations of course, there would be other intervening factors not included here. It should be noted that these results are for post-partum infertility intervals which average about 11 months. Larger effects are, therefore, possible.

The introduction of a further control, on the period since marriage in which the *r* births took place, will allow for some part of the bias explored above, namely in the increase of the subsequent exposure to risk when children die but not necessarily the carry over effect of the post-partum infertility distribution following the last birth. This is the typical situation in a prospective survey. Further measures derived from the model reproductive histories are given in Table 5.

For short intervals of follow-up there is a clear tendency for a lower proportion of women with no children dead to have a subsequent birth but by the end of three years the difference has disappeared. Nor is there any evidence that the mean subsequent births are higher when the child mortality in the first *r* is more severe. The sample fluctuations are substantial but the precision is sufficient overall to demonstrate that with the method of analysis the bias which comes from post-partum infertility is small if the follow-up interval is not too short or, presumably, if allowance is made for births where the post-partum effect may be carried over into the prospective period.

Although the more obvious reflections of variations in child mortality by fertility characteristics into the inverse relationship are removed by prospective or quasi-prospective forms of investigation, others without this property may be postulated. One possible mechanism is through birth spacing. There is evidence from developing countries that there can be heavy excess child mortality when births to a mother are closely concentrated. In several East African surveys of the 1950s child mortality (both under one and under five years) was about twice as high when the mean birth interval was less than 3 years in comparison with the incidence for mothers with longer intervals. That such effects are far too large to be a consequence of the post-partum infertility interaction with child deaths is again illustrated by the computer simulation exercise.

Mean Birth Interval in Years	Total Births	% Child Mortality
Less than 3	21,511	22.3
3 and over	2,806	20.8

A more detailed breakdown of the data shows that the greater concentration of births because of child deaths only has an apparent effect on the mortality of any consequence for very low mean birth intervals ; the proportion of mothers thus affected is too small to introduce a significant bias with the broad classification shown. Equally, although in theory volitional effects of child deaths on subsequent births could contribute to the bias, they are unlikely to have more than a small influence. It should be noted that the observations show that the high child mortality with close birth spacing exists at short durations of marriage before volitional biases would be operative.

Accepting that there is a substantially higher child mortality with close birth spacing, the women experiencing these risks will tend to be the ones with high fecundity and/or consistently short post partum infertility periods. Since these characteristics will presumably continue into the period of exposure to risk, subsequent to that for which the deaths for fixed parities are measured as a base, nuisance interactions are again a possibility. In this model an effect which is from fertility to mortality will appear as the reverse in a parity progression type analysis and it is far from clear how it could be eliminated.

There is some evidence to suggest that in high fertility populations the chance variation in birth intervals dominates the systematic fecundity and post-partum infertility components. If this is so the source of bias discussed would be of limited nuisance value but little is established with any certainty.

In order to investigate possible consequences of a relation between child mortality and birth spacing, modifications were made to the simulated model. The probability of the death of a child was made to depend on the number of births in the five years preceding his or her own birth increasing linearly with the concentration. Although this is a greatly simplified method of introducing a birth spacing influence on child mortality it gives results which are in conformity with observations. It is consistent with the idea that the effect operates through the burden upon the mother of having several young children to rear at the same time. Among the simplifications made, (through lack of knowledge to do otherwise), are the specification of relative effects on probabilities of dying as the same for each month of the first one and a half years, the disregard of the influences of births following each one simulated or of deaths of those born in the preceding five years and the holding of child mortality at the standard level for the first five years of marriage. By trial

the change in child mortality with birth concentration was adjusted to give measures in accord with the East African evidence referred to previously. Table 6 indicates the variations in child mortality with parity and average spacing which are consequent on the model relations.

TABLE 6 – WOMEN OF COMPLETED FERTILITY MARRIED AT AGE 20 : CHILD MORTALITY VARIES WITH BIRTH CONCENTRATION. MORTALITY IN FIRST YEAR AND A HALF FROM BIRTH

Birth order	Probability of dying	Mean birth spacing (yrs)	Probability of dying
7 and less	.194	Zero to less than 2	.251
8 to 10	.201	2 to less than 2 1/2	.212
11 to 12	.220	2 1/2 and over	.177
13 and over	.236	Total	.211

The measures in Table 7, showing the mean subsequent births by deaths in the first *r*, that is with control for parity, are parallel to those in Table 4. The addition of the birth concentration relation to child mortality increases the bias as would be expected. Although its size can not be estimated with any precision because of the sample errors, an increase from some half to two thirds of a child in the mean subsequent births as mortality rises from zero to the highest levels is indicated. This is a substantial effect and it can not be claimed, plausibly, that the order of the maximum has been represented. A combination of a long post-partum infertility period and child mortality variations with birth concentration of the most extreme in the East African surveys would have raised the bias considerably.

TABLE 7 – WOMEN OF COMPLETED FERTILITY MARRIED AT DIFFERENT AGES : CHILD MORTALITY VARIES WITH BIRTH CONCENTRATION. MEAN SUBSEQUENT BIRTHS BY DEATHS IN FIRST *r*

r / Child deaths	3		4		5		6	
	No. of women	Mean subse't births	No. of women	Mean subse't births	No. of women	Mean subse't births	No. of women	Mean subse't births
				Age 20 at marriage				
0	1 297	5.78	987	5.01	756	4.24	547	3.56
1	1 070	6.24	1 074	5.31	953	4.44	827	3.77
2+	321	6.26	522	5.66	751	4.92	902	4.21
				Age 25 at marriage				
0	1 191	4.11	869	3.32	588	2.76	396	2.22
1	981	4.28	945	3.61	851	2.93	698	2.34
2+	292	4.46	475	3.79	601	3.24	684	2.59

The consequences of introducing the additional control of a fixed exposure to risk as well as parity before the examination of subsequent children born is investigated in Table 8. At first sight the results may seem surprising. Despite the sampling errors there is a clear tendency for the mean subsequent births to decrease with the severer child mortality. On further consideration the reason is apparent. Since child deaths increase the exposure to risk women who, without such mortality, achieve the same parity in the same time as those so affected will tend to have a higher potential fertility, which is reflected in their later births. The exposure to risk differences are partly a result of the mortality relation with birth spacing and partly from post-partum infertility. The lack of any indication of a gradient on mean subsequent births in Table 5 where only the latter effect is present is probably due to compensating pressures. The exposure to risk is offset by the carry-over of the post-partum infertility of the last birth into the prospective period.

The interaction just considered can be regarded as the consequence of population heterogeneity for factors (fecundity and length of post-partum infertility) which are associated with the measures whose relation is being investigated. It creates particular difficulties because the effects might be present to a similar degree in all populations whereas other social and economic causes of heterogeneity will be less consistent. Nevertheless it should be realized that the latter type of bias is a danger in all attempts to establish causal relations from survey observations. The problems of defining the child mortality-fertility links are not more acute than comparable complications in other areas but rather among the more easily specified. Progress will come from an accumulation of consistent studies rather than one. There is great virtue in repetition in different

TABLE 8 – WOMEN OF SPECIFIED AGES MARRIED AT 25 AND 30 YEARS : CHILD MORTALITY VARIES WITH BIRTH CONCENTRATION. MEAN SUBSEQUENT BIRTHS BY DEATHS IN FIRST *r*

r	1		2		3	
Risk exposure	20-25 yrs	25-30 yrs	20-25 yrs	25-30 yrs	20-25 yrs	25-30 yrs
Child deaths 0	4.94	3.28	6.52	4.66	7.01	5.17
Child deaths 1+	4.04	3.40	6.54	4.39	7.15	5.07

r	3		4		5		6	
Risk exposure	20-30	25-35 yrs	20-30	25-35 yrs	20-30	25-35 yrs	20-30	25-35
Child deaths 0	3.48	1.96	4.55	2.93	4.89	3.28	5.29	3.76
Child deaths 1	3.04	1.59	4.42	2.86	5.05	3.31	4.94	3.52
Child deaths 2			4.64	2.57	4.75	3.11	5.16	3.77

conditions. Such repetition can sometimes usefully be achieved in single surveys by the analysis of relevant sub-sets of data, for example by culture or religion. It may also be illuminating to sub-divide the observations according to indices of attitudes to child deaths and family sizes. If the indices have any validity differences would be expected over the sub-divisions in the measures designed to indicate volitional effects of mortality on fertility. The search is then for plausible patterns to confirm the relevance of the analytical approach.

APPENDIX

Model

In the Monte Carlo method adopted for this microanalytic simulation, events are represented individually ; the parameters characterising natality and mortality are specified below. This microanalytic approach permits greater realism, by allowing parameters to vary between women (or couples) and if necessary to depend on their ages, parities, or other desired factors, and facilitates the study of the relative effects of different parameters. The reproductive histories of a cohort of women are simulated from the beginning of marriage (usually at a fixed age) to the ends of the reproductive spans of life of the women (or couples), or until the woman's death. Events in this simulation occur only at intervals of one 'lunar' month, i.e. with 13 months to a year, which represents to sufficient accuracy the mean duration of a menstrual cycle. Commencing at marriage, there is a probability that a woman will conceive, equal to ρ per (lunar) month, which defines her fecundability. The fecundability ρ varies between women and declines with age as indicated below. The history of each woman is simulated in turn through a series of states, the first of which is susceptibility to conception (i.e. the fecund state) and the second of which (if the woman is not by then sterile) is pregnancy leading to a foetal death, (spontaneous abortion), stillbirth, or live birth. Induced abortions are not incorporated in the present work. Although the simulation incorporates a family planning strategy (Barrett and Brass, 1974), this is not used in the present analysis.

Susceptible (fecund) State

For this state, random numbers Z distributed uniformly between 0 and 1 are generated successively until a random number less than ρ (the fecundability to the particular woman) is obtained. In this way, a geometric distribution of times to conception is simulated, if ρ is constant, as it is taken to be until the woman reaches age 30. After age 30, fecundability starts to decline as described below. Variation in fecundability between women is also incorporated : values of ρ for women aged under 30 are drawn from a beta distribution

$$f(\rho) = \rho^{a-1} (1-\rho)^{b-1} \Big/ \int_0^1 x^{a-1} (1-x)^{b-1} \, dx$$

The parameters a and b were chosen to represent the distribution of completed family sizes in the population enumerated in the Census of Ireland (1911), given the other components of the simulation. These components now include a decline in fecundability with age, which was not represented in an earlier version of the model (Barrett, 1971), so different values a and b are naturally required ; these ($a = 3$, $b = 13$), turn out to be not very different from estimates by Jain (1969) by a more direct method, for Taiwanese women. To simulate the decline with age, the fecundability of a woman is redetermined at the beginning of each

fecund interval, by linear interpolation, if she is over 30, between her original fecundability (as at age 30) and zero fecundability at her predetermined age of onset of sterility which varies between women. If she does not conceive within two years, her fecundability is redetermined in the same way and the process repeated until she conceives, becomes sterile, or dies.

Pregnant State

A further random number Z determines the outcome of pregnancy as a foetal death, stillbirth, or live birth, with probabilities θ_2, θ_3, θ_4 (where $\theta_2 + \theta_3 + \theta_4 = 1$). These probabilities are made to depend linearly on the woman's age, t years :

$$\theta_2 = 0.24 + (0.005\,(t - 30)$$
$$\theta_3 = 0.03 + (0.001\,(t - 30)$$

The duration of pregnancy is fixed for stillbirths and live births (9 and 10 lunar months) and is a geometrically distributed variate for foetal deaths. In the latter case, the proportion of foetal deaths that occur in the n th month is $0.11\ (0.55)^{n-2}$ for $2 \leqslant n \leqslant 8$; losses in the first month are discounted by the fecundability function. This representation is based on survey data analysed by French and Bierman (1952).

Insusceptible State

The interval of insusceptibility to conception, which follows the pregnant state, is taken as 2 months for a foetal death, 3 months for a stillbirth, and as a random variable with a Pascal distribution, following a live birth. The latter distribution is obtained as the sum of a constant delay of one month, followed by two consecutive geometrically delays with parameters one-sixth per lunar month, giving a total mean delay of 11 lunar months, i.e. $1 + \frac{1-\gamma}{\gamma} + \frac{1-\gamma}{\gamma}$ where $\gamma = 1/6$. These values are based mainly on surveys by Potter, Wyon, Parker and Gordon (1965) and others. The advantages of a Pascal distribution in this connection have been discussed by Potter, Masnick and Gendall (1973). In the present model, the first month following a live birth is supposed to be always anovulatory. The value $r = 1/6$ is modified when the child does not survive for 1 1/2 years, since the duration of lactation is affected. Thus if the infant dies at birth, $r = 1/2$ and the mean duration of the insusceptible state is then:

$$1 + \frac{1-\gamma}{\gamma} + \frac{1-\gamma}{\gamma} = 3 \text{ months.}$$

In general, when a child dies under 11/2 years, the *expected* duration of the interval of insusceptibility is interpolated between 3 and 11 months as follows. Let m be the (lunar) month of the child's age at death ($1 \mid \leqslant m \leqslant 20$). Define

$$h = \frac{4(m-1)}{19} + 1$$

Then
$$\gamma = \frac{1}{1+h} \qquad (1/2 \geqslant r \geqslant 1/6).$$

This representation is broadly in line with the regression of post partum amenorrhea on lactation reported by Jain, Hsu, Freedman, and Chang (1970), and Jain and Sun (1972). There is thus considerable variability in the durations of the insusceptible intervals following live births even of children who die within 1 1/2 years. We note that in this respect the model differs from that of Ridley, Sheps, Lingner and Menken (1967), who state (p 86). "In the computer program, if a child dies before the time selected at random for the duration of the post partum non-susceptible period, the non-susceptible state terminates one month after the infant's death.". The difference in the structures of these models seems to be of small importance for the present purpose, however, which is chiefly to estimate biases in mean values, and we have found that our estimates would not be much affected if instead the post partum period were truncated more sharply as indicated by Ridley *et al.* It may even happen, in the present model, that the death of a child actually appears to lengthen the duration of a hypothetical interval, since a new random variable is generated, but this is not to be regarded as a direct effect of the death. Instead, it represents a selection from the durations of insusceptible intervals of women of similar physiological status or experience following childbirth.

The parameters for the duration of the insusceptible interval do not vary between women here, the more important sources of heterogeneity having been provided in fecundability and sterility.

After each insusceptible interval in the present model the woman returns to the susceptible state and conceives again, unless the end of the reproductive span is reached first, or unless she dies sooner. After each conception and each pregnancy her age is tested to establish whether such an event has occurred, and if it has, the program causes summary statistics to be computed, before proceeding with the next woman's history, for up to, say, 3 000 women.

Sterility

The sterility of a union, like fecundability, depends in reality on both the man and the woman, but for convenience of analysis is attributed entirely to the woman in the present model. It is represented as the lesser of two random variables. The first of these represents the woman's age at menopause, between ages 38 and 54, with mean 47.6 and mode 48.7 :

$$f(\chi) = (\chi - 38)^2 (54 - \chi)/12.$$

The second random variable represents sterility occurring before menopause, at an age 28 + (Z/0.012), where Z is, as before, a random number distributed uniformly between 0 and 1. Also based on data for Ireland (1911), 4.8 per cent of women are deemed to be involuntarily sterile at ages under 28. The combination of these sterility effects gives a mean age of 43 and a median of 46 years at the end of the reproductive span (Barrett, 1971).

Child Mortality

For the present application, which is intended for developing countries, we use a fixed probability of 0.94 that the child survives the first month, followed by a conditional probability of 0.99 of surviving each month up to 1 1/2 years. The risk that the child dies is in the first instance taken as independent of the woman's age and parity, or rather it is not made to depend on these in the structure of the model, in order to find the separate direct effect of child mortality on fertility. But in subsequent runs, described in the text, the probabilities of dying above (0.06, 0.01) were multiplied by a factor (s + 2)/4 where s is the number of children born to the woman in the most recent 5 years, i.e. before the current birth. This represents a 'birth concentration' effect on child mortality. It is thus possible for an involuntary effect to build up, by positive feedback, if the woman has a succession of births and deaths in a short interval.

Mortality of women

The mortality of women (although not of their husbands) is represented here by means of the logit model of Brass (1972). It was needed for some current work on orphanhood, and has little importance as regards the present investigation of biases. The logit $Y(x)$ of the proportion of females who survive from birth to age x is given by

$$Y(x) = \alpha + \beta Y_s(x)$$

where $Y_s(x)$ are the logits of the proportions surviving in the Brass standard population. The logit of a proportion ρ is defined as one half the natural logarithm of $\rho/(1-\rho)$ and the α and β are parameters which generate sets of life tables from an initial pattern specified by the subscript s (Brass). In the present case, $\alpha = 0.022$ and $\beta = 1.0$, which implies that the mean expectation of life of female infants at birth is 44 years, and about 80 per cent survive to their second birthday. The ages of the women at death are randomly selected from a life table formed from the values $Y(x)$, given that they all reach age 20.

All the random variates described in this appendix are generated independently of each other, in so far as sequences of pseudo-random numbers Z are formed successively by multiplicative congruences, i.e., from routines established for use with the CDC 6600 computer of the University of London.

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THE INFLUENCE OF CHILD MORTALITY ON FERTILITY : A REVIEW OF MECHANISMS

Robert D. RETHERFORD
East-West Population Institute, Honolulu

SUMMARY

This paper attempts to review the principal mechanisms by which child mortality influences fertility, with emphasis on the mediating role of economic and social factors. The basic explanatory framework consists of a highly simplified microeconomic decision model for couples. This model utilizes the concept of "demanded" as distinct from "desired" family size and introduces a distinction between the "demand effect" and the "replacement effect" of child mortality reduction on fertility. The demand effect refers to the rise in couple fertility stimulated by increased demand for surviving children due to reduction of mortality-related disutilities and costs of producing them. The demand effect is offset by the replacement effect, whereby fewer births are required to achieve a given number of surviving children when child mortality declines. It is hypothesized that because of differences between less-developed and more-developed societies in the mediating role of economic and social factors, demand effects are more important, relative to replacement effects, in the former than in the latter societies.

The paper also considers effects of mortality reduction on fertility through increase in age at marriage, with particular focus on rural areas. One mechanism explaining delayed marriage is postponement of inheritance due to increased longetivy of fathers. In this case all that matters is adult mortality, and we may speak of an "adult mortality effect" on age at marriage. But when there is reluctance to further subdivide land, child mortality also has an effect, especially upon introduction of capital-intensive farming techniques. In this case the child mortality experienced by a cohort affects the fraction of the children who cannot become farm operators and who therefore find it difficult to obtain a livelihood sufficient to marry and support a family at a young age. This we may call the "child mortality effect" on age at marriage.

The paper also discusses societal-level mechanisms by which child mortality reduction affects fertility, focusing on the intermediate role of population pressure. In today's less-developed societies, rapidly deteriorating land/population ratios appear to constitute part of the stimulus to governments to modernize their countries quickly. If developmental efforts succeed, the experience of more-developed societies suggests that rapid fertility decline will follow. It is therefore possible that the line of causation from imported mortality decline to population pressure to modernization to fertility decline will ultimately turn out to be an important mechanism by which mortality decline affects fertility in less-developed countries. A difficulty, however, is that in the early stages of development, many of the costs of increased numbers of surviving children at the individual level are paid not so much by parents as by their children when the latter reach adulthood and must obtain a livelihood to marry and start their own families. Delayed marriage, if it occurs, is therefore not necessarily accompanied by marital fertility decline. It is noteworthy that general economic and social development itself unleases a new set of motivations which reduces the significance of these external costs of childbearing. Moreover, economic and social

development is a general societal goal to which reduction of population growth is only a means. Therefore, an unresolved policy problem is to determine the optimal allocation of policy resources among measures aimed specifically at mortality reduction and measures aimed at other aspects of economic and social development.

Finally, the paper raises the question as to the extent to which child mortality can be treated as an exogenous variable amenable to policy manipulation. In many less-developed countries today, we may be close to the limit of what cheap imported environmental health measures can accomplish. Further substantial reduction of child mortality may require better nutrition and the development of individualized health services, which are extremely expensive and can normally be supported only by advanced economies. It follows that further reduction of child mortality may depend more on general economic and social development than many now suspect. If so, the ability of governments to manipulate this policy variable may be severely limited.

RÉSUMÉ

Dans cette communication, on s'efforce de passer en revue les principaux mécanismes par lesquels la mortalité des enfants influence la fécondité. On insiste sur le rôle joué par les facteurs économiques et sociaux qui s'interposent. L'étude s'appuie sur un modèle micro-économique très simplifié de la décision que prennent les couples. Ce modèle utilise le concept de dimension de la famille "demandée" qui est distinguée de la dimension "désirée". Une distinction est introduite entre l'"effet de demande" et l'"effet de remplacement" de la diminution de la mortalité des enfants sur la fécondité. L'effet de demande a trait à l'augmentation de fécondité du couple qui est stimulée par une demande accrue d'enfants survivants du fait d'une baisse de la perte économique causée par la mortalité et par conséquent d'une baisse du coût exigé par la production des enfants. L'effet de demande est compensé par l'effet de remplacement par lequel le nombre d'enfants nécessaires pour parvenir à un nombre donné d'enfants survivants tend à diminuer à mesure que recule la mortalité infantile. On part du principe que, les facteurs sociaux et économiques jouant un rôle différent dans les sociétés en développement de celui qu'ils jouent dans les sociétés industrielles, les effets de demande sont plus importants par rapport aux effets de remplacement dans celles-ci que dans celles-là.

Nous étudions aussi l'effet de la baisse de la mortalité sur la fécondité du fait de l'élévation de l'âge au mariage ; cette question est examinée surtout pour les zones rurales. Un mécanisme qui explique l'élévation de l'âge au mariage est le fait que la plus grande longévité des pères retarde l'époque où les fils héritent d'eux. Dans ce cas, le seul élément à prendre en considération est la mortalité des adultes. Nous pouvons donc parler d'un "effet de la mortalité des adultes" sur l'âge au mariage. Mais la mortalité des enfants peut aussi avoir un effet lorsque la famille répugne à diviser les terres, en particulier lorsque des techniques agricoles nécessitant un certain capital sont utilisées. Dans ce cas, la mortalité des enfants d'une génération donnée modifie la proportion des enfants qui, ne pouvant travailler sur l'exploitation familiale, éprouvent des difficultés à gagner assez pour se marier et fonder une famille lorsqu'ils sont encore assez jeunes. C'est ce que nous appelons "l'effet de la mortalité des enfants" sur l'âge au mariage.

Cette communication discute également, au niveau de la société, les mécanismes par lesquels la baisse de la mortalité des enfants affecte la fécondité, en insistant sur le rôle joué à cet égard par la pression démographique. Dans les sociétés peu développées de notre époque, le manque de terre provoqué par la croissance démographique incite les gouvernements à moderniser rapidement leur pays. Si ces efforts réussissent, l'histoire des sociétés industrielles est là pour nous montrer qu'il s'ensuivra une baisse rapide de la fécondité. Il se peut donc que la

baisse de la mortalité, importée de l'extérieur, qui entraîne la modernisation et par la suite le déclin de la fécondité apparaisse comme un mécanisme par lequel la baisse de la mortalité affecte la fécondité dans les pays peu développés. Une difficulté se présente, néanmoins, du fait que dans les premières phases du développement, la plus grande partie du coût de l'augmentation du nombre d'enfants survivants est payée au niveau individuel, moins par les parents que par leurs enfants lorsque ceux-ci, parvenant à l'âge adulte, doivent gagner leur vie pour se marier et fonder une famille.

L'élévation de l'âge au mariage, si elle se produit, ne s'accompagne donc pas forcément d'une baisse de la fécondité légitime. On constate que le développement économique, en général, et le développement social lui-même produisent une nouvelle série de motivations qui réduisent l'importance du coût extérieur entraîné par la naissance des enfants. En outre, le développement économique et social est un but général que se fixe la société et la diminution de l'accroissement démographique n'en est qu'un moyen. Il existe donc un problème de la politique démographique qui n'est pas résolu. Il s'agit de déterminer quelles ressources doivent être consacrées aux mesures spécifiquement destinées à réduire la mortalité dans l'ensemble de celles qui visent au développement économique et social.

Enfin, dans cette communication, nous examinons dans quelle mesure la mortalité des enfants peut être traitée comme une variable exogène sur laquelle on peut agir en prenant certaines mesures. Dans de nombreux pays peu développés d'aujourd'hui, nous sommes peut-être proches de la limite que l'on peut atteindre grâce à des mesures sanitaires qui, importées de l'extérieur, sont d'un coût relativement faible.

Un recul important de la mortalité des enfants nécessitera désormais une amélioration de la nutrition et il faudra mettre en place des services sanitaires plus spécialisés. Ces améliorations impliquent des dépenses énormes auxquelles seuls les pays industriels sont en mesure de faire face. Il s'ensuit qu'une plus forte réduction de la mortalité des enfants dépend beaucoup plus qu'on ne le pense généralement du développement économique et social. S'il en est ainsi, les possibilités qu'ont les gouvernements pour agir sur cette variable risquent dêtre extrêmement limitées.

RESUMEN

En este documento se revisan los principales mecanismos mediante los cuales la mortalidad de la niñez influencia la fecundidad, con especial énfasis en el rol intermediario de los factores económicos y sociales. El esquema explicativo básico está constituído por un modelo de decisión para parejas, altamente simplificado y de tipo microeconómico. En este modelo se utiliza el concepto de tamaño de la familia "demandada" como diferente a la "deseada". Se introduce, además, una distinción entre el efecto "demandado" y el efecto "reemplazo" de la disminución de la mortalidad de la niñez sobre la fecundidad. El efecto "demanda" se refiere al aumento de la fecundidad de la pareja, estimulado por la creciente demanda de niños sobrevientes debido a la reducción de las desventajas relativas a la mortalidad y de los costos de procrearlos. El efecto demanda es compensado por el efecto reemplazo, por lo cual se requieren pocos nacimientos para lograr un número dado de niños sobrevivientes cuando la mortalidad disminuye. Se ha formulado la hipótesis de que los efectos de demanda son más importantes que los efectos de reemplazo, en los países menos desarrollados que en las sociedades más desarrolladas, debido al rol intermediario de los factores económicos y sociales.

El documento se refiere también a los efectos de la reducción de la mortalidad sobre la fecundidad, a través del aumento de la edad al casarse, con especial atención a las areas rurales. Un mecanismo que explica la postergación del matrimonio es el atraso en heredar debido a la mayor duración de la vida de

los padres. En este caso si se toma en consideración solamente la mortalidad del adulto, se puede hablar de un efecto de la "mortalidad del adulto" sobre la edad al casarse. Pero, cuando existe una resistencia a subdividir la tierra, la mortalidad infantil tiene también un efecto, especialmente sobre la introducción de técnicas de explotación intensiva de la tierra. En este caso la mortalidad del niño, tal como la experimenta una cohorte, afecta la proporción de niños que no pueden llegar a ser hacendados y a quienes les resulta difícil obtener un medio de subsistencia suficiente para casarse y mantener una familia, a una edad joven. Este puede ser el "efecto de la mortalidad de la niñez" sobre la edad al casarse.

Este documento se refiere también a los mecanismos sociales mediante los cuales la disminución de la mortalidad infantil afecta la fecundidad, principalmente la presión demográfica. Actualmente, en los países menos desarrollados, el rápido deterioro de la relación tierra/población parece ser un poderoso estímulo para que los gobiernos promuevan rapidamente la modernización. Si se logra el desarrollo, puede decirse, sobre la base de la experiencia de los países más desarrollados, que se producirá una rápida disminución de la fecundidad. Puede pensarse también, que en los países menos desarrollados, la línea de causalidad que va desde la disminución de la mortalidad (importada), a la presión demográfica, a la reducción de la fecundidad y a la modernización, ha sido un mecanismo muy importante mediante el cual la reducción de la mortalidad ha influenciado la fecundidad. La dificultad que existe es que en muchos casos, en las primeras etapas del desarrollo, muchos de los costos del creciente número de niños sobrevivientes en el nivel individual, son pagados no tanto por los padres sino que por sus hijos cuando llegan a la edad adulta y deben ganarse la vida, casarse y constituir una familia. En el caso de producirse la postergación del matrimonio, no es necesariamente acompañada por una reducción de la fecundidad. Hay que hacer notar que el desarollo económico general y social acarrea por sí mismo un nuevo conjunto de motivaciones que reducen estos costos externos de la crianza de los niños. Más aún, el desarrollo económicy social es un objetivo general para al cual la reducción del crecimiento demográfico es sólo un medio. Sin embargo, puede decirse que no está resuelto el problema de como determinar las proporciones óptimas de la distribución del presupuesto en el sentido de determinar las medidas destinadas específicamente a reducir la mortalidad y las medidas destinadas a otros aspectos del desarollo económico y social.

Por último, el documento se refiere al problema de determinar en que medida la mortalidad del niño puede ser considerada como una variable exógena susceptible de un manejo político. En muchos países sub-desarrollados de la actualidad, se está casi en el límite de todo lo que las técnicas importadas pueden contribuír al mejoramiento de la salud. Nuevas reducciones de la mortalidad de la niñez requieren aumentos del nivel nutritivo, y el desarrollo de servicios de salud individuales, que son sumamente caros y que habitualmente sólo pueden ser costeados por economías desarrolladas. De lo que se desprende que la reducción de la mortalidad del niño puede depender, mucho más de lo que uno espera, del desarrollo general económico y social. Si así es, las posibilidades que tienen los gobiernos de manejar una política relativa a esta variable son muy limitadas.

Introduction

This paper reviews the principal mechanisms by which child mortality influences fertility in both modern and premodern societies. The emphasis is on economic and social causation, since purely demographic interrelationships between child mortality and fertility are already reasonably well understood (Ryder, 1955, 1973 ; Ridley et al., 1967 ; Keyfitz, 1971 ; Preston, 1972). An unresolved question of population policy underlies this review : Can further reduction of child mortality induce significant fertility decline in today's less developed countries ?

In the long run, of course, we can state with assurance that as long as humanity survives and large-scale migration to other worlds is impossible, human mortality and fertility are homeostatically balanced. Fertility cannot be lower than mortality, because humanity would then disappear. Nor can it be higher, because the finiteness of the planet guarantees that if fertility does not fall, resources per capita will eventually approach the subsistence level and mortality will rise. A demographic balance is inevitable.

But this a priori assertion of long-term homeostasis is not very helpful. The ultimate balance might be struck at either a high or low level of vital rates, and either a high or low number of population. The balance might be static or involve fluctuation within wide limits. From a policy point of view, we are interested in a particular kind of balance– one where birth and death rates are balanced at low levels and resources per capita are plentiful, so that both present and future generations may live long and prosperously.

On the face of it there is no compelling reason to believe that low death rates automatically induce low birth rates through simple homeostatic adjustment. Indeed, the present world population dilemma is largely the result of birth rates in less developed countries failing to respond rapidly enough to imported death rate decline. Why then is mortality decline, the root of the current dilemma, being proposed as its solution, in the form of a bigger dose of child mortality reduction aimed at reducing fertility ?

Part of the reason, no doubt, is the growing awareness among policy-makers that birth control programs are not enough. It is increasingly apparent that in most developing countries, optimization of fertility at the individual level through provision of perfect birth control services would still leave substantial excess fertility at the societal level (Davis, 1967 ; Demeny, 1970, 1972b).

A second reason concerns the political attractiveness of child mortality reduction as policy, both to governments and to family planning professionals. Some of the principal reasons underlying this attractiveness have little to do with potential effectiveness. Like birth control, child mortality reduction is attractive partly because it is a socially and politically acceptable health measure requiring no drastic changes in social institutions (Davis, 1971). It naturally finds favor among health professionals in current birth control programs who are in a position to promote it.

A third reason is that easy alternatives are lacking. The peculiar nature of the utilities and costs of children to parents is that they are diffuse, bound up with a wide range of human behavior. For the policy-maker this means that there is no single variable or small set of variables that government can easily manipulate to reduce fertility both rapidly and substantially. Indeed, the utilities and costs of children are intimately related to so many facets of social and economic organization that perhaps only general social and economic development itself can normally achieve low levels of fertility.

This latter viewpoint is implicit in classical demographic transition theory, which identifies overall modernization as the fundamental force underlying both mortality and fertility transition (Thompson, 1946 ; Blacker, 1947 ; Davis, 1949, Notestein, 1953 ; Coale and Hoover, 1958 : 12 ; Heer and Wu, 1974 : 3). By virtue of its posited common causation of mortality and fertility change, this theory implicitly denies the possibility of child mortality reduction as an effective fertility policy variable. Mortality decline is seen as tied to development and not amenable to substantial independent government-induced change.

Particularly since World War II, however, it has become apparent that rapid mortality decline in developing societies can be achieved through importation of modern health technology, with little accompanying socioeconomic change (Davis, 1956). With this development, mortality in these countries has gained new independent status as a policy variable that can be manipulated by government. The childhood component of mortality is of most interest, because the considerable potential for future mortality reduction in less developed countries exists primarily at the childhood ages, as indicated by the existence of substantial mortality differences between developing and developed countries usually only at ages 0-5. In many developing countries in the middle range of life expectancy (40-60 years), adult death rates at the older ages are actually lower than those for advanced countries (the puzzling so-called crossover effect ; see Thornton and Nam, 1968).

In developed countries child mortality is already so low that further reduction could have little effect on fertility. For example, even if mortality below age 15 were completely eliminated in the stationary population corresponding to the 1964 life table for United States females, stationarity could be maintained by a compensatory decline of less than 0.4 per thousand in the crude birth rate. It is fair to say that the substantial fertility fluctuations in developed countries since World War II have been closely related to the state of the economy and bear little relation to child mortality trends.

As a proposed fertility reduction policy for developing countries, child mortality reduction deserves particularly careful scientific scrutiny, not only because its political attractiveness colors policy-makers' perceptions of its potential effectiveness, but also because if not pursued as part of a balanced modernization policy, it may render society worse off than before. Unlike most other proposed fertility reduction policies, the failure of this one to obtain the desired fertility response would further increase population growth rates. This in turn might impede the general process of modernization, particularly economic development, (Coale and Hoover, 1958 ; Un, 1973 : chs. 13, 14), itself the fundamental force underlying fertility transition.

The potential effectiveness of the "adoption as policy" mechanism by which child mortality can influence fertility can be assessed only by careful examination of other mechanisms intervening between policy adoption and ultimate fertility behavior. The present paper attempts to outline these mechanisms, to ascertain the conditions under which they produce significant effects, to determine how fast these effects

occur, and to assess their relative importance through examination of both current and historical evidence. A basic distinction is made between individual level relationships and societal level relationships. This distinction is useful because child mortality reduction may operate on fertility at the societal level in ways that are difficult to identify from data on individuals. For example, population pressure from mortality decline may induce marital postponement or rural-urban migration that in turn affect birth rates, with individuals having little or no awareness of how these general social processes shape their own behavior (Preston, 1975). In the end, of course, all births occur to individuals, making it impossible to discuss one level adequately without reference to the other, and requiring an integrated treatment.

Individual level relationships

The basic explanatory framework utilized in this paper is the microeconomic framework (Schultz, 1973). It postulates that the reproductive behavior of individuals or families is largely a response to their underlying preferences for marriage at each age and children within marriage. Given the state of birth control technology and the various classes of uncertainty associated with such factors as contraception, mortality, health and fecundity, and the income individuals or families expect to realize over their life cycles, their preferences are constrained by their resources, by the costs of marriage, children, and other goods, and by alternative opportunities in using their resources as they attempt to maximize total utility. Resources, utilities, and costs of goods are conceived broadly to include nonmonetary as well as monetary components, making the model a general social science framework instead of a narrowly economic one. Given the all-encompassing allocative nature of the total utility function, this model belies any simple homeostatic adjustment mechanism between child mortality and fertility, the existence of which has nevertheless been suggested by some writers (Fredericksen, 1966 ; a number of earlier writers with this view are cited in Knodel, 1974 : 148 and UN, 1973 : 89).

For analytical purposes, we shall distinguish between utility derived from marriage and children within marriage, and utility derived from other goods, recognizing, however, that utilities from these two classes of goods are interdependent. Illegitimacy will largely be ignored. It is assumed that parents' gratification from and demand for children relate primarily to surviving children rather than children ever born. Changes in the demand for marriage and children are seen to stem from income effects and substitution effects, with income viewed in the broad sense of resources. Income effects stem from changes in income ; rise in income, ceteris paribus, will increase demand for marriage and children, and drop in income the opposite. It is assumed that children are not inferior goods. Substitution effects (defined more broadly than usual in economics), whereby one good substitutes for another at the same income level, stem from (1) changes in the composition of the marketbasket of available goods, (2) changes in costs of (a) marriage and children and (b) other goods, and (3) changes in the utilities derivable from (a) marriage and children and (b) other goods. Following Leibenstein (1973, 1974), utilities from children are broadly divided into (1) consumption utility, (2) production utility, and (3) security utility, and disutilities into (1) direct costs of feeding, housing, clothing, schooling, and general rearing of children and (2) indirect, or opportunity costs.

The microeconomic approach has recently been applied to the problem of child mortality and marital fertility by Cochrane and Cochrane (1974), who showed with a simplified mathematical model that a decline in child mortality, ceteris paribus, generally increases parents' demanded number of surviving children aged x, an effect noted also by Leibenstein (1957 : 163) and Schultz (1971 : 156 and 1972 : 12-13). The basic reason, in words, is that reduction of child mortality reduces the cost for the average family of producing an additional surviving child, say to age 15. This cost reduction involves income effects and substitution effects on the utility side, both of which act to increase the demand for surviving children. Child cost reduction, ceteris paribus, effectively increases real income. At the same time it may cause people to substitute children for other goods whose cost has not changed.

To facilitate the argument that follows, it is useful to introduce some new terminology. Let us call the change in family fertility due to the above-mentioned increase in demanded number of surviving children the "demand effect" of child mortality reduction on fertility. Ceteris paribus, the demand effect tends to increase fertility. But with child mortality reduction the demand effect is offset by fewer births being required to achieve the new demanded number of surviving children. Let us call this offsetting effect the "replacement effect" of child mortality reduction on fertility (not to be confused with the more general economic concept of substitution effect). Ceteris paribus, the replacement effect tends to decrease fertility. Whether fertility increases or decreases in response to child mortality reduction depends on which of these two effects predominates.

Demand and replacement effects can be examined more quantitatively as follows. Let

$C_t^* =$ Number of surviving children aged x demanded at time t

$P_t =$ Probability of surviving from birth to age x at time t

ΔB = Change in number of births for the average family caused by a ceteris paribus change in child mortality.

To simplify the argument, we shall ignore that births are spaced over time and assume that P_t and changes in it over time are the same for all children in any given family. We shall also assume perfect birth control. The condition for no change in family fertility with a ceteris paribus change in child mortality between time 1 and time 2 is then

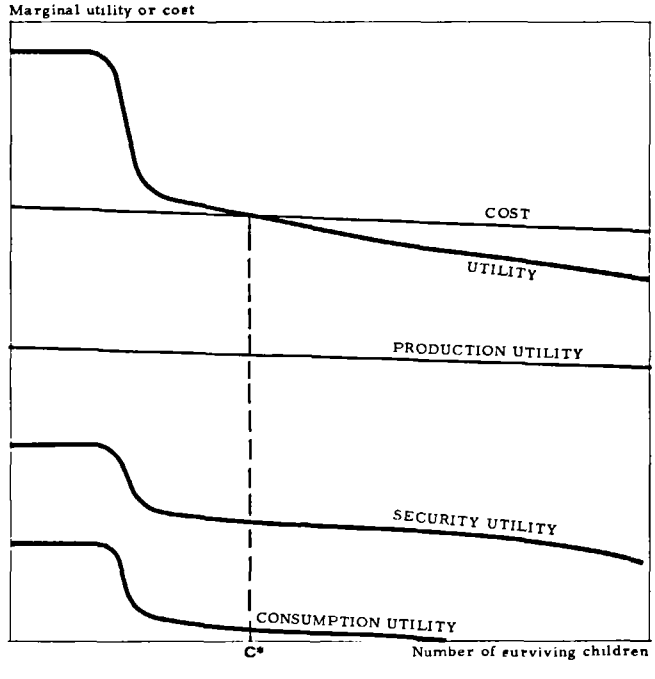
$$\frac{C_1^*}{P_1} = \frac{C_2^*}{P_2} \tag{1}$$

From this expression can be derived the following conditional statement which indicates how demand and replacement effects combine to influence direction of change in fertility :

$$\text{If}\left(\frac{C_2^*}{P_1} - \frac{C_1^*}{P_1}\right) \gtreqless \left(\frac{C_2^*}{P_1} - \frac{C_2^*}{P_2}\right) \text{ , then } \Delta B = 0 \tag{2}$$

The quantity $\left(\frac{C_2^*}{P_1} - \frac{C_1^*}{P_1}\right)$ is defined as the demand effect of child mortality change on fertility. It is the change in the number of births to the average family that would occur from child mortality-indiced change in demand for surviving children, holding constant child mortality at its initial level. The quantity $\left(\frac{C_2^*}{P_1} - \frac{C_2^*}{P_2}\right)$ is defined as the replacement effect of child mortality change on fertility. It is the change in the number of births needed to achieve C_2^* surviving children when child mortality changes from p_1 to p_2. The verbal equivalent of statement (2) is therefore the following : If the demand effect is greater than, equal to, or less than the replacement effect, then family fertility increases, remains unchanged, or decreases.

Judging from observed demographic transitions, the demand effect usually predominates in the early stage of transition, when mortality declines sharply and fertility often rises before declining after a lag. Some insight as to why this is so can be gained by graphical arguments, in a simple application of the classical theory of supply and demand. In societies just embarking on the process of modernization and demographic transition (Graph 1), we assume that production utility from each additional surviving child declines slowly with increase in the number of surviving children, an assumption that seems reasonable for labor-intensive

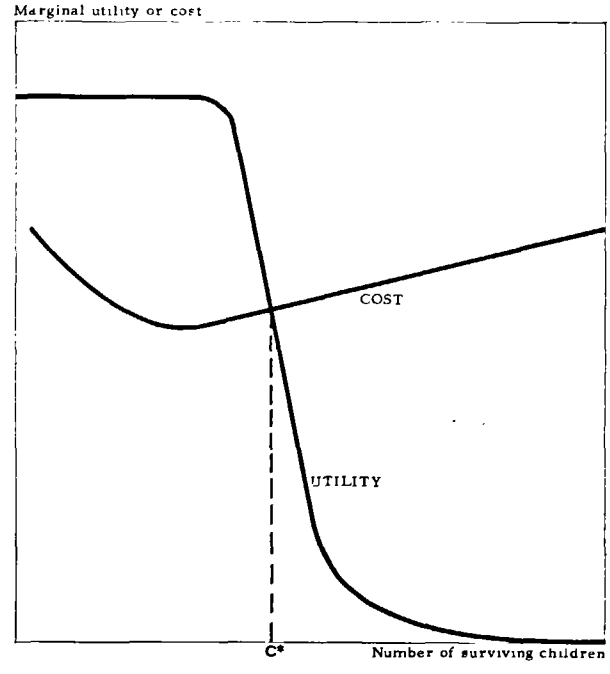


Graph 1 : Marginal utilities and costs of each additional surviving child : Early stage of modernization

Note : Utility refers only to utility derived from children, not from all goods. The curve labeled "utility" represents the sum of the production, security, and consumption utility curves. C* is the demanded number of surviving children, where the marginal utility from an additional surviving child equals its marginal cost. Children of course come in integral units, so that the utility and cost curves in reality are kinky ; for ease in illustrating arguments made in the text, they are drawn smoothly.

economies. Security utility at the time parents are forming their families is assumed lower than production utility, since it is deferred until later in the life cycle and must be discounted. Security utility is particularly high for the first two surviving children (one surviving son). It is assumed to drop off sharply for the next surviving child, but only slowly thereafter, since additional surviving children can be expected to find other rural employment or migrate to cities and send remittances to parents in their old age (Mamdani, 1972). Consumption utility is drawn as lower yet and is also assumed to drop off rapidly after the first two or three surviving children, who are sufficient to continue the family line, an important consideration in societies where kinship status is important. The direct cost of children is assumed to decrease slowly because of certain economies realized with more surviving children, such as hand-me-downs and the like (Liebenstein, 1973). Indirect (opportunity) costs are assumed low in the rural settings that typify these societies. The demanded number of surviving children C* is determined by the intersection of the utility (demand) and cost (backward-bending supply) curves, where the marginal utility from an additional surviving child equals its marginal cost.

In an advanced society production and security utility are near-zero, utility from children being primarily a function of consumption utility (Graph 2). With modernization, the consumption utility curve is assumed to shift upward for the first few surviving children in response to higher quality of children (piano lessons, etc.) that enhances their consumption value (Becker, 1960). The cost curve is assumed to be in the form of an attenuated J. Direct costs are assumed to diminish slowly as before. Indirect (opportunity) costs are high for the first child, since it entails abrupt cessation of employment and other activities outside the home for the wife. They are low for the next child or two, since the wife is tied down anyway until the first child enters school. Subsequently opportunity costs rise. With regard to the wife's employment, for example, it is assumed that the longer the period in which a woman's outside activities are interrupted because of preschool children in the household, who require her continuous presence, the larger are subsequent opportunity costs, particularly for women pursuing careers. Overall, it is assumed that for higher numbers of surviving children indirect costs predominate over direct costs, the cost curve rising.



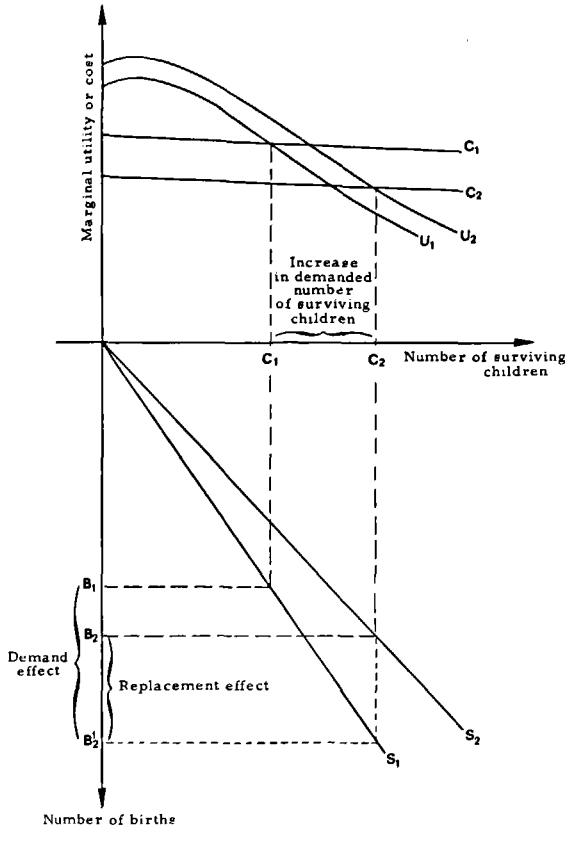
Graph 2 : Marginal utilities and costs of each additional surviving child : Late stage of modernization

Note : In this case production and security utility of children are assumed negligible, so that utility is determined by consumption utility. See also note to Graph 1.

What happens to these two graphs when child mortality drops, ceteris paribus ? In societies in the early stages of modernization, the utility curve shifts upward and the cost curve downward, the principal shift probably involving costs. The upward shift in the utility curve occurs because child mortality reduction is associated with increased health and robustness of surviving children, which enhance their utility. Because the two curves are relatively flat in the region of their intersection, small shifts in either curve move the intersection substantially to the right, increasing the demanded number of surviving children. The demand effect is therefore large, and it roughly offsets and may even exceed the replacement effect, as evidenced by frequently observed fertility increase in the early phase of demographic transition. If the hypothesis of

offsetting effects is correct, then child mortality reduction cannot play a key role in policies aimed at reducing fertility in these societies.

In the second graph, for advanced societies, the intersection of the utility and cost curves occurs in a region of sharp decline in the utility curve. That the slope of this segment of the utility curve is indeed highly negative (but perhaps kinkier than drawn) is suggested by the distribution of survey responses on ideal family size in advanced societies. For example, among white women in the United States in 1972, almost no one favored no children, 3 percent favored one, 56 percent two, 20 percent three, 17 percent four, and 4 percent five or more (Blake 1974 : 28). Because of the steep slope of the utility curve in the region of intersection, shifts up or down in either curve, due to a ceteris paribus change in child mortality, have little effect on the horizontal coordinate of the intersection. The demand effect therefore is near-zero and the replacement effect predominates. But since child mortality is already low in the average family, the magnitude of fertility change is necessarily small, again implying negligible relevance of child mortality reduction for fertility policy. A graphical representation of demand and replacement effects in the general case of a ceteris paribus change in child mortality, regardless of level of modernization, is contained in Graph 3.



Graph 3 : Graphical representation of demand and replacement effects on family fertility due to a ceteris paribus change in child mortality : general case

Note : U, C, S, B, and C* denote utility, cost, survivorship, births, and demanded number of surviving children, respectively. Subscripts denote time 1 and time 2. The graph as drawn assumes reduction in child mortality, but it could just as well have been drawn to portray an increase. The shift in demand for surviving children is drawn large enough that the demand effect on births exceeds the replacement effect, but it could just as well have been drawn to make the replacement effect exceed the demand effect. B_2^1 represents the new number of births that would have occurred after the child mortality-induced change in demand for surviving children, holding constant child mortality at its initial level.

It must be emphasized that the crucial assumptions in Graphs 1 and 2 are that in Graph 1 the utility and cost curves are relatively flat in the region of intersection and that in Graph 2 the utility curve is steeply declining in the region of intersection. The assumptions about relative levels and shapes of curves in other regions of the horizontal axis are presented as plausible, but they are not so crucial to the argument. The relative level and shape of the consumption utility curve in Graph 1 must be viewed as especially tentative.

It should also be noted that since Graphs 1 and 2 represent two polar cases, the approach here is one of comparative statics. A detailed dynamic analysis of the transition from one type to the other is beyond the scope of this paper, although certain fundamental points will be covered later in the section on societal level relationships.

As with theoretical studies, empirical studies of the influence of child mortality on fertility at the individual level have also generally focused on marital fertility and have ignored age at marriage. Most such studies have sought to measure the effects of mechanisms whereby fertility adjusts to improved child survivorship, with demanded surviving family size assumed relatively constant. The flaw of these studies is that they consider only replacement effects and fail to take into account offsetting demand effects, and this flaw in part explains their inconsistent findings. Moreover, most of these studies do not make the necessary distinction between demanded and desired number of surviving children. As evidenced by the desire and demand for Cadillacs, these are not the same. Clearly demand is more relevant than desire for assessment of causation and prediction of fertility (Demeny, 1970 : 36).

Heer and Wu (1973 : 5) and Rutstein (1970, 1974) found less than complete replacement in Taiwan, implying an increase in the population growth rate attendant upon child mortality reduction. On the other hand, Schultz (1971 : 162), using different methodology, found overreplacement in Taiwan. Hassan (1966) found overreplacement in Egypt, but failure to control for birth order renders his findings questionable (Heer and Wu, 1974 : 5). Wyon and Gordon (1971) found less than complete replacement in rural Indian Punjabi villages in 1959, as did also Harrington (1971) in Africa. Knodel (1968) found no replacement at all in nineteeth century rural Bavaria, leading Heer and Wu (1973 : 2) to speculate that replacement occurs only when at least some parents anticipate the possibility of excess births, as evidenced by the practice of conscious birth control.

A mechanism related to replacement involves uncertainty and the fear of child loss. Higher mortality risks imply greater variance in mortality, which may itself lead couples to have more children than they otherwise would have. If the replacement mechanism is also operating, child mortality reduction might then induce a decline in fertility that would more than compensate for decline in mortality, so that natural increase would actually fall (Heer and Smith, 1968 : 106). In fact the result depends on the form of the demand funtion for number of surviving children, as suggested also by Schultz (1969). If parents value highly having not less than a certain number of children and are indifferent or fatalistic about additional children, uncertainty will tend to increase demanded surviving family size. Conversely, where parents regard too many children as a burdensome demand on their resources and too few as only a modest inconvenience, uncertainty will tend to decrease demanded surviving family size. In developing countries, where family size ideals often consist of a minimum instead of a maximum (Freedman, 1965 : 419), uncertainty may well increase birth rates over what they would otherwise be. Some evidence supporting this conclusion is provided by Rutstein (1974), who found in Taiwan a small positive association between fear of child mortality and ideal tamily size.

A subtler question is whether people really have more children than they want as a hedge against uncertain mortality, or whether family size ideals and desires evolve higher than actual family size so as to make conscious hedging unnecessary. Probably both phenomena take place. Certainly ideals do get revised upward at the societal level. In traditional societies with long-standing balances of vital rates at high levels, ideal family size typically exceeds considerably actual surviving family size (Levy, 1965), suggesting that evolutionary selection of societies does not favor those that rely on conscious hedging to make up for uncertainty. This is perhaps not surprising, since even demographers have difficulty in assessing the magnitude of the uncertainties involved. It should be noted that higher ideal than actual family size functions to make up for uncertainties not only in mortality but also in fecundity and other factors relating to reproduction.

If uncertainty induces a fatalistic frame of mind about childbearing, the validity of the economic framework, which is based on rational calculation, is called into question. As noted by Schultz (1973 : 3), it can be argued that under premodern conditions parents are indifferent to economic considerations relating to childbearing, on grounds that the future is not known to parents with enough certainty to influence their decisions at the time they bear their children. Indeed, it is well-documented that the application of rationality to the reproductive sphere is highly correlated with its application elsewhere, and that each in turn depends largely on the extent to which there is certainty and confidence in future rewards for present effort (Ryder, 1973 : 65 ; Rainwater, 1967 : 51-52). That reduction of child mortality will reduce uncertainty and fatalism and encourage conscious regulation of births is undeniable, constituting another mechanism by which child mortality reduction can influence fertility. As to the challenge to the validity of economic model, it is not really so serious, because uncertainty can be viewed as a cost of childbearing and fatalism as a rational response. Both direct and indirect costs are affected. It is assumed that the utility and cost curves drawn in the earlier graphical supply-demand analysis include the effects of uncertainty and fatalism.

A number of studies have hypothesized that security utility of children plays an important role in how child mortality reduction affects fertility. Only less-developed societies are relevant here, since in advanced societies security utility is relatively unimportant. With modernization people rely more on pensions, securities, property, and other forms of retirement savings, and less on children for old-age security. Security utility appears to decline particularly rapidly in the later stages of the modernization process when fertility is already low. In Japan, for example, the proportion of men who expected to depend on their children in their old age fell from 52 percent in 1950 to 27 percent in 1961 (Simon, 1974 : 113).

If, as suggested in the earlier graphical analysis, the security utility curve in less-developed countries is indeed relatively flat in the region of the horizontal axis where the utility and cost curves intersect, then, by earlier arguments concerning offsetting demand and replacement effects, the old-age security mechanism probably contributes little to fertility reduction when child mortality falls. Heer and Smith (1968, 1969), in their well-known simulation approach to this problem, ask the question : How many children are needed to be 95 percent sure of having C* children survive to age 20 under conditions of varying child mortality ? Posing this type of question assumes that the security utility curve falls off vertically in the region of C*, so that the demand effect is zero ; moreover, it ignores the contributions of production and consumption utility to the overall utility curve. That these assumptions are dubious is suggested also by Ohara (1972 : 492) in his refinements of the Heer-Smith models.

Some studies have emphasized the role of lactation in the response of fertility to fall in child mortality. In breast-feeding noncontracepting populations, infant deaths shorten lactation, post-partum amenorrhea, and birth interval, thereby increasing fertility. Decline in infant mortality reverses this mechanism and causes fertility decline. But simple mathematical models suggest that this mechanism cannot affect fertility by more than a few percent (Knodel, 1974 : 150).

The influence of changes in child mortality on fertility is not an instantaneous adjustment process. In the long run of the demographic transition, fertility decline normally lags mortality decline, but by a time span that varies considerably from one context to another. If in a given set of circumstances it is possible for reduction of child mortality to induce fall in fertility, and if fertility reduction is a goal of policy, then an understanding of the factors affecting lag time becomes highly pertinent, since it may be possible to reduce lag through appropriate policy measures.

A detailed examination of these factors is beyond the scope of this paper, but a few fundamental points can be mentioned. The basic reason for the lag is that social values almost always favor low mortality (wartime being the most notable exception), whereas under conditions of high mortality social values and institutions are ingeniously and elaborately organized to ensure a birth rate high enough for society to survive (Notestein, 1945 : 39). When underlying economic and social conditions become favorable to lower mortality, mortality drops immediately, but this is not true of fertility, because the institutional and value structures favoring high fertility take time to adjust.

It has been suggested by some that lagged perception of child mortality decline explains partly the lag in fertility decline (e.g., Schultz, 1971 : 161 ; Schultz, 1972 : 17 ; Heer and Wu, 1973 : 5 ; Heer and Wu, 1974 : 8ff). If this effect is substantial, one would expect a well-organized campaign to inform the citizenry of current mortality levels and their implication for surviving family size to shorten considerably the lag time. To my knowledge, such a campaign has never been mounted nor its effect on fertility measured. It seems rather doubtful that such an information campaign would have much effect. In societies commencing rapid mortality decline, previous experience consists of periods of relatively low mortality punctuated with short episodes of high mortality due to famine and epidemic diseases. It would probably be difficult to convince most people that the likelihood of more such episodes is near-zero until the time elapsed since the last episode was fairly long. Using this kind of argument, Cochrane and Cochrane (1974 : 107) have speculated that the 1968 resurgence of malaria in Sri Lanka has delayed fertility decline in that country.

The effect of perception lag can be examined usefully in the light of the graphical approach utilized earlier. It was argued then that if in a less-developed society the utility and cost curves are both relatively flat in the region of their intersection, a drop in child mortality can be expected to produce little change in fertility and may actually increase it. If it is true that actual changes in child mortality have little effect, then lag in perception of those changes should also have little effect. The explanation of the lag of fertility decline behind child mortality decline would seem to lie primarily in the realm of economic and social factors. Fragmentary evidence that mortality perception lag is not very important in developing countries is found in Stycos' (1965) study of Lima, Peru, in which many respondents thought infant mortality had increased, although both it and fertility were in fact declining.

Knodel (1974) has pointed out that lag of fertility decline behind child mortality decline depends on which mechanisms are operating. If the principal mechanism is prolonged lactation, post-partum amenorrhea, and birth interval, then the lag should be no more than one or two years (Ibid. : 150). If the replacement mechanism predominates, with people having a fixed surviving family size in mind and ceasing to have children once it is attained, then one would expect a lag of no more than five or ten years (Ibid. : 153). In fact, time lags of fifty years and more have commonly been observed, as will be discussed in more detail in the next section.

Societal level relationships

Observed empirical relationships between child mortality and fertility at the aggregate level are inconsistent. Correlation studies show associations between mortality and fertility that are sometimes positive,

sometimes negative. Positive associations normally occur when the units of analysis (usually countries) are distributed over the entire range of the demographic transition (UN, 1954 : vol. 2 : 5 ; Weintraub, 1962 ; UN, 1965 : 137 ; Fredericksen, 1966 ; Heer, 1966 ; Kirk, 1971 : 139ff). Both positive and negative associations of varying degrees of strength occur when the units of analysis are concentrated in a narrow range of the demographic transition (Friedlander and Silver, 1967 ; Nag, 1962 : 140 ; Heer and Boynton, 1970 ; Chandrasekhar, 1972 : 260 ; Schultz, 1972). Short-term time-series data for a given country often show negative association between mortality and fertility (Carlsson, 1969, 1970 ; Drake, 1969 ; Simon, 1974).

Correlation and multiple regression studies that distinguish between infant mortality, child mortality, and life expectancy usually show life expectancy more highly associated with fertility than child mortality, and child mortality more highly than infant mortality (UN, 1954 : vol. 2 : 5 ; UN, 1965 : 145 : Friedlander and Silver, 1967 ; Kirk, 1971). The higher the level of infant mortality, the more tenuously related it is to child mortality, life expectancy, per capita income, and general level of development (UN, 1954 : vol. 2 : 6, 24 ; UN and WHO, 1973 : 4).

The literature on threshold levels of mortality upon initiation of fertility decline is scarcely more illuminating. Studies examining this question indicate that the threshold consists of a range that is fairly wide. The threshold zone is much larger for infant mortality than for life expectancy and most other social indicators (UN, 1965 : 149ff ; Kirk, 1971 ; Demeny, 1972a : 172).

The evidence on lag of fertility decline behind mortality decline also fails to show a clear relationship. Mortality normally declines before fertility in the demographic transition as a whole, but the time lag varies enormously. In the United States and France there was virtually no lag, mortality and fertility falling more or less together (Taeuber and Taeuber, 1971 ; Landry, 1934 : 38). In Norway the lag was approximately fifty years (Drake, 1969 : 157), as it was also in Taiwan (David, 1971 : 7).

Demographic transition theory helps to explain the lack of a clear relationship between child mortality and fertility in the above empirical studies. For our purposes it is desirable to make the usual division of the demographic transition into three principal stages, the first characterized by high birth and death rates, the second by falling vital rates and transitional growth, mortality normally falling first, and the third by low birth and death rates.

In the first stage, changes in vital rates generally consist of short-run fluctuations that exhibit little or no long-term trends. Mortality and fertility usually move in opposite directions in response to short-run fluctuations in economic conditions, particularly harvests (Carlsson, 1969, 1970 ; Drake, 1969). Variation in age at marriage plays an important role in the fertility fluctuations, so that first order births are particularly sensitive to harvest conditions, in contrast to the long-term secular trend where higher order births are most sensitive ; this is also true in modern business cycles (Simon, 1974 : 30, 31, 165). Mortality and fertility fluctuations are thus commonly caused, and there is little independent effect of mortality on fertility (Carlsson 1970 : 418). The association between the two is negative, in contrast to the positive association observed over the demographic transition as a whole.

Sometimes, however, fluctuations of mortality and fertility during the first stage are in the same direction (e.g., Matras 1973 : 25). It seems likely that parallel fluctuations occur primarily when mortality fluctuations stem from epidemics unrelated to changes in economic conditions. For example, if an epidemic causing unusually high child mortality struck during a period of constant economic conditions, fertility might rise due to shorter lactation and post-partum amenorrhea. An epidemic causing unusually high adult mortality might result in earlier marriage and higher fertility due to inheritances and jobs appearing sooner than expected (Drake, 1969 : 157). These effects are probably small. Fragmentary evidence from England indicates that when plague struck during periods of reasonably constant economic conditions, birth rates varied little (Wrigley, 1969 : 115).

According to the transition model, when mortality starts its sustained fall in the second stage, fertility first rises slightly, then falls, eventually catching up with mortality. During the first part of the second stage, when fertility rises slightly, mortality and fertility move in opposite directions and are negatively associated. During the second part they fall together and are positively associated. Classical demographic transition theory relies principally on demographic mechanisms to explain why fertility should first rise with mortality decline. When mortality declines, fecundity improves and widowhood in the reproductive period declines (UN, 1965 : 7-8 ; Ryder, 1955). The earlier graphical supply-demand analysis throws additional light on how an initial rise in fertility might occur.

In the third stage of low vital rates, mortality depends primarily on a highly developed infrastructure of individualized health services, which vary little in response to short-term fluctuations in the economy. Epidemic diseases are tightly controlled, and mortality tends to hover around a constant low level. Fertility, on the other hand, is responsive to economic factors, rising and falling over the course of business cycles. During the third stage, therefore, significant correlation between mortality and fertility is normally lacking.

Demographic transition theory thus explains, at least in part, the lack of a clear relationship between

mortality and fertility in the aggregate data. This relationship is nonlinear and changes markedly from one transitional stage to the next. It is therefore not surprising that correlations and multiple regression studies, which test only for linear relationships, have produced such inconsistent results. But although demographic transition theory is helpful, it still leaves a good deal unexplained. The processes by which modernization produces mortality and fertility decline are not specified in enough detail to explain the wide variation in threshold level, lag time, and speed of decline. A detailed discussion is beyond the scope of this paper, but one class of processes, involving the effect of mortality on fertility through population pressure, is of particular interest.

Expanding upon Matras (1973 : 72ff), we may distinguish four major societal responses to population pressure, in the simple sense of increase in numbers in a fixed area : (1) population redistribution, (2) adoption of technological and social innovation, (3) fall in fertility, and (4) rise in mortality. None of these is inevitable, and to a certain extent each is an alternative to the others. For example, population redistribution, through migration from farms to cities or conquered lands, can mitigate pressure to reduce fertility ; variation in migration patterns perhaps explains some of the variation among European countries in the historically observed lag of fertility decline behind mortality decline (Friedlander, 1969).

The view that population pressure can stimulate adoption of technical and social innovation, the second response, has been put forth also by Sauvy (1969), in his examination of European development, and by Boserup (1965) in her explanation of the transition from hunting and gathering to slash-and-burn agriculture, and from slash-and-burn to settled agriculture. In today's developing countries population pressure also appears to constitute part of the stimulus to governments to modernize their countries quickly (Hirschman, 1958). India's efforts at development, for example, would probably be smaller if imported mortality decline, consequent population pressure, and the spectre of declining living standards had not made development such an urgent priority. But exceedingly high population growth rates have so compressed the time scale of population pressure that in some countries it is not clear whether developmental efforts will succeed or fail (Demeny, 1965 : 69). If developmental efforts succeed, the experience of advanced countries suggests that rapid fertility decline will follow. It is therefore possible that the line of causation from mortality decline to population pressure to modernization to fertility decline will ultimately turn out to be an important mechanism by which mortality decline, including child mortality decline, affects fertility in developing countries.

The fourth response, the Malthusian nightmare of ultimate increase in mortality, is of course always possible but is not very interesting as a policy alternative. The most interesting response for the purposes of this paper is the third, fertility decline.

To begin with, it is important to realize that under some circumstances mortality decline and consequent population pressure historically have induced low fertility without modernization, in exception to demographic transition theory. Although no major world region has achieved both low birth and death rates without modernization, small societies have occasionally done so. For example, some of the more isolated Pacific islands characterized by relatively disease-free environments and delicate resource/population balances had exceptionally low mortality and fertility before contact with European civilization (Nag, 1962 ; Matras, 1973 : 319). Such societies are generally characterized by hunting, fishing, and gathering modes of production (Krzywicki, 1934 : chs. 5, 6). Production is highly inelastic with respect to population growth, since there is generally no way to stimulate an increase in the amount of game, fish, or gathered goods in response to population increase. In contrast, agricultural societies can clear more land or cultivate existing land more intensively to accommodate more population.

With the above few exceptions, modern low levels of fertility have been achieved on a sustained basis only through the process of modernization described in general terms by demographic transition theory. According to this theory, as we have seen, modernization is the common cause of mortality decline, consequent population pressure, and fall in fertility. Although important intermediate mechanisms link mortality decline and population pressure to fertility decline (Davis, 1963), the classical theory does not view either as having much independent effect on fertility.

These intermediate mechanisms are nevertheless of considerable interest for currently developing countries where rapid imported death rate decline without substantial modernization has accorded mortality and population pressure new independent status as policy variables. In these countries the policy-relevant question is : Can the mechanisms historically linking population pressure to fertility exert a significant depressing effect on fertility in the absence of economic development ?

In areas with falling mortality but little other evidence of modernization, such as rural Java or Bangladesh, slowly changing birth rates indicate that the fertility response even to unprecedently high population pressure is slow. On the other hand, in countries where rapid mortality decline and population growth have occurred with economic and social development, such as Korea and Taiwan, fertility decline began at substantially lower levels of living and has been proceeding faster than it ever did in advanced countries (Kirk, 1971 ; Retherford and Cho, 1973). Probably part of the reason for the rapidity of fertility

decline in these countries is that the precipitous drop in death rates and lack of international migration opportunities and new frontiers, which functioned as safety valves for European and New World countries, have combined to create unprecedented population pressure. In sum, mortality decline and population pressure without social and economic development do not seem to cause rapid fertility decline, but if combined with development they appear to accelerate substantially this response. This observation is consistent with the supply-demand analysis of the previous section.

Examination of the demographic transitions of advanced countries throws additional light on the effect of population pressure from mortality decline on fertility. A key point is that fear of poverty cannot have played a large role in the fall of fertility in the West, because living conditions were generally improving. Far from being tied to fear of poverty, population pressure appears to have worked through fear of relative loss of status in a period of rising prosperity. People found that their accustomed demographic behavior was handicapping them in their efforts to take advantage of opportunities being provided by the emerging economy (Davis, 1963 : 352, 362). The whole process was fundamentally tied to economic development.

The historical rural response to population pressure is of particular interest, since today's developing countries are still predominantly rural. In Northwestern Europe, improvements in living conditions, mortality decline, and consequent population pressure between the Middle Ages and the eve of the Industrial Revolution were associated with substantial decline in rural fertility, principally through postponement of marriage and increased celibacy. Typically demographers have explained the uniqueness of the European late marriage pattern by pointing to Europe's unique type of family organization (Hajnal, 1965). The European independent nuclear family ideal was that one should not marry and start a family until he achieved a livelihood. In rural areas that usually meant waiting to inherit a farm. This wait got longer as adult mortality declined. The apprentice system in villages and small towns also promoted late marriage, since it did not adequately remunerate persons until the long apprentice-journeyman period was completed. Between the Middle Ages and the eve of the Industrial Revolution the apprentice-journeyman period probably also lengthened as adult mortality improved, master craftsmen lived longer, and the craft guilds restricted opportunities for advancement to protect the interests of masters, without necessarily being aware of changes in mortality level.

In today's developing countries, in contrast, the joint family system provides an economic cushion for young married couples. In India, for example, the young couple traditionally is not expected initially to provide for itself. The broader kinship group sustains it for a while. The effect of population pressure on fertility through delayed marriage is therefore attenuated. (But even in Europe joint family arrangements were more common than the independent nuclear family ideal might suggest. In Sweden, for example, 62 percent of sons born to 25-year-old fathers from the cohort of 1850 could expect their fathers still to be alive at age 65 when the sons were 40. Since the costs of postponing marriage this long were so great, a common pattern was for aspiring farmers finally to marry and farm with their fathers during the latter's old age.)

If the principal mechanism by which mortality decline historically promoted delayed marriage in rural Northwestern Europe was postponement of inheritance due to increased longevity of fathers, all that mattered was adult mortality. Children waited until the father died, then divided the inheritance and started their own families. To the extent that this mechanism operated, we may speak of an "adult mortality effect" on age at marriage. Of course, not all land was inherited. Some was sold, since even in the second stage of the demographic transition, about 20 percent of marriages failed to produce a male heir (Ryder, 1973 : 6). But for the most part only established farmers had the wherewithal to buy it. Young people generally had to rely on inheritance to acquire land.

But there is reason to believe that child mortality decline also had a substantial effect on age at marriage, particularly as economic development and modernization of agriculture progressed. Beyond a certain point, farmers were reluctant to subdivide land further, although some subdivision inevitably occurred anyway with the press of increased rural population. As mentioned, a typical pattern was that one son would finally marry and farm with the father during the latter's old age. Under systems of equal inheritance, other sons would lease their land to the farmer son, but the rent was low and irregularly paid and was not enough to provide a livelihood. The decision as to which son farmed therefore often became a source of considerable friction in farm families. Under systems of primogeniture, other sons did not even have this much. Some of the other sons might be fortunate enough to enter a trade in the village and eventually be able to marry and support a family following the apprentice-journeyman period. Many others became farm laborers, working for and living in the house of a farm owner. Since most farm owners could provide only a room, the incidence of celibacy among farm laborers was very high. Those able to save enough eventually to buy land or other property also married late. Some sons migrated, lessening the pressure for late marriage and celibacy among those who remained (Friedlander, 1969). In sum, to the extent that land was not subdivided, the child mortality experienced by a cohort affected the fraction of them who could not become farm operators and who would therefore find it difficult to obtain a livelihood sufficient to marry and support a family at a young age, if at all. This we may call the "child mortality effect" on age at marriage.

The child mortality effect on age at marriage is not restricted to societies with an independent nuclear family ideal. In developing societies where modernization is well underway, there also has been a sharp increase in age at marriage in rural areas, despite joint family organization. For example, West Malaysian Malays, who are predominantly rural, reduced their crude birth rate by 17 percent between 1960 and 1970, principally through later marriage. Marital fertility actually increased overall and tended to raise the crude birth rate. Similar postponement of marriage in rural areas has occurred in Korea and Taiwan, where economic and social development has also been rapid (Retherford and Cho, 1973). It must be noted, however, that increase in age at marriage with modernization is not universal ; in some cases fertility transition has been accomplished by marital fertility reduction with little change in age at marriage (Matras, 1965 ; Demeny, 1972a).

Within the group of countries with joint family organization, why has mortality decline and consequent rural population increase produced rapid marital postponement when accompanied by substantial economic and social change ? Part of the answer, though somewhat speculative, would seem to lie in the shift to capital-intensive agriculture, which makes further subdivision of land impractical if newly appearing economies of scale are to be realized, regardless of type of family organization. The chemical revolution in agriculture (fertilizers), for example, is not economically profitable on small plots (Geertz, 1963 : 130ff). This is even more true of the subsequent mechanical revolution (tractors, etc.). At the same time, the number of persons who can perform useful work on a given piece of land declines. Young men are motivated either to wait to acquire a sufficiently large piece of land to take advantage of new capital-intensive techniques, or to migrate to cities for more rewarding employment. This latter alternative normally exists, because urban economic expansion generally goes hand in hand with modernization of agriculture (Fei and Ranis, 1964).

Individual-level mechanisms by which child mortality affects rural marital fertility were discussed in the previous section. It remains to discuss some of the principal societal-level mechanisms. Typically rural marital fertility declines somewhat after the initial response of delayed marriage, although, as mentioned, there are exceptions. A drop in adult mortality means that children have to wait longer to inherit the farm. Those who inherit and become farm operators generally do not limit fertility within marriage until further economic and social changes have occurred. The empirical evidence indicates that in Germany during a substantial part of the nineteenth century, for example, there was little restriction of marital fertility, despite considerable marital postponement (Knodel, 1968). A similar pattern is visible in Sweden (Kumar, 1971) and, as noted earlier, in Malaysia, Korea, and Taiwan.

The explanation of the lag in rural marital fertility decline behind the initial response of delayed marriage has much to do with the externalities of childbearing. In the early stages of modernization, the economic prerequisites of marriage constitute costs that fall directly on the prospective husband. But once married, the costs of high marital fertility are borne not so much by the parents as by their children when the latter reach marriageable age and seek a livelihood in order to marry and start their own families. Economically, the crucial point in the life cycle is inheritance. Subsequent to inheritance and marriage, the economic utility of higher order surviving children to the new couple may still be significant. Children can contribute to family savings, enabling parents to buy more land, and children who migrate to cities can send back remittances (Davis, 1963 ; Mamdani, 1972). Moreover, in a labor-intensive system, higher order surviving children tend to have at least some net economic value, even when landholdings are subdivided. Numerous inconsequential tasks, such as tending grazing animals, be their number large or small, still require someone to do them. It is usually only at a somewhat later stage of development, when agriculture is more capital-intensive, per capita productivity higher, formal education more valued, and the old-age security functions of children less important that the net economic value of higher order surviving children to farm families is sharply reduced and marital fertility declines rapidly.

This analysis is consistent with the supply-demand arguments of the previous section. If it is correct, the important policy question in rural areas of today's less developed countries would seem to be : Is it somehow possible to shift the costs of large families to fall principally on parents instead of subsequent generations, without having to rely on general economic and social development ? No clear answers exist to this question, but it is difficult to see how further government-induced reduction in child mortality, unaccompanied by other modernizing influences, could play this role.

Although the empirical evidence does not indicate that subdivision of land and the gradual descent of a rural area into poverty have a very substantial effect on birth rates, nevertheless there is good reason to suspect that there is some effect, albeit slow. From the earlier theoretical discussion of income effects on fertility, subdivision of land, ceteris paribus, should induce a fall in fertility. Moreover, although parents act largely out of self-interest, they are by no means totally insensitive to the problem that land subdivision poses for their children as future adults. Furthermore, although with smaller plots there are still many inconsequential tasks in a labor-intensive system for which children are useful, nevertheless, as land subdivision becomes severe, underemployment of higher order surviving children must gradually increase, reducing their economic utility and the incentive for having them in the first place.

There is some evidence supporting this theoretical expectation of fertility decline from land subdivision. Richer farmers usually have more children than poorer farmers in traditional rural societies (e.g., Stys, 1958), and rural fertility generally varies directly with size of harvest in the short run, as remarked upon earlier. In Japan, land subdivision led to marital fertility restriction and infanticide during certain periods (Hanley and Yamamura, 1972). In rural Java, where birth rates have not responded rapidly to population pressure, abstinence is nevertheless widely practiced as a birth control method, and birth rates are somewhat lower than on the less densely populated outer islands (Singarimbun, 1972 ; McNicoll and Mamas, 1973). Moreover, fertility varies directly by income in rural areas (Singarimbun and Manning, 1974 : 117), and the relatively more prosperous regions by and large have somewhat higher fertility than the poorer regions (McNicoll and Mamas, 1973 : 45). The unusually high crude birth rate of around 50 in the early nineteenth century United States (Glass and Grebenik, 1966 : 97) probably had a good deal to do with seemingly limitless land and other resources. It seems reasonable to conclude that subdivision of resources, ceteris paribus, reduces fertility.

But the slow response of fertility to subdivision of land in the absence of substantial economic and social change implies that this type of population pressure is not a policy-relevant mechanism by which child mortality reduction can affect fertility. If one were to rely only on this mechanism in such areas as rural Bangladesh or Java, a balance in birth and death rates might be achieved only at very low levels of living. Moreover, with population growth and land subdivision proceeding so rapidly at already very high rural densities, mortality might well level off or even rise before either mortality or fertility reached modern low levels.

In cities, the relation of mortality decline and population pressure to fertility is more complex than in rural areas, because per capita resources depend more on the organization of labor and capital, which is highly variable, and less on availability of land. Moreover, during the early phase of demographic transition, rural-urban migration figures more importantly in urban population growth than in rural population growth.

In early nineteenth-century European cities, mortality was extremely high, due largely to polluted water supplies and rudimentary public sanitation, so that natural increase was frequently negative. City growth stemmed mostly from rural-urban migration (Davis, 1965). Children had substantial economic value. In the English textile industry, for example, women and children were extensively employed (Smelser, 1959 : chs. 9-11), and children had considerable economic utility in family enterprises as well. There was little motivation to defer marriage, since a livelihood could be earned at a young age.

In this early stage of the Industrial Revolution one might therefore expect higher urban than rural fertility, in contrast to the more recent pattern of lower urban fertility. Higher urban fertility in fact seems to have obtained during this early period, although remarkably there seems to exist no comprehensive study of the historical trend in rural-urban fertility differentials that would allow one to document this apparent fact easily and thoroughly. The following fragmentary evidence can be mentioned. In France and Germany toward the end of the nineteenth century, urban fertility appears frequently to have exceeded rural fertility (Carlsson, 1969 : 154 ; Friedlander, 1969 : 361). In Sweden, urban fertility exceeded rural fertility between roughly 1850 and 1890, being highest in the three major cities of Stockholm, Goteborg, and Malmo, where new modes of production predominated, lower in the country's towns, and lowest in rural areas. Mortality was also highest in the largest cities, lower in the towns, and lowest in rural areas (Sweden, CBS, 1955 : 48), the acuteness of public sanitation problems apparently varying directly with city size. In England around 1780, when industrialization was getting underway, both mortality and fertility were considerably higher in Manchester, a budding textile center, than in rural parishes (Krause, 1969 a : 124). Much of the rural-urban difference in English fertility appears due to differentials in age at marriage, which was particularly low in the new textile areas (Ibid. : 126).

Rapid fertility decline occurred in European cities with increase in factory-centered production, which discouraged the use of child labor ; enactment of child labor and compulsory school attendance laws, which also substantially reduced the monetary value of children to parents ; and mortality decline. It is interesting that fertility in the English textile areas fell far more sharply than did the national average between 1821 and 1851, during which time these other urban changes also occurred (Krause, 1969a : 126). Changes in the Poor Laws have also been mentioned as contributing to urban fertility decline in early nineteenth-century England (Krause, 1969b : 109), but this factor cannot account for apparently similar trends in Germany and Sweden during their nascent industrialization later in the century.

In Swedish towns and in Stockholm after 1850, urban mortality and fertility generally varied in the same direction from one decade to the next, but in Goteborg and Malmo fertility rose until 1880 despite steadily dropping mortality (Sweden, CBS, 1955 : 48). In these latter two cities, it is quite clear that rise in mortality cannot explain rise in fertility because the former did not occur. This is not to say, however, that rise or fall in mortality did not tend to induce corresponding rise or fall in fertility, only that such causal effects of mortality, if present, were more than offset by other factors. It could still be argued, for example, that higher mortality in cities made jobs more available and that this factor led to lower age at marriage and higher fertility than in rural areas. But this argument ignores that rural-urban migration accounted for most

urban growth and that it was responsive to urban employment opportunity. It seems likely that when mortality increased, thereby reducing population pressure on jobs, rural-urban migration increased, thereby keeping up the pressure on jobs and rendering the relationship between mortality and unemployment rather tenuous.

The fraction children were of the workforce probably had greater bearing on fertility than the level of unemployment. This interpretation is supported by the apparent peak in English urban birth rates during the decade 1811-1820, which featured harvest failures and widespread unemployment, as well as widespread child labor (Krause, 1969b : 109). Unemployment during this period may have affected adults more than children, since employers could pay children less. The literature abounds with examples of husbands who put their wives and children to work in the mills but had difficulty finding work themselves.

It would seem on the whole that the initial rise and subsequent fall of urban fertility during early European industrialization had mainly to do with changes in the economic prerequisites of marriage and in the production utility of children, and less to do with changes in their consumption utility, security utility, or mortality. Since it was possible for men to earn a livelihood and start a family at a young age, and since children could work and contribute to family income, large families were advantageous regardless of the level of child mortality. In terms of our earlier supply-demand analysis, we may infer that in these early cities, production utility per additional child declined only slowly with increases in the number of surviving children, and that it dominated the function for overall utility per additional child. Variation in child mortality, ceteris paribus, produced demand effects that roughly offset replacement effects, with little change in marital fertility from this source.

The demographic development of cities in currently less-developed countries differs in some important respects from the experience of the West. Imported health technology has arrived first in cities, so that the initial rise in urban mortality observed in the West is no longer seen. Neither usually is the rise in fertility, tempting one again to attribute causal significance to mortality. But the economic situation in the cities of today's developing countries is also very different than it was in the West. Today, the expanding economic sectors of a city like Bangkok are modern and capital-intensive. Jobs require training, and are not so simple and mind-numbing as those in the textile industry of late-eighteenth-century England. City residents need education and training for themselves and their children, the cost of which provides incentive to reduce fertility. In Thailand, which saw considerable economic development over the 1960s, mortality and fertility were both considerably lower in urban than in rural areas around mid-decade (Thailand, NSO, 1969).

Summary and Conclusion

Since child mortality reduction may operate on fertility at the societal level in ways that are difficult to identify from data on individuals, it has been convenient to divide this review into two related sections, one dealing with individual level relationships between child mortality and fertility, and the other with societal level relationships.

In the analysis of individual level relationships, some new terminology was introduced, which distinguished the "demand effect" of child mortality reduction on fertility from its "replacement effect". The demand effect refers to the increase in family fertility from child mortality-induced increase in demanded number of surviving children, with child mortality held constant at its initial level. Demanded number of surviving children increases principally because child mortality reduction lowers the marginal cost of producing an additional surviving child. The demand effect is offset by the replacement effect, whereby fewer births are required to achieve the new demanded number of surviving children. Whether fertility increases or decreases in response to child mortality reduction depends on which of these two effects predominates. Similar reasoning holds for the effect on fertility of an increase in child mortality.

Judging from observed demographic transitions, the demand effect usually predominates in the early phase of transition, when mortality declines sharply and fertility often rises before declining after a lag. Some insight as to why this is so was gained by graphical arguments, in a simple application of the classical theory of supply and demand. It was argued that when marginal utility and marginal cost of each additional surviving child are graphed against number of surviving children for societies in this early stage of development, the two curves are both fairly flat in the region of their intersection (Graph 1). This intersection defines the point where the marginal utility of an additional surviving child equals its marginal cost, and hence determines the demanded number of surviving children. Since both curves are flat, a shift up or down in either, due to a ceteris paribus change in child mortality, will strongly affect the demanded number of surviving children, rendering theoretically plausible the empirical fact that demand effects roughly offset and sometimes exceed replacement effects during this stage of transition. If this argument is valid, child mortality reduction cannot play a key role in policies aimed at reducing fertility in these societies.

In advanced societies, the replacement effect predominates. In the region of the intersection of the marginal utility and cost curves, the marginal utility of an additional surviving child drops off rapidly, so that shifts in either curve have little effect on the demanded number of surviving children (Graph 2). But since child mortality is already very low, replacement effects are necessarily small, again implying negligible relevance of child mortality reduction for fertility policy.

Earlier empirical studies of the influence of child mortality on fertility at the individual level have generally sought to measure replacement effects and have failed to take into account offsetting demand effects, a defect which helps to explain the inconsistency of their findings. Some of these studies have tried to measure the effect of uncertainty and fear of child loss in addition to the replacement effect. Higher mortality risks imply greater variance in mortality, which in less-developed countries may itself lead couples to have more children than they otherwise would have as a form of insurance. With reduction in child mortality, replacement plus reduction in uncertainty might then induce a decline in fertility that would more than compensate for decline in mortality, so that natural increase would actually fall. The failure to take into account demand effects makes the results of these studies difficult to interpret, but there is some evidence that uncertainty increases birth rates somewhat over what they would otherwise be.

A number of studies have hypothesized that in less-developed countries old-age security utility of children plays an important role in how child mortality reduction affects fertility. But these studies also ignore demand effects and examine only replacement effects. They implicitly assume that the security utility curve drops off steeply in the region of C*, the demanded number of surviving children, whereas this paper argues that it drops off fairly slowly (Graph 1). If the curve in fact drops off slowly, a ceteris paribus decline in child mortality may produce roughly offsetting demand and replacement effects through the security mechanism and contribute little to fertility change.

Some studies have emphasized the role of lactation in the response of fertility to fall in infant mortality. In breast-feeding noncontracepting populations, decline in infant mortality lengthens lactation, post-partum amenorrhea, and birth interval, thereby reducing fertility. But simple mathematical models suggest that this effect is small.

Lag in perception of fall in mortality has often been invoked to explain the normally observed lag of fertility decline behind mortality decline in the demographic transition. But if it is true that actual changes in child mortality have little effect on fertility in societies just embarking on demographic transition, then lag in perception of these changes should also have little effect. That factors other than mortality perception lag primarily explain the lag of fertility decline behind mortality decline is suggested by the tremendous variability in lag time of fertility decline behind mortality decline from one society to another. This lag time ranges from near-zero to fifty years and more.

Observed empirical relationships between child mortality and fertility at the societal level are inconsistent. The nonlinearity of the demographic transition goes a long way toward explaining this inconsistency, since most studies test only for linear relationships. In the stage of high vital rates, fertility and child mortality generally move in opposite directions in response to harvest conditions and are therefore negatively related. Over the transition as a whole both birth and death rates fall and are positively related. In post-transitional modern societies mortality is low, tightly controlled, and fairly constant, whereas fertility varies substantially in response to fluctuations in economic conditions, so that correlation between child mortality and fertility is largely lacking.

But demographic transition theory still leaves much unexplained. The processes by which modernization produces mortality and fertility decline are not specified in enough detail to explain the wide variation in threshold level, lag time, and speed of decline. In the context of this paper one class of processes is of particular interest, involving the effect of child mortality reduction on fertility through population pressure.

Four major societal responses to population pressure, in the simple sense of increase in numbers in a fixed area, were distinguished: (1) population redistribution (2) adoption of technological and social innovation, (3) fall in fertility, and (4) rise in mortality. For this paper the second and third responses were of most interest. If population pressure from child mortality decline produces the second response, then the experience of advanced countries suggests that fertility decline will follow. But exceedingly high population growth rates have so compressed the time scale in some of today's less-developed countries that it is not clear whether developmental efforts will succeed or fail. It is highly questionable whether further efforts to reduce child mortality would enhance the probability of success.

In less-developed countries such as rural Java or Bangladesh, where imported mortality decline has been occurring with little other evidence of modernization, the third response of fertility decline has been disappointingly slow, even though population pressure has been unprecedentedly high. Yet in countries where rapid mortality decline and population growth have occurred with economic and social development, such as Korea and Taiwan, fertility decline has commenced at lower levels of living and proceeded faster than it ever did in the West, with delayed marriage, also related to child mortality, playing an important role. The fertility

response is slow in the former case because the costs of population growth are borne primarily by the children themselves when they reach adulthood and must obtain a livelihood, not by the parents. With modernization, externalities intrude less and costs of high fertility are borne more directly by parents.

The general conclusion of this paper is that child mortality reduction does not seem to be a potent policy measure by which governments can reduce fertility. But this conclusion must be viewed as somewhat tentative, because it based largely on reasoning which, though theoretically seductive, is not firmly anchored in empirical observation. This is particularly true of the graphical supply-demand analysis, which is plagued by difficulties of direct measurement of utilities and costs. Moreover, the analysis deals principally with two polar types of society and does not systematically examine the process of transition from one to the other. It is possible that during some phases of this transition, child mortality reduction may have a greater effect on fertility than it does at either end point. A further weakness is that the graphical approach has not been adequately integrated with the quantitative microeconomic approach (e.g., Cochrane and Cochrane, 1974).

On the other hand, the general conclusion is strengthened when it is realized that further reduction of child mortality in less-developed countries may be unexpectedly difficult in the absence of further economic and social development. There are two principal reasons for suspecting this. First, we may be close to the limit of what cheap imported environmental health measures can accomplish. Further substantial reduction of child mortality may require the development of mass individualized health care services, which are extremely expensive and can normally be supported only by advanced economies. Second, there is evidence that without adequate levels of nutrition, even the best medical care cannot bring down child mortality to levels typifying advanced societies (Mata, 1974). It follows that further reduction of child mortality in less-developed countries may depend more on general economic and social development than many now suspect. If so, the ability of governments to manipulate this policy variable may be severely limited.

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INFLUENCE OF VARIATIONS IN CHILD MORTALITY ON FERTILITY : A SIMULATION MODEL STUDY

K. VENKATACHARYA
Faculty of Economics,
University of Benghazi (Libya)

SUMMARY

Decrease in mortality in general and child mortality in particular bring about changes in fertility. The interrelationships between mortality and fertility are complex, and in the present paper the effect of decreasing mortality on fertility is studied.

In this paper two problems are examined: (i) How various levels of mortality (including child mortality) and fertility result in different existing family sizes at different points of reproductive life; and (ii) Given preference of certain number of children or a number of children by specific sex distribution, how does family's history of child mortality and anticipation of subsequent mortality influence family size.

The model used is a micro simulation model of cohort fertility. The fertility histories of each of 600 women, under various input combinations is obtained and a number of fertility measures such as mean number of children (or sons or daughters) at various reproductive ages are derived.

It has been observed that the decreases in child mortality have considerably increased the number of living children per couple, thereby increasing the dependency burden. Further, it has been observed that the percentage increase in the number of living children is more under low fertility combinations than under high fertility combinations.

RÉSUMÉ

Le recul de la mortalité en général et celui de la mortalité des enfants en particulier provoquent des changements dans la fécondité. Les relations réciproques entre mortalité et fécondité sont complexes. Dans la présente communication, on étudie l'effet du recul de la mortalité sur la fécondité.

Deux problèmes y sont examinés : 1) Comment à partir de divers niveaux de mortalité (y compris la mortalité des enfants) et de fécondité, on parvient aux dimensions actuelles de la famille à différentes époques de la vie génésique ; et 2) étant donné la préférence manifestée pour un certain nombre d'enfants, compte tenu ou non de leur répartition par sexe, quelle influence sur la dimension de la famille exercent les décès d'enfants qui y sont parvenus et les prévisions que font les couples relativement aux décès d'autres enfants.

Le modèle utilisé est un modèle de microsimulation de fécondité par cohortes. On en déduit l'histoire génésique de chacune des 600 femmes selon diverses combinaisons ainsi qu'un certain nombre de mesures de la fécondité, telles que nombre moyen d'enfants (de fils ou de filles) à divers âges de la mère.

On a constaté que le recul de la mortalité des enfants a beaucoup fait augmenter le nombre d'enfants vivants par couple, d'où une élévation sensible du taux de dépendance dans la population. En outre, il apparaît que l'augmentation en pourcentage du nombre d'enfants vivants est plus forte pour les combinaisons où la fécondité est faible que pour celles où elle est élevée.

RESUMEN

La baja de la mortalidad en general, y de la mortalidad de la niñez en particular, trae consigo cambios en la fecundidad. Las inter-relaciones entre la mortalidad y la fecundidad son complejas, y en este documento se estudia el efecto de la reducción de la mortalidad sobre la fecundidad.

Se examinan principalmente dos problemas : (1) Cómo los distintos niveles de mortalidad (incluyendo la mortalidad de la niñez) han originado los diferentes tamaños de la familia en diversos puntos de la vida reproductiva ; y (2) dada la preferencia por un cierto número de niños o por un número de niños según una determinada distribución por sexo, en qué forma la mortalidad infantil que ha ocurrido en el pasado de una familia y la posible mortalidad de los niños que se prevé para el futuro, influencia el tamaño de la familia ?

Se utilizó un micro modelo de la simulación de la fecundidad. Se obtuvo la historia de la fecundidad de 600 mujeres, según diversas clasificaciones, y se calcularon varias medidas de fecundidad, tales como el número medio de niños (hijos o hijas) a distintas edades reproductivas.

Se ha observado que la disminución de la mortalidad de la niñez, aumenta considerablemente el número de niños sobrevivientes por pareja, aumentando por lo tanto la carga de la población dependiente. Más aún, se ha observado que el porcentaje de aumento en el número de niños vivos es más importante cuando la fecundidad es baja que cuando es alta.

Introduction

The present unprecedented growth of population around the world has made it imperative to understand the causes and look for cures of this growth. The two important factors that contribute to this growth are fertility and mortality. Many countries in the recent past have shown significant declines in the level of mortality (United Nations, 1965). The theory of demographic transition states that a slow decrease in fertility will follow in a gradual manner, the decline in mortality through such developments as economic, industrial and urban growth. (Blacker, 1947 ; Davis, 1949). Some studies have shown that recent decrease in infant mortality rate is associated with a decrease in fertility (Schultz, 1970). However, it is argued that the future declines in fertility in developing countries need not follow the slow historical decline in view of the many technological innovations in the control of human fertility. In this context the study of impact of declines of mortality in general and child mortality in particular on human fertility is of great interest.

Problems

Mortality affects fertility and is being affected by it in turn. Some of their interactions are direct and some indirect involving a number of socio-economic and cultural variables. Therefore, it is more convenient to only consider the impact of mortality on fertility in the first place.

The impact of mortality on fertility can be studied to some extent through the analysis of historical data if such data are available and are of reasonable accuracy. Model studies can throw some light on this aspect but the utility of the results depends to a large extent on the assumptions involved. The assumptions underlying models are dependent in turn on the amount of information or knowledge already available on the particular aspect under question. Thus without enough data on the various intricate aspects of the problems we are considering, model studies, whatever their complexity, fail to solve these problems.

Many of the questions connected with the demographic changes that follow the decline in general mortality (implying declines in infant and child mortality) will be discussed at the various sessions of this seminar. In the present session, we confine to the quantitative aspects of the impact of the decline in mortality on fertility.

The objective of the present work is to examine two problems connected with the direct and indirect effects of varying mortality levels in general and child mortality in particular on fertility. They are :

1. How various levels of mortality (including child mortality) and fertility result in different existing family sizes at different points of reproductive life ?

2. Given preference of certain number of children or a number of children by specific sex distribution, how does family's history of child mortality and anticipation of subsequent mortality influence family size ?

To answer these questions a cohort micro-simulation model (FERSIM – I) using biological and demographic inputs has been developed. The model and the results will be discussed later in the paper.

Review

A decrease in the level of mortality affects fertility in a number of ways. The increase in the proportion of marriages due to decrease in the probability of female deaths has only a moderate effect on fertility. On the other hand the impact of increasing marriage duration per couple, in the case of decreasing mortality will have a significant effect on the future fertility. These two factors tend to increase the future level of fertility. In most of the developing countries where prolonged breast feeding is quite common, a decrease in the infant and early child mortality tends to increase the lactation period of mothers. Thus a decrease in mortality tends to increase lactation amenorrhea and hence birth interval. This increase in the birth interval tends to decrease the fertility per couple (Potter et al., 1965 ; Hyrenius 1958 ; Coale and Hoover, 1958 ; Ryder, 1955). Through the use of a computer simulation model, Ridley (1967) and her associates found that as $^{o}e_{o}$ (females) increases from 31 to 72 years, the live birth intervals increased by 9 months for eighth order birth intervals, by 5 months for seventh order birth intervals and by 3 months for second order birth intervals under the specific assumptions and parametric values used in their model. The increase in mean birth interval of all orders will be in the range of 5 months. The effect of lactation amenorrhoea on fertility at different levels of mortality can be studied using steady state results (Venkatacharya, 1974).

As infant mortality decreases in future it is not necessary that lactation continues to increase. The set of demographic variables that bring about declines in mortality (e.g. education of women) may possibly tend to arrest further increases if not to decrease the present lengthy periods of breast feeding in developing countries.

Instead of viewing the effect of declining mortality from a cohort angle we can examine it from a cross-sectional or period angle. Basavarajappa (193) has examined the effect of changes in mortality on crude birth rate and related indices.

The indirect effect of declining mortality on fertility is more complex and less understood. As mentioned earlier knowledge on the changes in a couple's attitudes to fertility planning due to declining infant and child mortality is essential for the formulation of any model and this knowledge can only be obtained through carefully carried out field studies and surveys. Let us digress a little to take a quick review of the relevant material.

A number of studies have shown that couples desire to have a certain number of children. Many terms, with different meanings such as 'ideal size' (personal or general), preferred family size etc. are used in the literature. The point is that women seem to be influenced to some extent by their existing children (Stycos, 1965 ; p. 652 ; Gille and Pordoko, 1966 ; p. 515 etc.). However Knodel and Prachuabmoh (1973) using data from Thailand, found that such influence of living children on responses to desired family size is not strong. Therefore a decline in infant mortality is going to influence the desired number of children, to some extent, and hence future fertility of couples.

A number of studies in many developing countries have indicated that couples desire to have at least one son till their old age (Operations Research Group, Baroda 1973 ; Eliot, 1968 ; Hassan, 1967 ; Rizk, 1959). This son preference in India and other countries is made for one or more of the reasons such as to carry on the family name and property, to provide economic and emotional support in old age, to perform religious rites and to give a helping hand to father in the farm and in running the home. In countries like India where there are no general old age social security schemes for the population, dependence on the son or sons in the old age continues. Further in agriculture-based economies, such as India and other developing countries a son becomes productive at an early age despite laws forbidding child labour, thereby becoming an economic asset to the family. In a nation wide survey in India 56 % of couples wanted a son "to support family" and 42 % "to carry on the line" (Operations Research Group, 1973). Under such circumstances the parents might plan their families in such a way that at least one son survives to old age.

Evidence on the effect of son preference on subsequent fertility of couples is not conclusive. One study in Taiwan found that the greater the number of sons the couple possesses, the lower is the subsequent fertility (Heer and Wu, 1974). However another study based on data from India, Bangladesh and Morocco did not show any differentials in the subsequent fertility of couples having three male live births or three female live births (Repetto, 1972). A possible explanation for this is that couples having one or more sons feel less "demographic pressure" as sons are of a less financial burden than daughters and such families feel the necessity of controlling fertility only towards the later part of reproductive life, which leads to higher fertility.

Son preference is likely to influence subsequent fertility especially if child loss occurs earlier. Some studies indicate that previous child loss impels couples to compensate for this loss (especially a son) in their remaining reproductive life (Hassan, 1966 ; Wyon and Gordon, 1971 ; Harrington, 1971 ; Rutstein, 1970 ; Heer and Wu, 1974). However, one study did not show such a relation (Knodel, 1968).

The above facts indicate that the survival of a son, which in turn depends on the child mortality, at any stage of reproductive life of a couple, might influence the future fertility performance of a couple.

Let us examine how the parent's attitudes towards a specific sex composition of their children affects the fertility. Many efforts have been made by stochastic models to illustrate that in order to have a number and a sex composition of children, a couple have to procreate a large number of children (Pathak, 1973 ; Mitra, 1970 ; Sheps, 1963). Also a number of couples will be unable to meet their desired composition, if not size, due to chance causes. In these studies mortality is ignored.

The effect of sex preference in the presence of varying mortality levels has been explored extensively by Heer and his associates using simulation models (Heer and Smith, 1968, 1969 ; May and Heer, 1968). They have developed a model under the assumption "that parents have a perfect method of birth control but also want to be highly certain that at least one son will survive to the father's sixty-fifth birthday, so that he can support his parents in their old age". Heer and Smith's models brought out two important findings : (1) At the levels of low mortality that are current in most of the developing countries fairly large family sizes are required to insure the specified high son survivorship, (say .95). (2) As the level of mortality fell from high death rate to low death rate the impact on intrinsic rate of growth is curvilinear. When $^{o}e_{o}$ is less than 30 the improvements in mortality resulted in an *increase* in the intrinsic rate of growth, for in this case women attempt to insure son survivorship by bearing many sons. When $^{o}e_{o}$ is 50, further improvements in mortality tend to *decrease* the intrinsic rate of growth as women in this case have already had enough sons to insure the required son survivorship. One of the practical problems in applying the results of such models to real world situation is that most of the parents living in the rural parts of developing countries may have a different mechanism of insuring their son survivorship than through their perception of son survivorship probability. Some of them might work with some simple rules, such as 3 sons to be born to have one son surviving to old age. Even survey material on this aspect is deficient. Further it is likely that parents might modify their son survivorship criterion due to a number of developments in their after-life like the economic pressures on the family. Another basic question is the degree of motivation. How motivation of son survivorship insurance weighs against the motivation to limit families due to economic pressures and poverty. The recent success in mass sterilizations in India supplemented by economic incentives, indicates that the motivation for son survivorship is probably not rigid.

A Monte Carlo simulation model has been developed by Immerwahr (1972) to study the variations in the father's survival of their son (s) and or daughter (s) under varying mortality, fertility or both. If the level of Indian mortality declined to that of U.S. mortality for Whites in 1959-61, he found that the probability of a father being survived by at least one son is .824 based on Indian mortality of 1950-61 and this will improve to .942 under U.S. mortality (1959-61) – assuming the present Indian fertility. If couples were to use a one son limit the corresponding probabilities will be .680 and .902. Immerwahr (1967) has studied the probabilities of son survivorship under declining mortality and concludes that "the risks of a father being outlived by even one son are remarkably high, particularly after that son has lived the first two years of life".

Model

The model (FERSIM) used for the present work generates fertility histories of a cohort of women beginning with marriage till the age of 50 years or the dissolution of marriage whichever happens earlier. In the model only first marriages are considered (between ages 15-35 years) and marriage is assumed to be universal. The determination of events such as marriage is made by the usual method employed in Monte Carlo models. After marriage, the ages at the death of the woman and the husband are determined. For this the age of the husband is assumed to be five years older than that of the wife at all ages. The survival probabilities are those derived from the West model life tables (United Nations, 1967). The lowest value of the ages of the death of the husband, wife and the age of cessation of reproductive capacity i.e. 50 years, is taken as the terminal age

of procreation. Between the age at marriage and the terminal age of procreation births are generated. A number of probabilities corresponding to monthly chance of conception ; termination of a conception in a live birth, stillbirth and abortion ; termination of gestation and the termination of post-partum amenorrhoea following a live birth, still-birth and abortion are used in determining a birth. The method of determining the event is again done randomly. Once a birth occurs, the sex of the birth is determined randomly using the sex-ratio at birth assumed in the model to be 1.05 males per female. Soon after the determination of the sex of the child, the age of death of the child is determined. As soon as the simulation of all births and related events for one married woman are completed, the next woman is taken up and the same procedure is adopted. 600 women-histories are simulated in three replicates of 200 women each. All output tabulations are made first on the basis of 200 women, and later the results are pooled. The size of 600 is sufficient for the analysis of most of the output variables discussed in the paper (Venkatacharya and Roy, 1972). In the model the level of mortality is assumed to remain constant for a period of 35 years, which is the maximum duration of marriage for any cohort. The model simulates fertility and mortality cohort-wise and gives results for one generation.

Inputs :

All probability density functions are discrete and numeric in form. In Table 1 only the mean values and variances of the probability distributions are presented. The distribution of age at marriage is based on Indian experience. Monthly chance of conception (MCC) is taken at two levels (Table 1). The lower level is adapted from the estimates derived from the age specific marital fertility rates of India (Venkatacharya and Roy, 1972). The higher level of MCC is chosen to correspond to a higher fertility pattern. The MCC is assumed to vary with the age of women only, but neither with parity nor between women, though the model FERSIM provides for both variations (Venkatacharya, 1971). The probability of a conception terminating in a live birth, stillbirth and abortion are assumed to vary by five year age groups. The values of these probabilities are based on Khanna study (Wyon and Gordon, 1971). The pregnancy periods leading to different types of conception are based on the Indian experience. The means and variances of these distributions are also shown in Table 1. The post partum-amnorrhoea (PPA) period is taken at two levels. The lower level with a mean of 10.4 months is based on Khanna study. The higher level of PPA with a mean of 17.4 months is chosen arbitrarily to reflect long breast-feeding. However, two runs (C9 and C10) are made to study separately the contribution of changes in lactation amenorrhoea due to improving mortality. In the present paper, the lactation amenorrhoea is kept constant under all levels of mortality (except for C9 and C10). In the model primary sterility is ignored. However, the effect of primary sterility can be taken care of by proper inflation of the results. Secondary sterility is not taken into account except through lower monthly chance of conception assumed for later ages.

The other important input, is the life table survival probabilities (p_x). The survival probabilities are available in the West Model life tables by five year age groups. From these five year survival probabilities, single year probabilities are obtained in two stages. For all ages above 5, the single year values are obtained by applying Spraque's multipliers to log (p_x), where p_x are taken from West Model life tables. For ages under 5, the single year figures are obtained by fitting a negative exponential curve to l_0, l_1, and l_5. In the model the mortality risks of each member of a family is assumed to be independent of others. Some of the characteristics of the life tables used in the model are shown in Table 2.

Output :

Various types of fertility output are made. Births by age of women, number of married women by age of the women, single year age-specific fertility rates ; live birth intervals by five years of age and parity ; number of children ever born and alive by sex for intact marriages at various durations (five years apart) ; distribution of couples by sons and daughters born etc.

All these output are obtained for each combination of input variables. The various combinations considered in this paper are shown in Table 3.

Results

The input combinations C1, C2 and C3 provide three levels of fertility. While the input combination C3 generates fertility close to Indian experience, the other two patterns are arbitrarily chosen. The only criterion used in their choice is that they yield an average of 2 and 4 live births more than C3 (for intact marriages by age 50 years). The mean number of births for intact marriages by age 50, under C3 is around 6.

A) Impact of declining mortality on fertility :

Figures 1, 3 and 5 illustrate the mean number of living children and living sons under six mortality levels (Table 2) for C2, C1 and C3 respectively. In all these figures, the mean values of the sons and children

TABLE 1 – VALUES OF THE VARIOUS FERTILITY INPUT VARIABLES

1. Monthly chance of conception by age in months (x) – measured from the beginning of 15 years i.e. 169th month.

	x	MCC
F1	1 – 60	.05 + .0025 x
	61 – 120	.20
	121 – 300	.20 – .00083 (x – 120)
	301 – 419	.05 – .00042 (x – 300)
F2	1 – 60	.03 + .0009166 x
	61 – 120	.085
	121 – 180	.085 – .0005833 (x – 120)
	181 – 240	.05 – .000466 (x – 180)
	241 – 300	.0221 – .000201 (x – 240)
	301 – 360	.01004 – 00015 (x – 300)
	361 – 419	.001

2. Probability of conception termination in a live birth (L) still birth (S) and abortion (A) by five year age groups.

Age group	L	S	A
15-19	.806	.078	.116
20-24	.879	.048	.073
25-29	.895	.042	.063
30-34	.875	.050	.075
35-39	.829	.060	.103
40-49	.760	.090	.144

3.* Mean value of the gestation period leading to:

	Mean	Variance
Live birth	9,6 months	0.4
Still birth	8,1 months	0.6
Abortion	3,7 months	1.4

4.* Mean value of the post-partum amenorrhoea following a:

Live birth	Level A1	17.4 months	24.29
	Level A2	10.59 months	38.70
Still birth		2.90 months	1.25
Abortion		1.50 months	0.45

5.* Mean age of marriage of the female.

	16.8 years	7.4

* In the simulation model the various periods used are discrete probability distribution having the above mentioned means and variances.

TABLE 2 – SOME INDICES OF THE LEVELS OF MORTALITY (WEST MODEL) USED

	Level of mortality					
	3	7	11	15	19	23
Males ($^0e_0$)	22.85	32.48	42.12	51.83	61.23	71.19
Females ($^0e_0$)	25.00	35.00	45.00	55.00	65.00	75.00
Life table infant mortality (1 000 q_0) by level						
Male	351.3	248.2	171.7	111.4	62.9	21.4
Females	305.5	213.9	146.1	93.4	49.9	15.2
Life table childhood mortality (1 000 $_4q_1$) by level						
Males	214.4	145.5	94.4	51.1	21.0	3.4
Females	215.5	145.6	93.7	50.5	19.0	2.4

TABLE 3 – DESCRIPTION OF INPUT COMBINATIONS

Input combination	Monthly chance of conception	Post-partum amenorrhoea	Son survivorship or other criteria
C1 (Medium fertility)	F1	A1	None
C2 (High fertility)	F1	A2	"
C3 (Low fertility)	F2	A2	"
C4	F1	A1	Fertility ends as soon as a son lives to 10 years
C5	F1	A2	"
C6	F2	A2	"
C7	F1	A1	Fertility ends as the presently born and the previous sons are alive, if the son born now is the second or third. For the fourth son born, fertility ends if the third and the fourth sons live another five years, otherwise the couple continues procreation till the end of reproductive life.
C8	F2	A2	
C10	F2	A2	
C9	F1	A1	No son survivorship criteria. Post-partum amenorrhoea is assumed to depend on child survival, unlike in C1 – C8.
C10	F2	A2	

Note : All the combinations C1 – C10 assume mortality to be constant with time.

are obtained on women with intact marriages by that age. Thus the mortality differential of the couples does not enter into these values. The only difference between the various trends shown in the figures for the six mortality levels is the mortality differential of the children born. A study of these figures reveals that at lows levels of mortality ($^{o}e_{o}(f) = 25{,}35$) as the duration of marriage increases, the increase in the mean number of living children is linear in the beginning, but drops at later ages. However, as mortality improves, the increase in the number of living children and living sons is almost linear in the early marital durations and then gradually decreases. The impact of the improvement in child mortality on the living children or sons is more significant in the case of C1 and C2 than in the case of C3. This is obvious, because when fertility is high a loss of a child is more likely to be made up than in the case of low fertility.

As mortality improves from the level 11 ($^{o}e_{o}(f) = 45$) to level 23 ($^{o}e_{o}(f) = 75$) the percentage increase in the mean number of living children and sons for intact marriages by age 50 are shown below.

Level of mortality

	11		23		% increase	
	Living Sons	Living Children	Living Sons	Living Children	Living Sons	Living Children
C2	3.53	7.39	5.22	10.21	48	38
C1	3.02	6.08	4.32	8.47	43	39
C3	2.09	4.26	3.02	6.03	45	42

The above table illustrates two interesting points. As mortality increases, both the mean number of living children and the mean number of living sons increase. The percent increase in the number of living children for C3 (low fertility) is greater than the corresponding percent for C1. That is, as both mortality and fertility decline, the percent increase in the number of living children tends to increase. However, if we look at the living sons the pattern is not clear. The reason for this is the differences in the distribution of male births or births over the reproductive span under the three input combinations C2, C1, and C3. As fertility decreases through a reduction in fecundability, (in a pattern similar to those assumed in the paper) the proportion of male births or births occurring in the earlier reproductive years increases. Thus the mean number of years a male child or a child has to survive from the time of birth to the age 50 of mother, increases as the level of

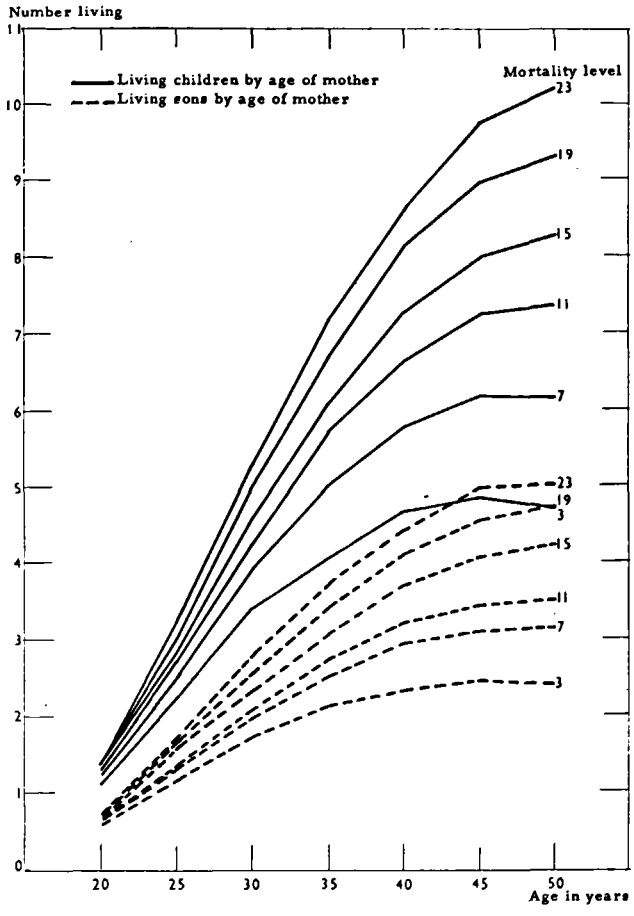

Figure 1 – Number of living children and sons by age of mother
Input Combination–C2.

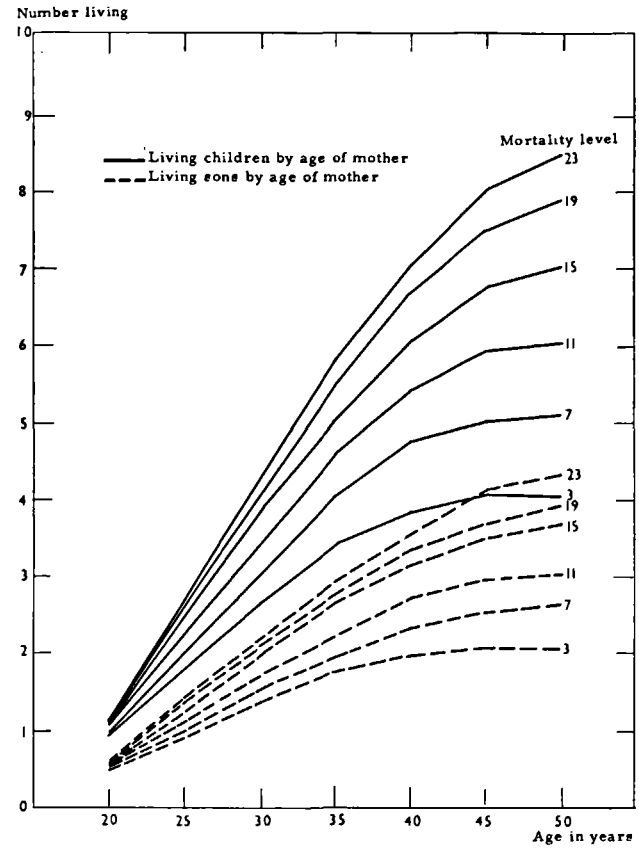

Figure 3 – Number of living children and sons by age of mother
Input Combination–C1.

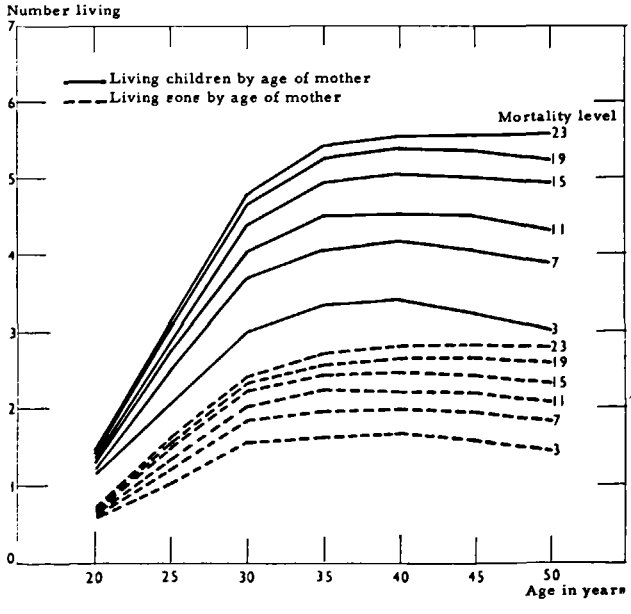

Figure 2 – Number of living children and sons by age of mother
Input Combination–C5.

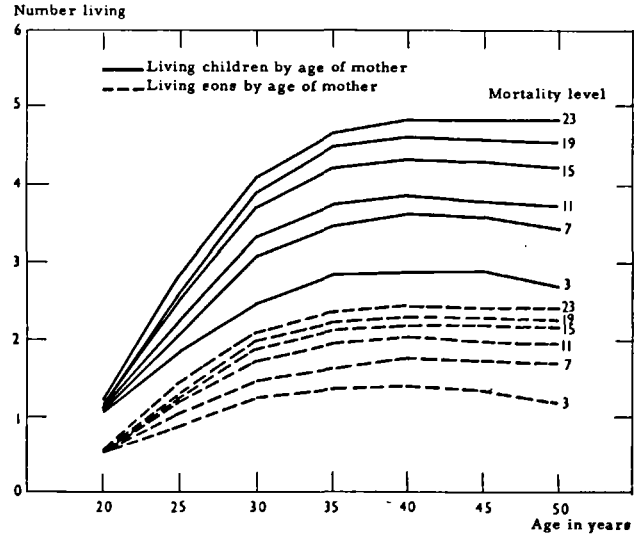

Figure 4 – Number of living children and sons by age of mother
Input Combination–C4.

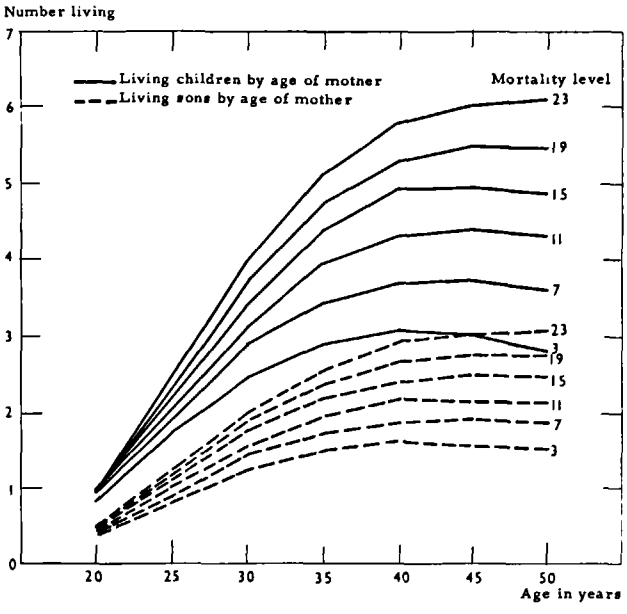

Figure 5 – Number of living children and sons by age of mother
Input Combination–C3.

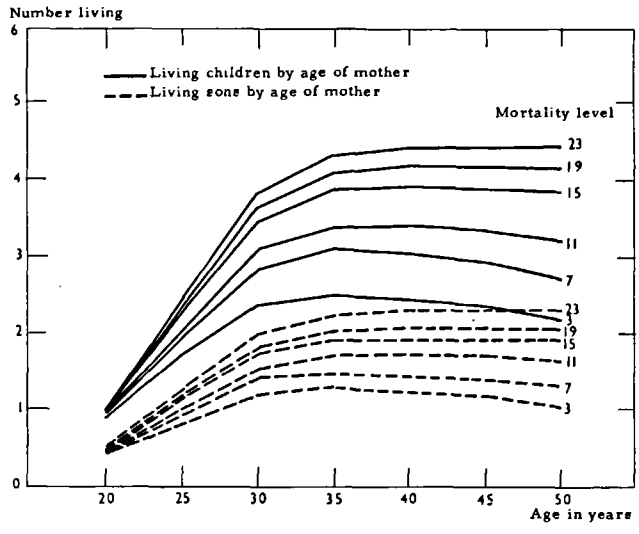

Figure 6 – Number of living children and sons by age of mother
Input Combination–C6.

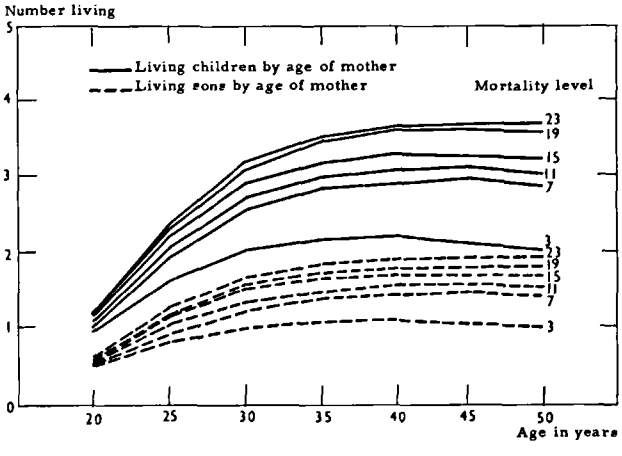

Figure 7 – Number of living children and sons by age of mother
Input Combination–C7.

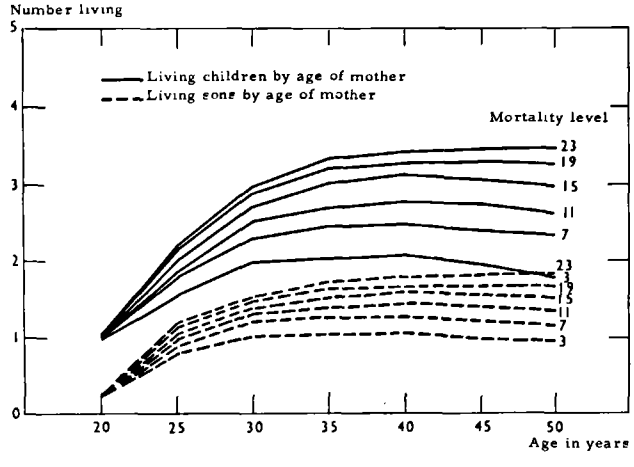

Figure 8 – Number of living children and sons by age of mother
Input Combination–C8.

fertility decreases. Therefore improvements in mortality have greater scope to influence the mean number of living male children or children under low fertility than under high fertility level for intact marriages at age 50. Thus the improvement in mortality is likely to step up the rate of increase of the dependency burden when the level of fertility is low than when it is high.

The impact of declining mortality on age-specific marital fertility rate (ASMFR) will be negligible. In Table 4 the ASMFR for C1, C2, and C3 are shown. Making use of these rates, the intrinsic rates are obtained which are shown in Table 5 (United Nations, 1968). As mortality declines the intrinsic death rate also decreases, but the population growth rate and net reproduction rate increase. The values for total fertility rate and gross reproduction rate, both being independent of mortality, remain unchanged. The intrinisic death rates for C2, C1 and C3 are in the decreasing order. The increase in the net reproduction rate and intrinsic rate of growth are significant for higher fertility. The intrinsic birth rates on the other hand do not show a smooth trend for C1 and C3. In C2 the intrinsic birth rates show a steady decline. Some of these relations are similar to those obtained by Basavarajappa (1963) and Ridley et al (1967).

TABLE 4 – AGE SPECIFIC MARITAL FERTILITY RATES (BY FIVE YEAR AGE GROUPS) FOR EACH INPUT COMBINATION (SEE TABLE 3)

Input combination	Mortality level	Age group						
		15-19	20-24	25-29	30-34	35-39	40-44	45-49
C1*	All levels	269	346	345	312	217	104	93
C2*	All levels	307	427	426	384	308	206	102
C3*	All levels	221	329	311	231	135	54	8
C4	3	285	347	306	224	122	53	22
	7	300	346	312	191	93	33	12
	11	302	345	317	153	63	19	5
	15	300	350	300	161	62	18	3
	19	291	344	309	150	44	12	4
	23	296	358	295	122	31	7	1
C5	3	342	412	392	241	116	56	18
	7	331	426	382	203	87	27	7
	11	347	418	385	181	39	21	4
	15	330	435	394	175	53	11	5
	19	333	429	376	155	44	8	1
	23	324	421	373	153	35	10	2
C6	3	232	327	304	162	56	18	1
	7	250	335	289	144	51	16	2
	11	237	337	293	145	45	8	1
	15	230	346	301	130	32	8	1
	19	242	341	292	120	30	7	1
	23	232	340	296	115	26	5	0
C7	3	287	313	226	145	89	39	17
	7	293	306	219	126	67	30	14
	11	302	302	195	106	52	26	5
	15	296	296	176	84	33	15	5
	19	295	293	178	90	38	16	7
	23	287	289	175	73	28	12	3
C8	3	239	300	205	102	53	17	1
	7	233	313	196	101	44	13	3
	11	237	292	202	90	36	13	1
	15	231	505	184	88	32	9	1
	19	242	289	173	77	24	11	2
	23	237	286	171	71	28	5	3

*For these combinations ASMFR does not vary by level of mortality. So for each of these combinations all 6 x 600 case histories were used to obtain the ratio. For each of the other combinations only 600 cases were used.

B) Impact on fertility by changes in lactation amenorrhoea brought about by declining mortality :

In the computer runs C9 and C10 the same input combinations, including the distribution of PPA, used for C1 and C3 are used respectively. Further in C9 and C10 the PPA is made to depend on the survival of the child born. In these runs a random PPA period is first selected and this value is used if the child survives till the end of PPA of the mother. If the child dies earlier than the end of the selected PPA, the PPA is modified so that it is equal to one month more than the life of the child that died. Therefore the results of C9 and C10 are expected to be equal to C1 and C3 respectively if every child survives to a period equal to the longest possible PPA. Thus a comparison of the results of C1, C3 with C9, C10 indicates the effect of changes in PPA under varying mortality levels.

A study ASMFR obtained for the six mortality levels under C9 and C10 show small variations. The deviation from the maximum ASMFR and minimum ASMFR among six mortality levels for any age group (except 40-44 and 45-49) belonging to C9 was less than 10% of the mean ASMFR for that age group (the

TABLE 5 – INTRINSIC BIRTH RATE, DEATH RATE, GROWTH RATE AND OTHER RELATED MEASURES UNDER VARIOUS INPUT COMBINATIONS

Input combinations	Mortality level	Growth rate	Birth rate	Death rate	Total fertility rate	Gross reproduction rate	Net reproduction rate
			(Rates per 1 000)				
C1	3	15.86	66.72	50.86	8.41	4.10	1.57
	7	26.68	67.41	40.73	8.41	4.10	2.16
	11	34.14	66.95	32.81	8.41	4.10	2.70
	15	39.77	66.19	26.42	8.41	4.10	3.19
	19	44.07	65.35	21.29	8.41	4.10	3.66
	23	46.96	64.37	17.41	8.41	4.10	3.98
C4	3	8.70	53.81	45.08	6.36	3.10	1.26
	7	18.75	54.21	35.46	5.98	2.92	1.61
	11	24.90	52.69	27.80	5.56	2.78	1.86
	15	30.08	53.15	22.35	5.51	2.69	2.15
	19	34.48	52.07	17.60	5.33	2.60	2.34
	23	36.74	50.63	13.89	5.10	2.49	2.43
C2	3	22.96	80.64	57.68	10.31	5.03	1.93
	7	33.77	79.80	46.02	10.31	5.03	2.65
	11	41.22	78.22	37.00	10.31	5.03	3.31
	15	46.85	76.62	29.77	10.31	5.03	3.39
	19	51.14	75.19	24.04	10.31	5.03	4.46
	23	54.03	73.84	19.81	10.31	5.03	4.88
C5	3	14.91	64.94	50.03	7.36	3.59	1.47
	7	24.45	63.59	39.15	6.80	3.32	1.85
	11	31.43	62.69	31.26	6.45	3.14	2.16
	15	37.92	63.47	25.54	6.50	3.17	2.54
	19	41.41	61.65	20.24	6.21	3.03	2.73
	23	43.80	60.10	16.30	6.09	2.97	2.90
C7	3	1.40	42.00	40.63	5.16	2.52	1.04
	7	11.00	42.49	31.49	4.84	2.36	1.32
	11	16.82	41.23	24.41	4.50	2.19	1.51
	15	19.89	38.48	18.59	4.10	2.00	1.61
	19	25.06	39.77	14.71	4.16	2.03	1.83
	23	26.31	37.42	11.11	3.92	1.91	1.87
C3	3	6.63	50.28	43.65	6.08	2.97	1.19
	7	17.90	52.87	34.96	6.08	2.97	1.62
	11	25.70	53.89	28.19	6.08	2.97	2.00
	15	31.63	54.32	22.70	6.08	2.97	2.35
	19	36.14	54.34	18.21	6.08	2.97	2.65
	23	39.18	53.88	14.70	6.08	2.97	2.89
C6	3	1.57	42.29	40.73	5.13	2.50	1.04
	7	12.77	45.04	32.27	5.03	2.46	1.37
	11	20.34	46.07	25.73	4.95	2.41	1.66
	15	26.16	46.68	20.52	4.87	2.38	1.91
	19	30.39	46.60	16.21	4.78	2.33	2.10
	23	32.97	45.71	12.74	4.70	2.29	2.24
C8	3	−5.94	32.04	37.98	4.21	2.06	.86
	7	5.37	34.94	29.56	4.15	2.03	1.14
	11	12.10	35.16	23.06	3.99	1.95	1.34
	15	17.49	35.53	18.04	3.89	1.90	1.52
	19	20.63	34.45	13.82	3.72	1.81	1.64
	23	23.08	33.65	10.57	3.64	1.78	1.73

mean calculated over all six mortality levels of an age group). For the last two age groups the deviations are large as they are based on small number of births. The deviations for C10 are slightly larger than those of C9 but are less than 12% of the mean (except for the two age groups 40-44 and 45-49). A comparison of the ASMFR (pooled for all the six mortality levels) under C1 and C3 with the corresponding C9 and C10 can be made from the results of the following table :

Age-group	ASMFR			ASMFR		
	C1	C9	% increase	C3	C10	% increase
15-19	.269	.296	10.1	.221	.245	10.9
20-24	.346	.357	3.2	.329	.335	1.8
25-29	.345	.347	0.6	.311	.316	1.6
30-34*	.312	.312	2.8	.231	.234	1.5

*For higher age groups as the rates are based on small number of births sometimes the increase is negative.

From the above table it is clear that the increase in ASMFR of C9 and C10 is small except for the first age group. The first age group shows a significant increase because in that age group most of the first births occur during 17-18 years (the last part of the age group) and the PPA following these births in C9 and C10 are shorter (leaving greater chance for second births) than C1 and C3 due to infant mortality. The total number of live births for intact marriages by age 50 in C9 have increased by 3.1% from the corresponding values of C1. In the case of C10 the corresponding percent increase is found to be 2.5%. Thus the contribution of changes in lactation amenorrhoea due to mortality improvements to total fertility is not significant. The other interesting aspect is the increase in the number of live births and the number of living children at different stages of the reproductive life. In the following table the number of children born for mortality levels 3 and 23 for C1 and C9, at different ages of reproductive performance are shown for illustration.

Age	Mortality level					
	3			23		
	C1	C9	% increase	C1	C9	% increase
25	2.64	2.83	7.3	2.74	2.77	.8
30	4.32	4.62	6.9	4.41	4.45	.8
35	5.93	6.24	5.2	5.97	6.04	1.3
40	7.19	7.63	6.2	7.28	7.38	1.3
45	8.23	8.61	4.6	8.28	8.33	.6
50	8.62	8.95	3.8	8.75	8.81	.7

In C9 the mean number live births are larger than the corresponding values of C1 for both levels of mortality. For any mortality level the per cent increase in the number of births for younger ages (less than 30) is found to be smaller than that of the older ages (40 to 50) with slight increase in the middle age groups. The general pattern observed in the per cent increase in live births is a tendency for this value to decrease as we proceed from the young age of 25 to 50 years in an irregular manner rather than smoothly.

For any age, as mortality improves the percent increase in live births (in C9 compared to C1 and C10 compared to C3) steadily decreased except for fluctuations due to sampling.

A similar analysis made on the number of living children for intact marriages at various ages also yielded similar results.

C) Impact of son survivorship criteria on fertility under improving mortality :

We can now examine the impact of declining mortality through voluntary causes. As mentioned earlier in the paper, not much is known on how a couple assesses the level of mortality, and how this level is functionally related to the future fertility performance. Under these circumstances, two assumptions are made. A couple is assumed to procreate till one son reaches the age of 10, and then terminates fertility as soon as that child reaches 10 years. Here it is implied that a couple feels that mortality is still high if a son dies before reaching age 10. Also it is implied that all couples will be able to terminate their fertility at their choice

through perfect method of contraception. The results under this assumption for the three patterns of fertility are labelled C4, C5 and C6 corresponding to C1, C2 and C3 (Table 3). In the second assumption a couple is supposed to terminate procreation after the birth of a son – who is second or third son born – if the previous son is alive by that time, otherwise they continue procreation to replace a son (s) lost earlier. However, after the birth of a fourth son a couple decides to terminate their fertility if both third and fourth sons survive next five years. If on the other hand, one of them dies within five years she will not attempt to terminate fertility in the remaining reproductive life. Results under this assumption are shown for medium (C1) and low (C3) fertility patterns, and these are labelled C7 and C8 respectively.

Consider the results under the first assumption. Figures 2, 4 and 6 illustrate the mean number of living children and sons at different ages of the mother. It is interesting to note that in all these figures, for all mortality patterns, the mean number of living sons as well as the mean number of living children increase in a linear fashion up to age 30 and thereafter the effect of improvements in mortality gets damped down. This is due to proportionately larger improvements of survival probabilities in the model life tables in early life than in later life.

Although in all these runs it is assumed that fertility is terminated as soon as one son reaches the age of 10, the mean number of living sons by age 40 for level 3 are 1.25, 1.4 and 1.75 for C6, C4 and C5 respectively. This is because fertility is undisturbed for at least ten years following the birth of a son. At the highest expectation of life these figures increase to 2.25, 2.40 and 2.75 for C6, C4 and C5 respectively. The percent increase in the mean number of living children, and mean number of living sons (for intact marriages by age 50) are shown below :

	Level 11		Level 23		% increase	
	Living Sons	Living Children	Living Sons	Living Children	Living Sons	Living Children
C4 Medium fertility	1.978	3.709	2.411	4.840	22	31
C5 High fertility	2.121	4.351	2.804	5.610	32	29
C6 Low fertility	1.654	3.186	2.261	4.428	37	39

The above table shows, whatever the level of fertility the per cent increase in the mean number of living sons and children due to improvements in mortality lie in the range 22-39, which is quite significant. The percent increase in the mean number of living children increases as the fertility level decreases. However, no such clear trend is evident in the case of living sons. But the percent increase in the mean number of living sons for C6 (low fertility) is higher than for both C4 and C5. The differences between C4 and C5 could be due to sampling errors, as the results are based on simulated events. Thus it is clear that the dependency burden brought about through increased number of living sons or children due to improving mortality is large.

In Table 4, the ASMFR for C4, C5 and C6 are also shown for each of the six mortality levels. In all the three cases as the mortality improves, the ASMFR show a steady declining trend for age groups 30-34 and higher. For the earlier age groups the trend is not clear and smooth. This is because for families having already one son (which can be accomplished by age 30), the probability of terminating fertility increases as the level of mortality improves. We can also compare the effects of the various patterns of ASMFR by obtaining the intrinsic rates on the assumption that each level of mortality and ASMFR used, remains constant for a number of future years. These rates are shown in Table 5.

In C5 (high fertility) the intrinsic birth rate shows a declining trend, but in the case of C4 and C6 the changes in intrinsic birth rates are small. However, both the intrinsic growth rates and net-reproduction rates increase as mortality improves. Also both the total fertility rate and gross reproduction rate show a declining trend. The percent increase in the net-reproduction rate, as the level of mortality improves from level 11 to level 23, are 31, 34 and 35 for C4, C5 and C6.

Let us now turn to the second assumption. Figures 7 and 8 illustrate the number of living sons and children for women at different ages (with intact marriages). The general remarks made with reference to C4 – C6 hold as well. The percent increase in the number of living sons and children (for intact marriages by age 50) due to improvements in mortality is shown overleaf :

	Level 11		Level 23		% increase	
	Living Sons	Living Children	Living Sons	Living Children	Living Sons	Living Children
C7	1.511	3.002	1.906	3.659	26.1	21.9
C8	1.323	2.595	1.796	3.460	35.8	33.3

From the above table it is clear that, as mortality improves, the mean number of living sons and children increases and the percent increase is larger for the lower fertility combination. Table 4 shows the ASMFR for C7 and C8. Except for the first age group, for all other age groups the ASMFR shows a declining trend as mortality improves. The corresponding intrinsic rates are also shown in Table 5. The remarks made with reference to C4 – C6 also hold here.

One other interesting aspect is the variation in the distribution of the couples by the number of children, sons and daughters born to them under each input combination. In order to save space, instead of the detailed two-way tables for each combination, the mean number of children, sons and daughters born are presented in Table 6. This table summarizes the way the distribution of children by sex varies in each of the input combinations considered in the paper.

TABLE 6 – MEAN NUMBER OF CHILDREN (MNC), SONS (MNS) AND DAUGHTERS (MND) BORN TO WOMEN BY VARIOUS MORTALITY LEVELS UNDER DIFFERENT INPUT COMBINATIONS

Level of mortality	$^0e_0$ (f)	MNS	MND	MNC	MNS	MND	MNC	MNS	MND	MNC
			C2			C5				
3	25	3.77	3.40	7.15	2.83	2.61	4.46			
7	35	4.01	3.84	7.83	2.81	2.82	5.63			
11	45	4.04	4.15	8.15	2.96	2.89	5.85			
15	55	4.65	4.25	8.90	3.04	2.90	5.94			
19	65	4.88	4.67	9.19	2.97	2.94	5.91			
23	75	5.22	4.91	10.13	3.04	2.82	5.86			
			C1			C4			C7	
3	25	3.13	2.85	6.03	2.43	2.33	4.76	1.99	1.88	3.87
7	35	3.23	3.33	6.59	2.42	2.45	4.87	1.97	1.98	3.95
11	45	3.60	3.50	7.13	2.55	2.34	4.89	1.99	1.92	4.00
15	55	3.96	3.68	7.70	2.67	2.45	5.10	2.00	1.77	3.78
19	65	3.99	3.97	8.03	2.55	2.45	5.00	1.97	1.97	3.94
23	75	4.34	4.09	8.49	2.59	2.45	5.04	1.97	1.79	3.76
			C3			C6			C8	
3	25	2.45	2.19	4.64	2.04	1.87	3.91	1.80	1.63	3.43
7	35	2.42	2.51	4.80	2.12	2.15	4.27	1.81	1.73	3.54
11	45	2.68	2.67	5.35	2.26	2.18	4.43	1.77	1.74	3.51
15	55	2.79	2.71	5.49	2.27	2.16	4.43	1.79	1.79	3.58
19	65	2.92	2.91	5.67	2.28	2.27	4.55	1.80	1.72	3.58
23	75	3.05	3.03	6.08	2.44	2.18	4.62	1.86	1.70	3.56

Conclusion

The results of the paper show that improvements in mortality affect family size thereby increasing family dependency burden ; whatever be the level of fertility. It has also been found that the increase in the family size adds to the dependency burden when mortality improves even if some son survivorship criterion is used by couples.

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THE INFLUENCE OF CHILD MORTALITY ON FERTILITY IN EUROPEAN POPULATIONS IN THE PAST : RESULTS FROM INDIVIDUAL DATA

John KNODEL
Visiting Associate Professor,
Brown University, Providence

SUMMARY

The limited number of studies which provide evidence based on individual data on the influence of child mortality on fertility in European populations in the past and the small number of cases involved in many of the studies make firm conclusions impossible. The difficulties are aggravated by the fact that with rare exception these studies did not direct their analysis to examining this relationship beyond presenting evidence of the "physiological" effect of infant deaths in the birth interval. Thus much of the evidence reviewed in this paper had to be based on a reanalysis of data presented in the appendices of several of these studies. Since these data were not presented in an ideal format for this purpose, several otherwise unnecessary constraints were imposed on resulting tabulations. Additional limitations arose from the fact that only a very few studies covered periods during which marital fertility began its secular decline. Finally the interpretation of results was impeded by the difficulty of separating the impact of the different effects infant mortality would exert on fertility and the impact of other mediating factors.

The most conclusive finding to emerge from this review concerns the impact of the "physiological" effect of infant mortality on the birth interval. Among pre-industrial European populations an infant death typically results in shortening the time taken until the next birth. Exluding the two communities studied in which prolonged breastfeeding was known to be rare, the impact of an infant death at the onset of the birth interval shortened the average time until the next birth by 2 to 13 months. Clearly much, if not all of the reduction in the length of the birth interval, can be accounted for by the fact that an infant death curtails lactation and prematurely ends the period of postpartum sterility typically associated with extended periods of breastfeeding. Nevertheless, the fact that the fate of the first child apparently influenced the length of the interval between the second and third birth suggests that infant mortality may also exert an additional effect on birth spacing independent of the "physiological" effect.

Evidence to support the operation of a "child replacement" effect in pre-industrial Europe prior to the onset of at least moderately widespread voluntary family limitation was much less consistent than evidence on the "physiological" effect and it is not possible to conclude that deliberate efforts to replace children dying early in life were actually taking place.

In the few studies included in this review which covered periods in which marital fertility was substantially reduced (presumably through the adoption of family limitation within marriage) there is some suggestion, at least in data for the French village Meulan and to some extent for the Genevan bourgeoisie, that the "child replacement" effect is set into operation under these circumstances. In

the case of Meulan and the Genevan bourgeoisie, declining marital fertility and the apparent strengthening of the "child replacement" effect appears to be more or less coincident with a reduction in child mortality. It is not clear if either of these phenomena would have occurred in the absence of lower general child mortality.

More significantly, the experience in Meulan suggests that once fertility begins to decline the impact as measured by parity progressive ratios, the age of mother at last birth or children ever born is greater among couples not experiencing infant deaths among their first few children than among couples who lose one or more of their births in infancy. Partial confirmation of this is apparent in the experience of the Genevan bourgeoisie who show the same pattern with respect to parity progression ratios but show about roughly equal reductions in the age of mother at the last birth or in the mean number of children ever born regardless of early infant mortality experience. Couples in the German village of Anhausen, however, do not show a similar strengthening of the "child replacement" effect as marital fertility declines nor is the decline greater among couples with no child deaths among their first few children. The number of family histories that can be analyzed for Anhausen during the period of fertility decline is very small and thus little confidence can be placed in these results. It is worth noting, however, that infant mortality was extraordinarily high in Anhausen even during much of the period of the fertility decline and thus the "insurance" effect of infant mortality might have operated to prevent the "child replacement" effect from asserting itself.

One tentative implication of this review of evidence based on individual data for European populations in the past is that once family limitation is introduced into a population and starts to spread, couples who have unfavorable experiences with child mortality will be more reluctant than couples with favorable experience to practice birth control. Thus a reduction in child mortality should facilitate a decline of fertility. It is not clear, however, from the data reviewed if a reduction in child mortality is a necessary prerequisite for spread of family limitation. It if unfortunate that most studies utilizing family history data in the study of European demographic history have neglected to confront the question of the relationship between infant mortality and fertility beyond examining the "physiological" effect. The present review suggests that future research aimed directly at this problem should prove to be a fruitful area of inquiry, particularly if it encompasses the period of the transition from high to low fertility.

RÉSUMÉ

Peu d'études par reconstitution des familles ont été faites et celles dont on dispose ne portent que sur un nombre réduit d'observations. Il est donc difficile de parvenir à des conclusions solides. En outre, à de rares exceptions près, ces études n'ont pas été faites pour analyser la relation entre fécondité et mortalité infantile. Elles se limitent le plus souvent à montrer que l'effet "physiologique" des décès d'enfants se fait sentir sur les intervalles entre naissances. C'est pourquoi, pour la présente communication, il a fallu analyser de nouveau les données présentées en annexe dans les monographies tirées de reconstitutions des familles. Ces données ne se prêtaient guère à une étude de ce genre et plusieurs autres contraintes ont gêné leur exploitation. En outre, il n'existe que peu de monographies portant sur des périodes où la fécondité légitime était en baisse. Enfin il est difficile d'interpréter les résultats car on ne peut aisément distinguer les effets qu'exerce la mortalité infantile sur la fécondité de ceux d'autres facteurs qui agissent eux-mêmes sur la mortalité.

Le résultat le plus sûr qui se dégage de cette étude a trait à l'effet "physiologique" de la mortalité infantile sur les intervalles entre naissances. Dans les populations européennes, avant la Révolution industrielle, un décès d'enfant fait diminuer l'intervalle entre la naissance de cet enfant et celle du suivant. Si on écarte de l'étude les deux villages où l'on sait que l'allaitement maternel était

peu pratiqué, un décès d'enfant réduit l'intervalle moyen entre les naissances de 2 à 13 mois. Il est évident qu'une grande partie ou même la totalité de cette réduction tient au fait qu'un décès d'enfant, en interrompant l'allaitement fait cesser la stérilité après l'accouchement qui est liée à un allaitement prolongé. Cependant comme le destin du premier né semble exercer une influence sur la durée de l'intervalle entre la seconde et la troisième naissance, il apparaît que la mortalité infantile peut exercer un effet supplémentaire sur l'espacement entre les naissances indépendamment de l'effet "physiologique".

Il est beaucoup plus difficile de déceler l'existence d'un effet de "remplacement d'enfant" dans l'Europe pré-industrielle avant l'apparition d'une limitation des naissances plus ou moins diffuse que celle de l'effet "physiologique" et on ne peut conclure qu'on essayait délibérément de remplacer les enfants morts en bas âge.

Dans les quelques monographies utilisées qui portent sur des époques où la fécondité légitime est réduite (du fait de l'adoption de la limitation des naissances, peut-on penser), il apparaît, tout au moins pour la petite ville française de Meulan et, jusqu'à un certain point, pour la bourgeoisie de Genève qu'il y avait un certain "remplacement des enfants". Dans ces cas, le déclin de la fécondité légitime et le renforcement de l'effet du "remplacement des enfants" s'accompagnent d'une diminution de la mortalité des enfants.

De manière plus significative, il semble qu'à Meulan, lorsque la fécondité amorce son déclin, celui-ci, qu'il soit mesuré par la probabilité d'agrandissement des familles, par l'âge de la mère à la dernière naissance ou par le nombre des naissances, est plus fort chez les couples qui n'ont pas perdu d'enfants parmi leurs premiers nés que chez ceux qui en ont perdu un ou davantage en bas âge. L'étude sur la bourgeoisie de Genève confirme en partie cette observation. On la retrouve en effet pour la probabilité d'agrandissement encore que l'âge de la mère à la dernière naissance ou le nombre de naissances par couple ne semble guère affecté par la mortalité infantile. Cependant, dans le village allemand de Anhausen, ce renforcement de l'effet de "remplacement des enfants" n'apparaît pas à mesure que baisse la fécondité légitime ; le déclin n'est pas plus fort chez les couples qui n'ont pas perdu d'enfants parmi leurs premiers nés. Le nombre de familles reconstituées dont l'histoire peut être analysée dans ce village au cours de la période de déclin de la fécondité est, il est vrai, très réduit et ces résultats restent très sujets à caution. Il convient de remarquer, cependant, que la mortalité infantile était très élevée à Anhausen, même au cours de la période du déclin de la fécondité. Ainsi donc, l'effet "d'assurance" de la mortalité infantile aurait pu jouer et empêcher l'effet de "remplacement des enfants" de se faire sentir.

Une conclusion semble se dégager de cet examen des monographies par reconstitution des familles sur les populations européennes du passé. Lorsque la limitation des naissances apparaît dans une population et qu'elle commence à s'étendre, les couples dont l'expérience à l'égard de la mortalité des enfants a été défavorable répugneront plus que les autres à pratiquer la limitation des naissances. Ainsi donc, une baisse de la mortalité des enfants devrait faciliter un déclin de la fécondité. Cependant, d'après les données utilisées une baisse de la mortalité infantile n'est pas une condition nécessaire à l'extension de la limitation des naissances. Il est regrettable que la plupart des études sur l'histoire démographique de l'Europe fondée sur la reconstitution des familles aient négligé d'examiner la relation entre fécondité et mortalité infantile en dehors de l'effet "physiologique" de celle-ci. Les recherches à l'avenir devraient être orientées dans ce sens. C'est un domaine qui pourrait fournir des résultats très intéressants surtout si ces recherches portent sur la période de transition démographique.

RESUMEN

Es imposible formular conclusiones definitivas acerca de la influencia de la mortalidad de la niñez sobre la fecundidad, en las poblaciones europeas del pasado, debido tanto al pequeño número de estudios realizados sobre la base de

antecedentes individuales, como al reducido número de casos incluídos en muchos de esos estudios. Las dificultades se ven agravadas por el hecho de que, salvo raras excepciones, estos estudios no dirigen su análisis a examinar estas relaciones y no van más allá de presentar evidencias acerca del efecto "fisiológico" de las muertes infantiles sobre el intervalo entre nacimientos. Por este motivo, muchas de las evidencias presentadas en este documento están basadas en un nuevo análisis de los datos incluídos en los apéndices de varios de esos estudios. Más aún, las tabulaciones resultantes adolecen de otras restricciones, ya que los datos de los trabajos analizados no estaban presentados en la forma adecuada para los propósitos de este análisis. Además, otras limitaciones adicionales se derivan del hecho de que muy pocos estudios cubren períodos durante los cuales la fecundidad marital empezó su declinación secular. Por último, la interpretación de los resultados se vió obstaculizada por la imposibilidad de separar el impacto de los diferentes efectos que pudo ejercer la mortalidad infantil sobre la fecundidad, del impacto que pudieron tener otros factores intermedios.

El hallazgo más destacado que fluye de esta revisión, se refiere al impacto del efecto "fisiológico" de la mortalidad infantil sobre el intervalo entre nacimientos. En las poblaciones europeas de la época pre-industrial una defunción infantil provoca, de una manera típica, un acortamiento del período que va hasta el próximo nacimiento. Si se excluyen dos comunidades, en las cuales se sabía que no era frecuente la lactancia prolongada, el acortamiento del promedio de duración del intervalo entre nacimientos fluctuaba entre 2 y 13 meses como una consecuencia de una defunción infantil ocurrida al comienzo del intervalo. Aparece claramente también que la mayor parte, si no toda la reducción de la duración del intervalo entre nacimientos, puede ser interpretada por el hecho de que una defunción infantil corta la lactancia y pone prematuramente término al período de esterilidad post-partum, clasicamente asociado a los largos períodos de amamantamiento. Sin embargo, debido a que aparentemente la suerte del primer hijo influye en la duración de los intervalos entre el segundo y el tercero, es posible pensar que la mortalidad infantil puede también ejercer un efecto adicional sobre el esparcimiento de los nacimientos, independiente del efecto "fisiológico".

Las evidencias existentes para afirmar que en la Europa pre-industrial existía un "remplazo", aún antes que se hubiera iniciado una moderada limitación voluntaria de la familia, son mucho menos coherentes que la evidencia relativa al "efecto fisiológico" y no es posible concluír que existieran esfuerzos deliberados para reemplazar a los niños que murieran a una edad temprana.

Los escasos estudios incluídos en esta revisión, que cubren períodos en los cuales la fecundidad marital era substancialmente baja (debido presumiblemente a la adopción de la limitación de la familia en los matrimonios) sugieren que el "reemplazo del niño" se inició en tales circunstancias, por lo menos es el caso de la aldea francesa Meulan y, en alguna medida, el caso de la burguesía genovesa. En estos dos ejemplos, la disminución de la fecundidad marital y el aparente fortalecimiento del "efecto reemplazo" aparece más o menos coincidente con una reducción de la mortalidad infantil. No está claro si cualquiera de estos fenómenos pudieran haber ocurrido en la ausencia de una mortalidad infantil general más baja.

De una manera más significativa, el estudio de Meulan, en el cual se midió el impacto de la declinación de la fecundidad mediante las probabilidades de agrandamiento de la familia, sugiere que una vez que la fecundidad empieza a bajar: la edad de la madre, en el momento de nacer el último de sus hijos, es mayor entre las parejas que no han perdido ningún hijo entre los que nacieron primero, que entre aquellas en que uno o más de sus hijos han muerto en la infancia. Una confirmación parcial de esta misma relación se encuentra en el estudio de las familias burguesas de Génova. Aquí se encuentra la misma característica con respecto a las probabilidades de agrandamiento de la familia, pero se encuentran reducciones aproximadamente iguales en la edad de la madre al último nacimiento o en el número medio de hijos tenidos, independientemente de la proporción de hijos muertos en la temprana infancia. Sin embargo, en la

aldea alemana de Anhausen no se encuentra un fortalecimiento similar del efecto "reemplazo" a medida que la fecundidad marital disminuye, ni tampoco es mayor esta declinación en las parejas que no han sufrido pérdidas infantiles entre los primeros hijos. Pero, debido a que el número de fichas de familia que pudo ser analizado en Anhausen durante el período de declinación de la fecundidad fue muy pequeño, no se puede dar plena confianza a los resultados obtenidos. Sin embargo, es valioso notar, que la mortalidad infantil era extraordinariamente alta en Anhausen, incluso durante gran parte del período de declinación de la fecundidad y así, talvez el efecto "seguridad" podría haber operado impidiendo que el efecto "reemplazo" se asegurara a sí mismo.

Una deducción provisoria de esta revisión de la evidencia proporcionada por los datos de las poblaciones europeas del pasado es que una vez que la limitación de la familia es introducida en una población y empieza a expandirse, se observa que las parejas que han experimentado experiencias dolorosas por la pérdida de algún hijo serán las menos propensas a practicar el control de la natalidad que las parejas que han tenido una experiencia más favorable. De esta manera una reducción de la mortalidad infantil podría facilitar una declinación de la fecundidad. A partir de los datos revisados no es posible, sin embargo, establecer si la reducción de la mortalidad infantil es un requisito previo imprescindible para la difusión de la limitación de la familia. Desgraciadamente la mayoría de los estudios que han utilizado datos sobre historias de familias, en las investigaciones europeas de demografía histórica, no han ido más allá de examinar el efecto "fisiológico" y no han profundizado el problema de las relaciones entre la mortalidad infantil y la fecundidad. En este análisis se sugiere que un fértil campo de estudios en el futuro estará constituído por las investigaciones que aborden directamente este problema, abarcaudo especialmente el período de la transición desde la alta hasta la baja fecundidad.

I. Introduction

One of the most prominent issues in the early literature on the decline of fertility in European countries concerned the relationship between declining child mortality and falling fertility rates. The issue gained added salience after the formulation of the demographic transition model which attributes central importance to the timing and interdependence of the secular declines in birth and death rates in Western demographic experience. Actually even in pre-industrial times some attention was given to the relationship between levels of fertility and child mortality. In the German literature as early as 1861, before fertility showed any sign of declining, Wappäus posited the following connections :

"First of all, a mother whose child was stillborn or died soon after birth generally gives birth sooner to another than a mother who nurses and rears her live born child. Second, as a rule it can be assumed that each parental couple wishes to raise a certain number of children and therefore when they already have this number of living children they no longer so actively want to enlarge the family as when the desired number has not been reached due to the loss of infants shortly after birth" (Wappäus, 1861, p. 322).

Wappäus states the two main ways the child mortality experience of individual couples might affect their fertility. The first, which we can label the "physiological" effect, relates the average length of a birth interval to the fate of the infant born at the onset of the interval in circumstances where mothers typically nurse newborn children. There is ample evidence that lactation inhibits conception through prolonging postpartum amenorrhea (see e.g. Van Ginneken, 1974). The death of an infant, by prematurely interrupting lactation, allows ovulation to be resumed sooner, and in the absence of contraception, results in an earlier subsequent pregnancy. The second, which might be labelled the "child replacement" effect, implies that couples continue bearing children, replacing those who die young, until they reach some number of surviving progeny which they consider sufficient. Implicit in the operation of this second effect is the assumption that couples are able to practise some means of family limitation once the desired number of children is attained.

Another effect, more recently suggested, posits that couples adjust their fertility to anticipate possible future child deaths thus insuring the survival of at least the minimum number of offspring considered sufficient (Heer and Smith, 1968). This "insurance" effect assumes that couples have some awareness of the community level of child mortality independent of their own experience and adjust their fertility with these risks in mind.

Finally we can mention a "societal" effect which would operate indirectly through social customs to insure that the community's fertility level was brought into some sort of balance with the community level of

general mortality (including child mortality). Such customs might govern age of marriage or breastfeeding customs in a way totally independent of the individual couple's fertility intentions. Indeed there need be no general recognition among the population of the connection between these social customs and their consequences.

In addition to these four types of effects, which can all operate in situations where neither the levels of fertility nor child mortality are changing, it is worth bearing in mind that a decline in child mortality might serve a catalytic role sparking a reduction in fertility in excess to that needed to restore any former balance between the two variables.

Both the "physiological" effect and the "child replacement" effect, if they operate, should be apparent in the reproductive histories of individual couples since the effect being exerted on fertility behavior arises from the couple's own direct experience with child mortality. Demonstration of the "insurance" effect, however, would require relating the individual couple's fertility behavior to the community level of child mortality (or at least their perception of it). In circumstances where the "insurance" effect is strong we might expect the "child replacement" effect to be obscured since the community child mortality level could have an influence which overrides the couple's experience with their own children. Indeed one test of the "insurance" effect hypothesis might be to see if the "child replacement" effect is more evident where child mortality is perceived to be low than where it is perceived to be high. Finally the "societal" effect would be revealed by a comparison of child mortality and fertility characterizing communities (or larger ecological or social aggregates) as a whole rather than through comparisons of the reproductive experiences of individual couples. Indeed the existence of associations on the "societal" level does not necessarily imply that parallel relationships exist among the individual constituents.

The purpose of the present paper is to review the evidence on the influence of child mortality on fertility in European populations in the past based on individual data. This means that consideration will be limited largely to examining evidence relating to the "physiological" and "child replacement" effects. In addition, it is worth noting at the start that the relationship between these two variables is both complicated by the operation of a multitude of additional influences acting on each of the main variables and that the relationship can be self-reinforcing with the influence operating in both directions. It is therefore particularly difficult to isolate the direct influence of infant mortality on fertility in such a manner that interpretation of the analysis becomes unambiguous.

The use of individual family histories to study demographic behavior in the past is a relatively recent development. In the last couple of decades, however, family reconstitution (i.e. linking together the entries of births, marriages and deaths from the parish records or some similar source into family histories of vital events) has become a central technique to historical demography and the number of studies analyzing reconstituted family data has proliferated. Examination of the effect of an infant death on the length of the subsequent birth interval, i.e. the "physiological" effect of infant mortality on fertility, is routinely reported in many of these studies. Unfortunately, with few exceptions (e.g. Knodel, 1969 and 1970 ; Smith, 1972), little attempt has been made in most historical demographic studies to examine other possible effects of child mortality on fertility. Part of the reason for this is probably that many of the studies deal with populations during pre-industrial periods when fertility was high and apparently uncontrolled by deliberate attempts at family limitation. Under these circumstances it may have been assumed that only the "physiological" effect of infant mortality on fertility was operating. Even in the studies which show clear evidence of the onset of family limitation, however, attempts were not made to examine changes in the relationship between these two important variables. Fortunately, several of the monographs based on reconstituted family data include appendix tables of basic data which permit at least some further analysis of the influence of infant mortality on fertility.

Most of the results presented in the remainder of the paper refer to periods prior to the secular decline in marital fertility associated with the demographic transition. Although special attention will be focused on the few situations where there is clear evidence of the onset of fertility reduction occurring during the period covered, the relationship of child mortality and fertility during the pre-decline period is also of interest. One of the more striking findings of a study utilizing aggregate level data for 19th century Germany was the strong positive correlation between levels of infant mortality and marital fertility in Bavarian districts where breastfeeding was customarily uncommon and at a time when fertility had yet to start on the path of secular decline (Knodel and Van de Walle, 1967). Furthermore, the same study showed that in a large number of German areas for which data on breastfeeding customs were available, strong positive correlations between infant mortality and marital fertility persisted even after differences in breastfeeding were statistically controlled. Such findings raise the question of whether or not a comparable relationship between infant mortality and fertility existed on the individual level independent of the "physiological" effect. The same question can of course be asked of pre-industrial societies today where fertility has yet to show signs of decline and its answer has implications for the impact on fertility that might be expected in a context of rapidly declining child mortality.

II. Infant mortality and birth intervals

In situations where deliberate attempts to control fertility are absent (i.e. "natural" fertility) and women typically breastfeed their children for extended periods of time, the "physiological" effect of infant mortality on fertility should be apparent in a comparison of birth intervals following infant deaths with "normal" birth intervals, i.e. those in which the child born at the onset survives past infancy. Table 1 summarizes the results of a number of studies which make this comparison for European populations during periods of assumed "natural" fertility. It should be noted that "natural" fertility does not necessarily imply that fertility is at its biological maximum but rather that no deliberate actions are taken by couples to stop childbearing once a given family size is achieved. "Natural" fertility is virtually always kept below its biological maximum by social customs – such as those governing breastfeeding or seasonal migration separating spouses – which operate independently of the number of children already born (Henry, 1961).

In only three of these areas, the German villages of Mömmlingen, Anhausen and Schönberg, was direct evidence on breastfeeding customs available : according to a survey conducted at the turn of this century as well as other supporting evidence, Mömmlingen is located in an area where almost all mothers were known to breastfeed their children for extended periods while Schönberg and Anhausen are situated in areas where any breastfeeding at all was uncommon and extended breastfeeding (over 6 months) virtually non-existent (Knodel, 1968). It is therefore of particular interest to observe that on the one hand the smallest average differences between normal intervals and intervals following infant deaths characterize the two villages where breastfeeding was known to be uncommon (and hence would hardly operate as the link between infant mortality and the length of the birth interval) and that on the other hand the village where extended breastfeeding was known to be common is characterized by one of the largest differences. From our limited knowledge of breastfeeding customs in Europe, it appears that during the late nineteenth century at least, mothers avoided nursing infants in wide areas of central Europe including southern Baden, Württenberg and Bavaria as well as parts of Austria, Bohemia and Saxony (Knodel and Van de Walle, 1968). Although equivalent information may be lacking for many other parts of Europe, it is at least worth noting that the other villages shown in Table 1 do not fall in these areas where extended breastfeeding was known to be

TABLE 1 – INTERVALS BETWEEN SUCCESSIVE CONFINEMENTS ACCORDING TO THE FATE OF THE INFANT BORN AT THE BEGINNING OF THE INTERVAL : RESULTS FROM STUDIES OF PERIODS OF ASSUMED "NATURAL FERTILITY"

Village or group	Country	Year of marriage	Mean interval (months)		
			After infant survival	After infant death	Difference in mean intervals
Saint Patrice	France	1640-1780	29.4	16.5	12.9
Mömmlingen	Germany	1840-1890	30.0	19.4	10.6
Bilheres-d'Ossau	France	1740-1779	32.3	21.7	10.6
Glostrup	Denmark	1677-1790	30.7	20.3	10.4
Troarn	France	1660-1760	30.6	20.8	9.8
Tourouvre-au-Perche	France	1665-1765	30.0	20.7	9.3
Crulai	France	1674-1742	29.6	20.7	8.9
Geneva bourgeoisie	Switzerland	before 1650[a]	29.5	22.1	7.4
Rumont	France	1720-1790	27.8	20.7	7.1
Sachsen Miners	Germany	before 1880	26.9	20.5	6.4
Thézels-St. Sernin	France	1700-1792	31.9	26.1	5.8
Ile-de-France villages	France	1740-1780	27.2	21.4	5.8
French Canadians	Canada	1700-1729	25.0	19.4	5.6
Scotteville-les-Rouen	France	1760-1790	24.1	19.3	4.8
Bléré	France	1707-1765	22.8	18.6	4.2
Meulan	France	1660-1739	26.1	22.4	3.7
Tonnerrois parishes	France	18th Cent.	23.8	21.6	2.2
Schönberg	Germany	1840-1890	22.0	20.0	2.0
Anhausen	Germany	1840-1890	19.9	19.7	0.2

Notes : a) birth years of husbands

Sources : Anhausen, Mömmlingen and Schönberg from Knodel (1968) ; Bléré calculated from data given in Lachiver (1969a) ; Crulai from Gauter and Henry (1958) ; French Canadians from Henripin (1954) ; Meulan from Lachiver (1969b) ; Rumont calculated from Robert (1969) ; Sachsen Miners from Giessler (1885) ; all other from Smith (1974).

uncommon. It is also interesting to note that average duration of birth intervals following infant deaths, and therefore those which are minimally influenced by the prevailing breastfeeding customs, cluster in a very narrow range of about 19 to 22 months with only a few exceptions. The evidence in Table 1 shows fairly conclusively that the "physiological" effect of infant mortality on fertility was operating in pre-industrial European populations except in those areas where breastfeeding was uncommon. Several related questions, however, merit answering: 1) Do studies of the effect of breastfeeding on postpartum sterility yield results which would indicate that the "physiological" effect of infant mortality on fertility could alone account for differences in birth intervals of the magnitude found in the studies of pre-industrial populations just reviewed? 2) How much of a reduction in fertility could we expect from the "physiological" effect of infant mortality alone if a major reduction in infant mortality took place? 3) Is there any internal evidence in the family history data which indicates infant mortality affects the length of birth intervals in a manner independent of the "physiological" effect? The rest of this section attempts to answer each of these questions in turn.

Essentially all studies utilizing direct evidence on lactation and either postpartum amenorrhea or postpartum resumption of ovulation indicate breastfeeding extends postpartum sterility. The extent of this effect, however, varies substantially from study to study. For example, Salber and her colleagues found a difference of only four months in the median duration of amenorrhea between mothers in the Boston area who did not breast-feed their children at all and those who breast-fed for almost a year (Salber, *et al.*, 1966). Results of studies based on women in less developed countries indicated differences in the average duration of amenorrhea up to 9 to 10 months (e.g. Potter, *et al.*, 1965; Van Ginniken, 1974). It appears that the physiological effect of lactation on fertility is itself subject to other influences such as the intensity of breastfeeding and nutritional differences. There is evidence that partial breastfeeding (i.e. done in conjunction with supplementary feeding) is less effective in suppressing ovulation than full breastfeeding (Van Ginneken, 1974). Recent research has also indicated that lactation extends amenorrhea longer among poorly nourished women than among better nourished women (Frisch, 1974). The important point for the present discussion is that it is not possible to determine how much influence lactation alone exerts on fecundability in a particular population without taking into account the other factors that affect this relationship. In pre-industrial Europe the nutritional level was probably not especially good among the rural peasantry or working classes and thus we might expect the impact of lactation on amenorrhea to be closer to the maximum than the minimum. Of course, not all infants who die before age one die immediately after birth so that mothers who lose an infant may have nursed that infant for a number of months. Typically, in pre-industrial European populations, over 40 percent of infant deaths occurred within the first month of life (Wrigley, 1968) so that the average age of death of infants dying before their first birthday is closer to three months than half a year. Since the effect of the first couple of months of lactation on postpartum sterility tends to be minimal (probably because even in the absence of lactation women typically experience several months of anovulatory cycles) average differences of up to 8 or 9 months between normal birth intervals and birth intervals following an infant death can plausibly be accounted for by the "physiological" effect alone; larger differences might also be attributable solely to this effect but they would exceed the range of differences found in studies on modern populations which observe the physiological impact of lactation directly.

Even assuming that the "physiological" effect of infant death could make a difference in the average birth interval of 10 months, a substantial reduction in infant mortality would yield only a small reduction in fertility as a result of this mechanism alone. The magnitude of this effect can be estimated fairly easily. Assume two cohorts of women marrying at the same age and ceasing childbearing at the same age. Suppose that for one cohort 25 percent of children died before age 1 (${}_1q_0 = .250$), a level as high or higher than was experienced by most of the populations covered in Table 1, and for the other cohort only 5 percent died before age one (${}_1q_0 = .050$), a level not unlike that being experienced by Western European populations in the 1930's when the secular decline in fertility typically came to an end. Contraceptive practice is assumed to be the same for both cohorts. If we further assume the average interbirth interval following an infant death to be 20 months, or about the average experienced by populations in Table 1 and the normal interval to be 10 months longer (i.e. 30 months), we can calculate what percent fewer second and higher order births the cohort experiencing lower infant mortality would have than the cohort experiencing higher infant mortality (the number of first order births would obviously be the same). The average interbirth interval for the high mortality cohort would be (.25)(20) + (.75)(30) or 27.5 months and for the low mortality cohort (.05)(20) + (.95)(30) or 29.5. The proportionate difference in the number of second or higher order births occurring to the two cohorts

$$\left(\frac{\text{average interval with low mortality}}{\text{average interval with high mortality}} - 1\right)$$

is about seven percent. The difference in the total number of births would be less since each cohort has the same number of first births. The difference would be even smaller if we assumed the infant mortality had less than the maximum average impact of 10 months on the difference in birth intervals. Furthermore, the increasing use of contraception and the probable increasing level of nutrition would both act to additionally

reduce the effect of lactation as a determinant of the birth interval. It is true of course that in some areas of Europe infant mortality prior to the decline was greater than the 25 percent assumed in our example and in these areas the decline in infant mortality was correspondingly greater. However, high infant mortality during the last half of the nineteenth and early twentieth century, at least, was often associated with the lack of breast feeding or with breast feeding of short duration (Knodel and Van de Walle, 1967). In such situations, the effect of a reduction in infant mortality would be much less than in areas where prolonged breast feeding was universal.

Finally we turn to the question of whether there is any internal evidence in the family history data which indicates that infant mortality affects the length of birth intervals independently of the "physiological" effect. One way to do this is to investigate the possible effect of the fate of the first-born on the interval between the second and third birth. It is evident that the death or survival of the first birth could not affect the duration of breastfeeding of the second infant even in areas where breastfeeding is common. However, if mortality risks among siblings were correlated with each other, there would be a higher probability of the second child dying and thus interrupting lactation if the first child died. This possible effect can be eliminated by holding constant the fate of the second child. Thus a relationship between the fate of the first child and the interval between the second and third births, when the fate of the second child is held constant, is one indication of the effect of infant mortality on the birth interval independent of any effects of breastfeeding. Only one study analyzes the family history data in this manner (Knodel, 1968) but several others include sufficient data in their appendices to permit this type of tabulation. The results are presented in Table 2. Caution is called for in interpreting these results since the numbers of cases in particular categories are occasionally quite small. Nevertheless a general pattern is evident. With only a few exceptions the interval between the second and third birth is shorter if the first child dies in infancy than when the child survives. The impact tends to be longer when the second child survives but also holds when the second child dies before age one. Furthermore, the interval between the second and third birth tends to be longest if the first two infants survive and shortest if the first two die.

Of particular interest are the results from studies based on families in the French village Meulan and the Genevan bourgeoisie since they both cover time periods during which family limitation was apparently

TABLE 2 – MEAN INTERVAL (IN MONTHS) BETWEEN THE SECOND AND THIRD LEGITIMATE CONFINEMENTS ACCORDING TO THE FATE OF THE PREVIOUS CONFINEMENT

Village or Group	Year of Marriage	Second Infant Survives					Second Infant Dies				
		First Survivor		First Dies Under 1		Difference	First Survivor		First Dies Under 1		Difference
		Int.	(N)	Int.	(N)		Int.	(N)	Int.	(N)	
Anhausen	1840-1890	23.4	(23)	17.6	(5)	5.8	17.6	(11)	17.0	(6)	0.6
Schönberg	1840-1890	23.9	(45)	21.1	(18)	2.8	17.5	(20)	16.9	(7)	0.6
Mömmlingen	1840-1890	29.0	(161)	25.4	(22)	3.6	18.5	(27)	15.6	(13)	2.9
Crulai[a]	1674-1742	32.6	(129)	29.1	(41)	3.5	23.8	(21)	19.9	(14)	3.9
Tourouvre	1665-1765	30.4	(323)	29.8	(120)	0.6	19.9	(91)	18.6	(43)	1.3
Ile-de-France villages	1740-1799	29.3	(112)	25.2	(26)	4.1	24.0	(19)	20.5	(10)	3.5
Thézels-St. Sernin[a]	1700-1792	32.3	(79)	34.4	(8)	-2.1	24.0	(17)	15.7	(5)	8.2
Meulan	1660-1739	24.7	(232)	25.4	(69)	-0.7	21.5	(41)	19.1	(15)	2.4
	1740-1789	24.9	(208)	23.8	(51)	1.1	18.8	(37)	24.1	(14)	-5.3
	1790-1839	33.3	(181)	24.1	(37)	9.2	27.4	(21)	23.8	(6)	3.6
Genevan Bourgeoisie[b]	Before 1650[c]	26.7	(91)	25.6	(15)	1.1	16.9	(20)	19.5	(1)	-2.6
	1650+[c]	34.9	(218)	22.1	(17)	12.8	17.8	(13)	-	(0)	-
All Studies		29.5	(1804)	26.4	(429)	3.1	20.5	(338)	19.2	(134)	1.3

Notes : In case of twins, the fate of longest surviving twin is considered ;

a) Excluding cases where the fate of preceding birth is unknown during periods when infant deaths were incompletely registered.

b) Excluding cases where the birth interval was estimated or where no information was available about the fate of the first two confinements.

c) Birth years of husbands.

Sources : Anhausen, Schönberg, and Mömmlingen from Knodel (1968), Table 10 ; Crulai calculated from Gautier and Henry (1958), Appendix Table VIII ; Tourouvre calculated from Charbonneau (1970), Appendix Table XXVI ; Ile-de-France villages calculated from Ganiage (1963), Appendix Table III ; Meulan calculated from Lachiver (1969b), Appendix Table VIII ; Genevan bourgeoisie calculated from Henry (1956), Appendix Table XI.

adopted by sizeable portions of population and marital fertility experienced a decline. In the case of Meulan, family limitation apparently begins to be practised among couples married in 1740-1789 but is considerably accelerated among couples married in 1790-1839 (Lachiver, 1969b). Among the Genevan bourgeoisie, family limitation and reduced fertility is apparent among couples in which the husband was born in 1650 or later (Henry, 1959). In both populations the effect of the fate of the first born seems to have greater impact after family limitation is firmly established than before. Such a pattern is what we would expect if the child mortality experience of a couple affects their voluntary actions over their fertility.

More difficult to interpret is the finding that even during periods of assumed "natural" fertility the infant death of a couple's first birth seems to shorten the time they take between their second and third birth. Perhaps more voluntary control over fertility was being practised than previously thought or some mechanism or even selection process is operating that we have so far failed to identify.

III. Child mortality and the limitation of family size

The "child replacement" hypothesis makes sense only in contexts where couples limit their fertility after they reach some number of children they do not wish to exceed. Otherwise couples would continue to bear children until one of the spouses became permanently sterile or died and be independent of the number of their children which survived or died at early ages. Any evidence of the "child replacement" effect operating in pre-industrial European populations would therefore suggest that at least some family limitation was being practised. Furthermore as marital fertility declines with the spread of family limitation, the "child replacement" effect of child mortality on the fertility behavior of individual couples should be more apparent.

To test the existence of the "child replacement" effect we need to see if the fate of the children born early in a marriage affects the couple's subsequent reproduction behavior. We will attempt to do this in three ways : by examining parity progression ratios, the age of mother at her last birth, and the number of children ever born.

a) Parity Progression Ratios

If a couple's experience with child mortality influences whether or not they continue their childbearing in such a way that couples attempt to replace lost children, we would expect that among couples with the same number of live births (or confinements), those who experienced the death of a previous child would be more likely to continue bearing children than those whose children had all survived. None of the published studies analyze their family history data in this way. Some approximation of the appropriate tabulation could be made based on data provided in the appendices of several of them or, in the case of several German villages, from the original data on hand. Table 3 presents the results, showing the proportion of women with n confinements who progress to $n + 1$ confinements according to the fate of their children. Since only infant deaths (i.e. deaths in the first year of life) were noted in the appendix tables of the French and Swiss studies used, Table 3 also limits consideration to experience with infant deaths and does not take account of deaths of children at older ages even though some would have occurred before the woman proceeded to the next parity and might have influenced her behavior. In addition, for the French and Swiss studies, the fate of the last child born to each couple is not stated in the appendix and thus the proportion progressing from parity n to parity $n + 1$ can only be related to the couples' experience with infant deaths among their first $n - 1$ children in order to avoid biasing the results. Since the original data for the German villages were available, this restriction was not imposed on them. For all studies, only women whose marriage remained intact by the time they reached age 45 (i.e. "completed families") were included in the tabulation. Finally the results of any particular study need to be interpreted with caution because of the small number of cases in some categories.

The results are mixed particularly for the cohorts for which there is no independent evidence that family limitation was being practised (according to the original studies), although perhaps some slight tendency is apparent for women experiencing infant deaths to be more likely to continue childbearing than women who did not experience any. The cohorts for which family limitation is known to be fairly widespread are of particular interest. These include couples married after 1890 in Anhausen and after 1740 in Meulan and Genevan bourgeoisie couples in which the husband was born in 1650 or later. The results for the Anhausen women do not exhibit a pattern consistent with the expectation that the "child replacement" effect increases as family limitation increases but since they are based on such small numbers of cases for the post 1890 marriage cohort little confidence can be placed on them. In contrast, for Meulan and the Genevan bourgeoisie the relationship between the parity progression ratios and the infant mortality experience is much more pronounced for cohorts among which family limitation is common. Both for Meulan and the Genevan Bourgeoisie the decline in the parity progression ratios over time is greater at each parity for women not experiencing infant deaths than women who did experience infant deaths.

It is usually assumed that women who are older when they marry are less likely to resort to family limitation than younger women since the number of children they can bear is limited by their age. Thus it seems plausible to assume that if child mortality is related to fertility through family limitation, the relationship should be stronger and more consistent among couples in which the wife was relatively young at the time of marriage. This seems to be generally true for both the combined German studies and the combined French and Swiss studies where women who were married before age 30 are compared with women who married at a later age.

Finally, it is worth noting in connection with Table 3 that a comparison of parity progression ratios by the number of infant deaths experienced could be affected by the "physiological" effect of infant mortality on fertility as well as the child replacement effect although the impact should be slight. All else being equal, women experiencing infant deaths would experience shorter birth intervals on the average than women whose children all survive and hence would be more likely to reach each successive higher parity. For this reason the results for Schönberg and Anhausen are particularly interesting since prolonged breastfeeding was not common in those villages at least for the marriage cohorts 1840-1890 and hence the "physiological" effect would not be operating. The results are rather mixed and are unfortunately based on only a small number of women. At best the child replacement hypothesis gains only weak support from the data in these two villages.

TABLE 3 – PERCENTAGE OF WOMEN IN COMPLETED FAMILIES WHO PROGRESS TO NEXT PARITY BY THE NUMBER OF INFANT DEATHS EXPERIENCED

Village or Group	Year of Marriage	2nd to 3rd			3rd to 4th			4th to 5th			5th to 6th		
		No. of Deaths :			No. of Deaths :			No. of Deaths ;			No. of Deaths :		
		0	1	2	0	1	2+	0	1	2+	0	1	2+
		A. According to deaths of the 1st *n* children for progression from parity *n* to *n* + 1											
Anhausen	1692-1839	89.5	97.3		88.0	92.6	(84.2)	(93.8)	(88.9)	86.2	91.3		84.8
	1840-1890	84.0	90.5		81.3	(92.9)	(90.0)	85.7		(92.9)	(100.0)		(100.0)
	1891-1939[a]	76.3	(66.7)		81.8	(86.7)		(90.0)	(71.4)		*	(70.0)	
Schönberg	1840-1890	97.4	97.6		93.1	87.9	(76.5)	(88.9)	93.1	90.9	(70.0)	85.2	80.8
Mömmlingen	1840-1890	96.3	100.0	(100.0)	93.0	94.5	85.7	86.1	89.3	100.0	77.7	80.4	88.2
Combined German Studies													
Age at Marriage < 30	-	96.3	97.1	100.0	95.1	96.1	96.2	89.1	91.8	96.2	80.0	89.0	93.5
Age at Marriage 30+	-	83.6	97.2	(81.8)	76.9	81.8	56.5	69.6	84.0	77.3	(61.5)	70.0	57.1
Total	-	93.5	97.1	94.6	91.9	92.6	84.2	86.5	90.2	92.0	78.0	85.6	86.7
		B. According to deaths of the 1st *n* – 1 children for progression from parity *n* to *n* + 1											
Crulai	1674-1742	92.6	(92.3)	-	73.8	(84.2)		77.4	(93.8)		66.7	(83.3)	
Tourouvre-au-Perche	1665-1765	84.8	94.8	-	84.0	90.4	(100.0)	78.2	81.2	85.7	85.7	80.8	71.7
Ile-de-France villages	1740-1799	90.6	100.0	-	95.7	100.0		86.2	87.2	(75.0)	90.2	83.3	(87.5)
Trézels-St. Semin	1700-1792	95.1	*	-	84.6	*		(93.3)	(70.0)		(66.7)	*	
Meulan	1600-1739	96.0	97.8	-	92.7	96.8		87.6	82.4	(94.7)	87.5	90.0	75.0
	1740-1789	91.6	91.1	-	88.0	92.1		82.4	85.3	(79.6)	72.6	83.3	80.0
	1790-1839	77.5	90.5	-	71.4	83.9		65.1	78.8		58.8	70.0	
Genevan Bourgeoisie	Pre 1650[b]	97.2	(83.3)	-	97.2	95.8		88.6	93.1		91.2	84.4	
	1650+[b]	82.3	(85.7)	-	70.4	85.0		53.7	82.1		51.9	79.3	
Combined French and Swiss Studies													
Age at Marriage < 30		92.4	96.3	-	88.9	96.9	100.0	82.9	87.6	90.2	81.7	87.7	80.9
Age at Marriage 30+		73.6	88.4	-	67.9	73.7		64.9	57.4	54.5	44.4	48.3	28.6
Total		88.6	94.7	-	85.3	92.6	95.0	80.7	82.7	86.0	78.4	83.1	75.2

Notes : In case of twins, death of longest surviving twin is considered ;
Adjacent categories are combined when either had less than 10 cases in it ;
* = results not shown for categories (or combined categories with less than 10 cases)
( ) = results based on 10 – 19 cases.
a) including cases where the date of death of only one spouse known.
b) year of husband's birth

Sources : Results for German villages were calculated for data originally collected by the author.
Results for French and Swiss studies calcualted from sources mentioned in Table 2.

b) Age of the Mother at Last Birth

One result of family limitation is usually a reduction in the age at which a mother bears her last child. Therefore, women whose initial births survive past childhood should bear their last child at a younger age than women whose first several children die at early ages if infant or child mortality is in fact related to family limitation and women tried to replace their lost children by having additional births. Table 4 presents the relevant data for the three German villages. Age of mother at the last birth is tabulated according to the number of children dying under age 10 among the first two and first three confinements. Those results should be largely independent of any influence from the "physiological" effect. No clear relationship between child deaths and the age of the mother at her last birth is apparent. In Mömmlingen the relationship is in the predicted direction when the number of child deaths among the first two births are considered, but the differences are unimpressive. Even when consideration is restricted to families in which the mother was less than 30 at the time of marriage, no clear relationship emerges. In addition, the relationship is either negligible or in the opposite direction among 1891-1939 marriage cohort even though there is reason to assume that they are practising some form of family limitation. Again we must bear in mind that the number of cases involved in this last group is very small.

Results from the French and Swiss studies on the age of the mother at last birth are presented in Table 5. Because these results had to be calculated from the appendix tables in those studies only experience with infant deaths can be considered. In addition, since the fate of the last child is not known, the fate of the first two confinements is known only for women with at least three confinements and the fate of the first three confinements is known only for women with at least four confinements. As with the German villages, the results are mixed with only a slightly older age at last birth being associated with women who experience the infant deaths among their first several children. The fact the relationship is in the expected direction among women married under 30 and not among women married at older ages suggests that family limitation may indeed be responsible for what weak relationship does exist. Further evidence of this is apparent in Meulan, where the expected relationship emerges only for the couples married from 1790-1839 which are the couples for which independent evidence suggests that family limitation is fairly extensively practised. It is interesting to note that the decline in the age of mother at last birth in Meulan is greater for women who did not experience infant deaths among their first few children than among women who did. This is not so for the Genevan bourgeoisie and indeed for this group the relationship between the age of mother at last birth and infant mortality shows no pronounced tendency to change as family limitation becomes widespread.

TABLE 4 – AGE OF MOTHER AT THE LAST BIRTH IN COMPLETED FAMILIES ACCORDING TO THE NUMBER OF THE FIRST SEVERAL CHILDREN DYING BEFORE AGE 10.

Village	Year of marriage	Age at marriage	Among women with 2 or more confinements, fate of first two :			Among women with 3 or more confinements, fate of first three :		
Village			None dies	One dies	Two die	None dies	One dies	2 or 3 die
Anhausen	1692-1839	all ages	41.1	40.8	(40.5)	(41.2)	41.6	(39.7)
		under 30	40.8	(40.7)		41.4	(39.9)	
	1840-1890	all ages	39.9	(38.6)	(40.4)	(39.3)	(39.0)	(40.8)
		under 30	(39.4)	(37.9)	(39.9)	(38.5)		(39.9)
	1891-1939[a]	all ages	37.0	(37.2)		39.3	(38.8)	
		under 30	36.1	(35.6)		(38.6)	(37.9)	
Schönberg	1840-1890	all ages	40.9	40.6	(40.9)	42.0	40.0	41.3
		under 30	40.5	39.6	(39.9)	(41.8)	39.2	(40.4)
Mömmlingen	1840-1890	all ages	39.7	40.5	(40.8)	40.1	40.1	41.1
		under 30	39.6	40.1	(40.6)	40.0	39.8	40.9
All villages[b]	-	all ages	39.7	40.1	40.5	40.3	40.1	41.0
		under 30	39.4	39.6	40.0	40.2	39.9	40.6

Notes : In case of twins, fate of longest surviving twin is considered ;
Adjacent categories are combined when either had less than 10 cases in it ;
( ) – results based on 10-19 cases.
a) including cases in which the death date of only one spouse is known ;
b) including cases for Anhausen marriages 1891-1939 in which the death date of only one spouse is known.

Sources : Results for Schönberg, Mömmlingen and Anhausen marriages 1840-90 from Knodel (1968) ; results for Anhausen marriages 1692-1839 were calculated from data originally collected by the author.

TABLE 5 – AGE OF MOTHER AT LAST BIRTH IN COMPLETED UNIONS ACCORDING TO THE NUMBER OF THE FIRST SEVERAL CHILDREN DYING IN INFANCY

Village or Group	Year of marriage	Among women with 3 or more confinements, fate of first two :			Among women with 4 or more confinements, fate of first three :		
		None Dies	One Dies	Two Die	None Dies	One Dies	2 or 3 Die
Crulai	1674-1742	39.7	(40.3)		40.0	(40.6)	
Tourouvre-au-Perche	1665-1765	40.4	40.2	(41.4)	40.8	40.6	40.9
Ile-de-France villages	1740-1799	40.0	39.1		40.2	39.4	(38.9)
Thézels-St.-Semin	1700-1792	38.4	*		39.1	(40.1)	
Meulan	1660-1739	40.7	40.2		41.1	40.3	(40.1)
	1740-1789	39.3	38.8		39.4	39.6	(37.5)
	1790-1839	36.1	38.2		37.3	(38.8)	
Genevan Bourgeoisie	Before 1650[a]	38.9	39.5		39.2	39.3	
	1650-99[a]	34.2[b]	35.2[b]		35.9	(35.6)	
	1700+[a]				34.8	(34.4)	
All Studies Combined :							
Age at Marriage < 30		38.9	39.4	39.8	39.5	39.6	39.8
Age at Marriage ≥ 30		41.4	40.6	40.4	42.2	41.5	(40.0)
All Ages at Marriage		39.3	39.6	39.9	39.8	39.9	39.8

Notes : In case of twins only, the fate of the longest surviving twin is considered ; Categories of "one" and "two (or more) dies" were combined when either had less than 10 cases in it ; * = results not shown for categories (or combined categories) with less than 10 cases ; ( ) = results based on 10-19 cases.

a) Refers to year of birth of husband.

b) Categories "1650-99" and "1700+" combined because of the small number of women with infant deaths among the first two confinements in each category.

Sources : Results calculated from sources mentioned in Table 2.

c) Number of Children Ever Born

If couples replace children who die young then we would expect women who experience loss of children among their first few to bear more births than women whose first few children survived. Table 6 indicates the mean number of legitimate confinements according to the number of child deaths under 10 among the first two and three confinements. Although the results show a mixed pattern some tendency is apparent for women who experienced the loss among the first several children to end up having more confinements by the end of the reproductive years, particularly among women married under 30. It should be noted that this relationship is not entirely independent of the "physiological" effect of infant mortality on fertility. Women with more infant deaths would experience shorter birth intervals on the average and hence be able to fit in more births in a given span of time. Thus the results of the 1840-1890 marriage cohorts of Anhausen and Schönberg are particularly interesting. The results are mixed and in the case of Anhausen must be interpreted with great caution because of the small number of cases involved. Curiously in Anhausen even among the couples married after 1890, there seems to be no relationship between the number of children ever born and the loss of the first few children even though family limitation is certainly being used to some extent by this cohort.

The results of the French and Swiss studies are presented in Table 7. The same constraints operate in these tabulations as were mentioned in connection with Table 5 since the results were calculated from the published appendix tables of these studies. Again the results are mixed but with some tendency detectable of larger mean numbers of children ever born to be associated with women who lose one or more of their first few children in infancy, particularly among women who married before they were 30 years of age. In Meulan, the association is more pronounced and in the expected direction for couples who married 1790-1839 than for couples who married earlier, thus suggesting it is related to the onset of family limitation. Interestingly, the reduction in the mean number of children ever born in Meulan is greater among women who experienced no infant deaths among their first few children than among women who did experience at least one infant death. Among the Genevan bourgeoisie the association between the mean number of children born and experience with infant mortality is in the expected direction both before and after the onset of widespread family limitations. The reduction in the mean number of children born, however, is about equal for women experiencing infant loss among their first few children and those who do not.

TABLE 6 – MEAN NUMBER OF LEGITIMATE CONFINEMENTS IN COMPLETED FAMILIES ACCORDING TO THE NUMBER OF THE FIRST SEVERAL CHILDREN DYING UNDER AGE 10

Village	Year of marriage	Age at marriage	Among women with 2 or more confinements, fate of first two :			Among women with 3 or more confinements, fate of first three :		
			None dies	One dies	Two die	None dies	One dies	2 or 3 die
Anhausen	1692-1839	all ages	7.0	7.8	(6.0)	(7.4)	8.5	(7.0)
		under 30	(8.1)	8.5		9.4	(6.9)	
	1840-1890	all ages	6.0	6.9	(7.2)	(7.4)	(6.6)	(8.0)
		under 30	(8.3)	(7.9)	(7.3)	(8.1)		(8.9)
	1891-1939[a]	all ages	4.7	(5.2)		(6.1)	(5.9)	
		under 30	5.0	(4.9)		(6.2)	(6.1)	
Schönberg	1840-1890	all ages	6.9	7.4	(7.3)	7.3	7.2	7.7
		under 30	7.9	8.2	(9.4)	8.2	7.9	(9.4)
Mömmlingen	1840-1890	all ages	6.6	6.6	(7.1)	6.7	6.7	7.1
		under 30	6.8	7.3	(7.9)	7.0	7.0	8.2
All villages[b]	-	all ages	6.4	6.9	6.9	6.8	7.0	7.5
		under 30	6.9	7.7	7.9	7.2	7.6	8.6

Notes : See notes for Table 4.

Sources : Previously unpublished results calculated from data originally collected by author.

TABLE 7 – MEAN NUMBER OF CHILDREN EVER BORN IN COMPLETED FAMILIES ACCORDING TO THE NUMBER OF THE FIRST SEVERAL CHILDREN DYING IN INFANCY

Village or Group	Year of marriage	Among women with 3 or more confinements, fate of first two :			Among women with 4 or more confinements, fate of first three :		
		None dies	One dies	Two die	None dies	One dies	2 or 3 die
Crulai	1674-1742	5.3	(6.8)		6.1	(7.6)	
Tourouvre-au Perche	1665-1765	6.6	6.9	(7.2)	7.0	7.3	7.5
Ile-de-France villages	1740-1799	7.2	7.5		7.4	7.6	(6.5)
Thézels-St. Sernin	1700-1792	6.1	*		6.8	(6.3)	
Meulan	1660-1739	7.7	(8.2)		8.4	7.9	(7.8)
	1740-1789	6.7	6.8		7.1	7.5	(6.5)
	1790-1839	5.1	6.4		5.9	6.6	
Genevan bourgeoisie	before 1650[a]	7.7	9.1		8.1	9.1	
	1650-99[a]	4.8[b]	6.4[b]		7.1	(7.4)	
	1700+[a]				5.0	(6.0)	
All studies combined :							
Age at marriage < 30	-	6.9	7.8	7.7	7.4	7.9	7.6
Age at marriage > 30	-	4.6	4.6		5.3	5.4	(4.9)
All ages at marriage	-	6.6	7.2	7.0	7.1	7.5	7.3

Notes : See Table 5.

Sources : Results calculated from sources mentioned in Table 2.

IV. Conclusions

The limited number of studies available which provide evidence based on individual data on the influence of child mortality on fertility in European populations in the past and the small number of cases involved in many of the studies make firm conclusions impossible. The difficulties are aggravated by the fact that with rare exception these studies did not direct their analysis to examining this relationship beyond

presenting evidence of the "physiological" effect of infant deaths in the birth interval. Thus much of the evidence reviewed here had to be based on a reanalysis of data presented in the appendices of several of these studies. Since these data were not presented in an ideal format for this purpose, several otherwise unnecessary constraints were imposed on resulting tabulations. Additional limitations arose from the fact that only a very few studies covered periods during which marital fertility began its secular decline. Finally the interpretation of results was impeded by the difficulty of separating the impact of the different effects infant mortality would exert on fertility and the impact of other mediating factors.

The most conclusive finding to emerge from this review concerns the impact of the "physiological" effect of infant mortality on the birth interval. Among pre-industrial European populations an infant death typically results in shortening the time taken until the next birth. Excluding the two communities studied in which prolonged breastfeeding was known to be rare, the impact of an infant death at the onset of the birth interval shortened the average time until the next birth by 2 to 13 months. Clearly much, if not all of the reduction in the length of the birth interval, can be accounted for by the fact that an infant death curtails lactation and prematurely ends the period of postpartum sterility typically associated with extended periods of breastfeeding. Nevertheless, the fact that the fate of the first child apparently influenced the length of the interval between the second and third birth suggests that infant mortality may also exert an additional effect on birth spacing independent of the "physiological" effect.

Evidence to support the operation of a "child replacement" effect in pre-industrial Europe prior to the onset of at least moderately widespread voluntary family limitation was much less consistent than evidence on the "physiological" effect and it is not possible to conclude that deliberate efforts to replace children dying early in life were actually taking place. It is interesting to note at this point that an analysis of family histories of a New England village during colonial times (not reviewed in the set of tabulations presented here), failed to show any clear evidence of couples attempting to replace children lost by early deaths. Smith (1972) shows that among eighteenth century women in Hingham, Massachusetts who married below age 25, there was no difference in their fertility above age 30 between those women with at least one child dying before the mother's 30th birthday and those not experiencing any child deaths before reaching age 30 when the number of children born before age 30 was taken into account.

In the few studies included in this review which covered periods in which marital fertility was substantially reduced (presumably through the adoption of family limitation within marriage) there is some suggestion, at least in data for the French village Meulan and to some extent for the Genevan bourgeoisie, that the "child replacement" effect is set into operation under these circumstances. A similar finding is reported by Smith (1973) in his study of eighteenth and nineteenth century marriage cohorts in Hingham, Massachusetts although his data include some anomalies. In the case of Meulan and the Genevan bourgeoisie, declining marital fertility and the apparent strengthening of the "child replacement" effect appears to be more or less coincident with a reduction in child mortality. It is not clear if either of these phenomena would have occurred in the absence of lower general child mortality. It is worth noting, however, that according to an analysis of reconstituted family histories from the English village of Colyton, a period during the latter 17th and early 18th centuries during which family limitation appears to be fairly extensively practised was not characterized by lower child mortality than adjacent periods when family limitation appears to be absent or less extensively practised (compare Wrigley, 1966 with Wrigley, 1968).

More significantly, the experience in Meulan suggests that once fertility begins to decline the impact as measured by parity progressive ratios, the age of mother at last birth or children ever born is greater among couples not experiencing infant deaths among their first few children than among couples who lose one or more of their births in infancy. Partial confirmation of this is apparent in the experience of the Genevan bourgeoisie who show the same pattern with respect to parity progression ratios but show about roughly equal reductions in the age of mother at the last birth or in the mean number of children ever born regardless of early infant mortality experience. Couples in the German village of Anhausen, however, do not show a similar strengthening of the "child replacement" effect as marital fertility declines nor is the decline greater among couples with no child deaths among their first few children. The number of family histories that can be analyzed for Anhausen during the period of fertility decline is very small and thus little confidence can be placed in these results. It is worth noting, however, that infant mortality was extraordinarily high in Anhausen even during much of the period of the fertility decline and thus the "insurance" effect of infant mortality might have operated to prevent the "child replacement" effect from asserting itself.

One tentative implication of this review of evidence based on individual data for European populations in the past is that once family limitation is introduced into a population and starts to spread, couples who have unfavorable experiences with child mortality will be more reluctant than couples with favorable experience to practice birth control. Thus a reduction in child mortality should facilitate a decline of fertility. It is not clear, however, from the data reviewed if a reduction in child mortality is a necessary prerequisite for spread of family limitation. It is unfortunate that most studies utilizing family history data in the study of European demographic history have neglected to confront the question of the relationship between infant

mortality and fertility beyond examining the "physiological" effect. The present review suggests that future research aimed directly at this problem should prove to be a fruitful area of inquiry, particularly if it encompasses the period of the transition from high to low fertility.

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ESSAI D'ESTIMATION DE LA SURFÉCONDITÉ CONSÉCUTIVE AU DÉCÈS D'UN ENFANT EN BAS ÂGE

Jacques VALLIN
Chargé de recherches
à l'Institut national d'études démographiques, Paris
Alain LERY
Administrateur
à l'Institut national de la statistique et des études économiques, Paris

RÉSUMÉ

S'agissant des pays en voie de développement à forte fécondité, la question sous-jacente à l'étude des relations entre mortalité infantile et fécondité est : une baisse de la mortalité infantile peut-elle entraîner une baisse de la fécondité ? Notre propos, concernant un pays industrialisé à faible fécondité, la France au XXe siècle, est très différent : un couple qui perd un enfant en bas âge tend-il à le "remplacer" par une naissance qui, sans décès, n'aurait pas eu lieu ?

Cette question ne se pose évidemment que pour une population malthusienne. En régime de fécondité naturelle, il n'y a aucune place pour un "remplacement" volontaire (tout au plus, peut-il y avoir un léger surcroît de fécondité dû a la réduction du "temps mort"). Ainsi, moins la fécondité est faible, moins la notion de remplacement a de sens. Cette relation est une source de difficulté pour notre analyse.

Celle-ci repose sur les données de l'enquête "familles" de 1962, réalisée auprès de 240.000 femmes non célibataires de moins de 70 ans et pour notre étude, nous ne retenons que les familles complètes (femmes mariées avant 45 ans et encore mariées en 1er mariage à 45 ans). Compte tenu du champ ainsi délimité, nous avons affaire à des femmes appartenant aux générations 1892 – 1916 et donc à la fécondité de l'entre-deux-guerres (2,29 enfants par femme en moyenne).

Deux voies sont explorées :

– variation de la probabilité pour un enfant né vivant d'être suivi d'une naissance selon que cet enfant est décédé ou non en bas âge :

– variation de l'intervalle entre une naissance et la suivante, selon que la première est suivie ou non d'un décès.

Dans les deux cas, on constate un "surcroît de fécondité". Mais, faut-il y voir la manifestation d'une volonté de remplacement ? Si la mortalité infantile est liée à la fécondité (du fait de la dépendance de ces deux variables par rapport à d'autres variables), sélectionner les familles qui ont eu un décès infantile revient aussi a sélectionner les familles les plus fécondes ; la mesure du phénomène de remplacement est donc impossible.

Malgré la portée de cet argument, il nous a paru intéressant de mesurer le surcroît de fécondité, quitte à en faire la critique.

I – Probabilité pour une naissance d'être suivie d'une autre

Soixante deux pour cent de l'ensemble des naissances observées ont été suivies d'une naissance ultérieure. Si on isole les naissances suivies d'un décès, cette proportion s'élève à 74 %. Globalement le "surcroît de fécondité" est donc de 22 % mais cette "mesure" est beaucoup trop grossière car elle mêle des situations très diverses. Il faut constituer des groupes de familles plus homogènes du point de vue de la fécondité. Un premier pas en ce sens consiste à distinguer selon le rang de l'enfant. On travaille alors avec les classiques "probabilités d'agrandissement".

A – Probabilités d'agrandissement selon le rang

Afin d'éviter l'élément perturbateur que constituent les décès survenus après la naissance de l'enfant suivant, nous comparerons le cas où l'enfant de rang n *est mort avant l'âge d'un an et le cas où il survivait à l'âge d'un an. Le résultat est le suivant :*

Rang	Probabilité d'agrandissement		"Surfécondité" [(1) – (2)]/(2)
	Enfants décédés avant un an (1)	Enfants survivants à un an (2)	
1	847	685	0,24
2	728	576	0,26
3	674	564	0,20
4	679	573	0,18
5	692	592	0,17

On constate donc :

– un "surcroît de fécondité" de l'ordre de 20 % ;

– une diminution de ce phénomène à partir du rang 2 ;

– un surcroît maximum au rang 2.

Mais cela ne nous renseigne guère car :

– on n'a pas éliminé, pour un rang donné, la sélection des familles fécondes par la mortalité infantile ; l'ordre de grandeur de 20 % ne mesure pas le seul effet du "remplacement".

– la décroissance avec le rang tient en grande partie au simple fait qu'avec le rang, le poids des familles fécondes augmente et donc, le temps disponible pour un remplacement diminue.

– quant au maximum observé au rang 2, il peut être dû à des problèmes d'observation, car la différence entre les rangs 1 et 2 est faible.

B – Catégories socio-professionnelles

La fécondité est fortement liée à la catégorie socio-professionnelle (CSP). L'effet de sélection des familles nombreuses par la mortalité infantile est donc probablement réduit (quoique non annulé) à l'intérieur de chaque CSP, et le surcroît de fécondité observé pour chacune est davantage dû au remplacement que pour l'ensemble. Mais ce fait, sans résoudre entièrement le premier problème, introduit une nouvelle difficulté : en passant d'une CSP à l'autre, on passe de groupes moins féconds à des groupes plus féconds où la place pour un remplacement est moindre, et toute comparaison d'une CSP à l'autre est impossible.

C – Sexe

Le rapport de masculinité à la naissance est indépendant de la fécondité. Le rapport entre le "remplacement" volontaire (non mesurable) et le surcroît de fécondité (effectivement observé) n'est donc pas lié au sexe et l'on peut comparer valablement le surcroît de fécondité consécutif au décès

d'une fille à celui qui suit le décès d'un garçon. Or on ne constate aucune différence. On en conclut qu'il n'y a aucune préférence des parents pour un sexe ou l'autre. C'est le premier résultat solide de cette étude. Hélas, tout important qu'il soit, il est hors du sujet qui nous préoccupe.

D – Générations de femmes

L'étude des probabilités d'agrandissement selon les générations de femmes n'apporte pas grand'chose de plus.

II – Intervalles de naissances

Pour essayer d'éliminer le biais introduit par la liaison entre mortalité infantile et fécondité, nous avons classé les familles complètes selon leur nombre final d'enfants. Dans une catégorie donnée, le décès d'un enfant avant l'âge d'un an entraîne un net raccourcissement de l'intervalle de temps qui, en moyenne, sépare la naissance de l'enfant considéré de celle de l'enfant suivant. Il n'est pas possible de distinguer dans cette diminution de l'intervalle ce qui est dû à un effet physiologique toujours existant de ce qui est dû à un éventuel effet de remplacement. Cette diminution est en moyenne de 6 mois à 1 ans, dans chacune des catégories de familles, quel que soit le rang.

L'examen détaillé de la répartition de l'intervalle de temps qui sépare deux naissances montre que, dans le cas où le premier de ces deux enfants meurt en bas âge, cette répartition est décalée : il y a un surcroît temporaire de fécondité particulièrement important dans la 2e année qui suit la naissance. Ainsi, par exemple, alors que 20 % environ des naissances de rang 2 (dans les familles complètes de 2 enfants) surviennent entre 1 an et 2 ans après la première naissance si le premier enfant est encore en vie à la date de l'enquête, ce pourcentage s'élève à 31 % en cas de décès avant 1 an, soit une augmentation de moitié.

Conclusion

Vue sous l'angle des probabilités d'agrandissement, la question ne reçoit qu'une réponse incomplète : on sait qu'un décès entraîne un surcroît de fécondité et donc vraisemblablement une volonté de remplacement, mais on ne peut pas mesurer la part de la seconde dans le premier. On ne peut par ailleurs faire de comparaison, ni d'un rang à l'autre, ni d'une CSP à l'autre. Le seul résultat acquis concerne l'attitude des parents à l'égard du sexe des enfants, ce qui est loin du sujet.

L'étude de l'intervalle entre naissances ne répond pas non plus à la question puisque pour éliminer les perturbations dues aux différences de fécondité, on a travaillé sur des groupes de familles complètes de même dimension et exclu du même coup la notion de remplacement. On observe seulement une modification du calendrier de la naissance suivante lorsqu'un enfant est décédé en bas âge.

Le phénomène de remplacement qui existe donc très vraisemblablement n'est pas mesurable avec les instruments dont nous disposions. C'est dire l'ampleur du champ ouvert à des analyses plus fines.

SUMMARY

Concerning the developing countries with high fertility, the underlying question to the study of the relations between infant mortality and fertility is : can a drop in infant mortality bring about a drop in fertility ? Our purpose, concerning an industrialised country with low fertility, France in the 20th century, is very different : does a couple which has lost a young child tend to "replace" it by a birth which would not have taken place, if not for the death ?

This question can obviously only be asked for a Malthusian population. When couples do not practise contraception, there is no place for a voluntary "replacement" (at the very most, there may be a slight increase in fertility due to the reduction of "dead time"). Thus, the higher the fertility, the more meaningful the idea of replacement. This relation is a source of difficulty for our analysis.

The latter is based on the data of the survey "Families" of 1962, carried out on 240 000 ever-married women of less than 70 years of age and, for our study, we retain only the completed families (women married before 45 years and still married in their first marriage at 45). Given the field defined, we are faced with women belonging to the generations 1892 – 1916 and thus to the fertility of the period between the two wars (2.29 children per woman on average).

Two subjects to be explored:

– variation of the probability for an ever-born child to be followed by a birth, whether this child died or not before he was one year old;

– variations in the interval between one birth and the following, whether the first is followed or not by a death.

In the two cases, an "over-fertility" is noticed. But, must we see in that a sign of willingness for replacement? If infant mortality is related to fertility (due to the dependance of these two variables in relation to other variables), to choose the families which have had an infant death means also to choose the most fertile families; the measurement of the phenomenon of replacement is therefore impossible.

I – Probability for one birth to be followed by another

Sixty two per cent of the aggregate observed births have been followed by a further birth. If we isolate the births followed by a death, this proportion rises to 74 %. Overall, the "excess of fertility" is therefore 22 %. But this "measure" is much too rough, for it mixes very differing situations. We must establish groups of families more homogeneous from the fertility aspect. A first step in this direction consists of making the distinction according to birth order of the child. We are therefore working with the classic "parity progression ratios".

A – Parity progression ratios according to the birth order

In order to avoid the disturbing element brought in by the deaths happening after the birth of the following child, we shall compare the case where the child of birth order n *died before it was one year old and the one where it was still alive at the age of one year. The result was as follows:*

Birth Order	Parity progression ratios		"Over-fertility" [(1) – (2)]/(2)
	Children dead before one year (1)	Children surviving at one year (2)	
1	847	685	0.24
2	728	576	0.26
3	674	564	0.20
4	679	573	0.18
5	692	592	0.17

We notice therefore:

– an "over-fertility" of about 20 %;

– a decrease of this phenomenon from birth order 2;

– a maximum excess at birth order 2.

But this hardly tells us anything for :

– we did not eliminate, for a given birth order, the selection of fertile families by the means of infant mortality ; the 20 % mentioned does not measure the only effect of the "replacement".

– the decrease of "over-fertility" with birth order can be mostly explained by the simple fact that with birth order, the weight of fertile families increases and therefore, the time available for a replacement diminishes.

– as for the observed maximum at birth order 2, it may be due to difficulties of observation, for the difference between birth orders 1 and 2 is slight.

B – Socio-professional categories

Fertility is closely linked to the socio-professional category. The selection effect of large families by infant mortality is therefore probably reduced (although not cancelled) within each SPC, and the excess fertility observed for each is more due to the replacement than for the whole. But this fact, without entirely resolving the first problem, introduces a new difficulty : in passing from one SPC to another, one goes from less fertile groups to more fertile groups, where there is less time for a replacement, and all comparison between one socio-professional category and another is impossible.

C – Sex

The sex ratio at birth does not depend on fertility. We can therefore validly compare the over-fertility consecutive to the death of a girl to that which follows the death of a boy, the portion of the excess due to the fertility level being the same in the two cases. Now, no difference is noticed. We draw the conclusion that there is no preference on the part of the parents for one sex or the other. It is the first tangent result of this study. Alas, as important as it may be, it does not belong to the subject which preoccupies us.

D – Generations of women

The study of the parity progression ratios according to the generations of women does not have much more to offer.

II – Birth intervals

In an attempt to eliminate the bias introduced by the relation between infant mortality and fertility, we classed the completed families according to their final number of children. In a given category, the death of a child before the age of one entails a clear shortening of the interval of time which, on average, separates the birth of the considered child from that of the following child. It is not possible to distinguish in this decrease in the interval what is due to a physiological effect still existing from what is due to a replacement effect, if any. This decrease is on average from 6 months to 1 year, in each of the categories of families, whatever the order.

The detailed examination of the distribution of the time interval which separates two births shows that, when the first of these two children dies at a young age, this distribution is altered : there is a temporary excess of fertility particularly important in the second year which follows the birth. Thus, for example, while around 20 % of the children of birth order 2 (in the completed families of two children) are born between one year and two years after the first birth, if the first child is still alive at the date of the survey, this percentage rises to 31 % in the case of a death before one year, say, increased by a half.

Conclusion

Seen from the angle of parity progression ratios, the question only receives an incomplete answer : it is known that a death entails an over-fertility, and therefore very likely a willingness for replacement, but the

portion of the second cannot be measured in the first. Moreover, a comparison cannot be made either from one birth order to the next, or from one socio-professional category to another. The single result gained concerns the attitude of the parents with respect to the sex of the children, which is far from the subject.

The study of the birth interval does not reply either to the question, since to eliminate the disturbances due to the differences in fertility, studies were made on groups of complete families of the same size and this choice excluded the idea of replacement. One observes only a modification in the timing of the next birth when a child dies under one year of age.

The phenomenon of replacement which exists is therefore very likely not able to be measured with the instruments available. That is to say, the volume of the field open to more sophisticated analyses.

RESUMEN

En los países en via de desarrollo, de alta fecundidad, la inquietud subyacente en los estudios de las inter-relaciones entre mortalidad infantil y fecundidad es : ¿ Puede una disminución de la mortalidad infantil acarrear como consecuencia una disminución de la fecundidad ? En nuestro caso, el problema es muy diferente. Se trata de un país industrializado de baja fecundidad, la Francia del siglo XX, y nuestro interrogante es : ¿ una pareja, que pierde un hijo de corta edad, tiende a "reemplazarlo" mediante el nacimiento de un nuevo hijo, lo que no habría ocurrido sin esa defunción ?

Esta pregunta no se plantea, evidentemente, sino en las poblaciones malthusianas. En el régimen de fecundidad natural no existe la posibilidad de un "reemplazo" voluntario (puede ocurrir, a lo más, un ligero aumento de la fecundidad debido a la reducción del "tiempo muerto"). Por lo tanto la noción de reemplazo adquiere menos sentido a medida que la fecundidad es menos débil. Esta relación es una fuente de dificultad para nuestro análisis.

Este estudio está basado en la información de la encuesta de "familias" realizada en 1962, y que incluye datos acerca de 240 000 mujeres no-solteras de menos de 70 años de edad. Para nuestro estudio hemos considerado solamente las familias completas (mujeres casadas antes de los 45 años y que se mantienen casadas aún en primer matrimonio a los 45 años). Por lo tanto las mujeres consideradas pertenecen a las generaciones 1892-1916 y se incluye por consiguiente la fecundidad del período entre las dos guerras (2,29 hijos por mujer, en promedio).

Se han estudiado dos aspectos :

– la variación de la probabilidad de que un nacido vivo sea seguido por otro nacimiento, según que este nacido vivo haya muerto o no de corta edad.

– la variación de la duración del intervalo entre un nacimiento y el siguiente, según que el primero sea seguido o no por una defunción.

En los dos casos se constata un "aumento de la fecundidad". Pero, ¿ puede verse en este hecho la manifectación de una voluntad de reemplazo ? Si la mortalidad infantil está ligada a la fecundidad (por el hecho de la dependencia de estas dos variables en relación a otras variables), seleccionar las familias que han tenido una defunción infantil equivale a seleccionar a las familias más fecundas. Es impossible, entonces, medir el fenómeno de reemplazo.

A pesar del alcance de este argumento, nos ha parecido interesante medir el aumento de la fecundidad, lo que no impide hacer la crítica correspondiente.

I – Probabilidad de que un nacimiento sea seguido por otro

El 62 por ciento del conjunto de los nacimientos observados han sido seguidos por un nacimiento posterior. Si se aislan los nacimientos seguidos por una defunción, esta proporción se eleva a un 74 %. El "aumento de la

fecundidad" es globalmente, entonces, de un 22 %. Pero esta medida es demasiado grosera debido a que mezcla situaciones muy diferentes. Es necesario constituir grupos de familias más homogéneas desde el punto de vista de la fecundidad. Un primer paso en este sentido consiste en diferenciar familias según el orden de nacimiento del niño. Se trabaja entonces con las "probabilidades de agrandamiento de la familia" clásicas.

A – Probabilidades de agrandamiento según el orden

Para evitar el factor perturbador constituído por las defunciones que ocurren después del nacimiento del niño siguiente, compararemos el caso en que el niño de orden n *muere antes de cumplir su primer año de vida y el caso en que sobrevive su primer aniversario.*

El resultado es el siguiente :

Orden de nacimiento (rango)	Probabilidad de agrandamiento		Aumento de la fecundidad [(1) – (2)]/(2)
	Niños que mueren antes de un año (1)	Niños que sobreviven un año (2)	
1	847	685	0,24
2	728	576	0,26
3	674	564	0,20
4	679	573	0,18
5	692	592	0,17

Se constata entonces :

– un aumento de la fecundidad de aproximadamente 20 %.

– una disminución de este fenómeno a partir de los nacimientos de rango 2.

– un aumento máximo en los nacimientos de rango 2.

Pero todo esto no nos dice mucho debido a que :

– no se ha eliminado, para los nacimientos de un orden determinado, la selección de las familias fecundas a través de la mortalidad infantil ; el orden de magnitud de un 20 % no mide el solo efecto del "reemplazo".

– la disminución del excedente de fecundidad a medida que aumenta el orden de nacimiento, se debe en gran parte al hecho de que la proporción de familias fecundas aumenta con el rango y por lo tanto disminuye el tiempo disponible para un reemplazo.

– en cuanto al máximo observado en el rango 2, puede ser ocasionado por problemas de observación ya que las diferencias entre los rangos 1 y 2 es débil.

B – Categorías socio-profesionales

La fecundidad está estrechamente ligada a las categorías socio-profesionales. El efecto de selección de las familias numerosas a través de la mortalidad infantil es probablemente reducido (aunque no anulado) en el interior de cada categoría socio-profesional, y el excedente de fecundidad observado en cada una de ellas se debe en mayor medida al reemplazo que en el caso del total. Pero este hecho, sin que resuelva enteramente el primer problema, introduce una nueva dificultad : al pasar de una categoría socio-profesional a otra, se pasa de grupos menos fecundos a grupos más fecundos, en los cuales hay menos posibilidades de reemplazo, y toda comparación de una categoría socio-profesional con otra es imposible.

C – Sexo

La razón de masculinidad al nacer es independiente de la fecundidad. La relación entre el "reemplazo" voluntario (no medible) y el excedente de la fecundidad (observado efectivamente), no está por lo tanto ligado al sexo y se puede comparar de una manera válida el excedente de fecundidad consecutivo al

nacimiento de una niña con aquel que sigue al nacimiento de un niño. En este caso no se constata ninguna diferencia. Se concluye que no hay ninguna preferencia de los padres por un sexo u otro. Es el primer resultado válido de este estudio. Pero, por importante que sea esta conclusión, queda fuera del tema que nos preocupa.

D – Generaciones de mujeres

El estudio de las probabilidades de agrandamiento según las generaciones de mujeres no aporta gran cosa de nuevo.

II – Intervalos entre nacimientos

Para tratar de eliminar el error introducido por la relación entre la mortalidad infantil y la fecundidad, hemos clasificado las familias completas según el número final de hijos. En una categoría dada, la defunción de un niño antes de cumplir un año de edad acarrea una clara disminución del intervalo que separa, en promedio, el nacimiento del niño considerado del nacimiento del niño siguiente. No es posible diferenciar en esta disminución del intervalo, en qué medida se debe a un efecto fisiológico, existente siempre, y en qué medida a un eventual efecto de reemplazo. Esta disminución es, en promedio, de 6 meses a 1 año, en cada una de las categorías de familias, cualquiera que sea el rango.

El análisis más detallado de la clasificación de los intervalos entre nacimientos muestra que, en el caso en que el primero de los niños muera a edad temprana, esta clasificación se desplaza : se produce un excedente temporal de fecundidad especialmente importante en el segundo año después del nacimiento. Así, por ejemplo, mientras que alrededor de un 20 % de los nacimientos de rango 2 (en las familias completas de 2 niños) se producen entre 1 y 2 años después del primer nacimiento, si el primer niño está todavía vivo en la época de la encuesta, este porcentaje se eleva a un 31 % en el caso de una defunción antes del primer año de vida, es decir se provoca un aumento de un 50 por ciento.

Conclusión

Desde el punto de vista de las probabilidades de agrandamiento, el problema sólo recibe una respuesta incompleta : se sabe que una defunción acarrea un excedente de fecundidad y por lo tanto verosímilmente una voluntad de reemplazo, pero no se puede medir la proporción de la segunda en la primera. No se puede, por lo demás, hacer comparaciones, ni de un rango con otro, ni de una categoría socio-profesional con otra. El único resultado seguro se refiere a la actitud de los padres con respecto al sexo de los niños, pero esto no corresponde al tema.

El estudio de los intervalos entre nacimientos tampoco responde a la interrogante ya que para eliminar las perturbaciones debidas a las diferencias de fecundidad, se ha trabajado sobre grupos de familias completas del mismo tamaño y se ha excluído al mismo tiempo la noción de reemplazo. Se observa solamente una modificación del calendario del nacimiento siguiente, cuando un niño muere a edad temprana.

El fenómeno de reemplazo que existe entonces, de una manera muy verosímil, no es nedible con los instrumentos que poseemos. Esto deja abiertas las posibilidades a análisis más finos.

L'étude des relations entre mortalité infantile et fécondité peut répondre à des questions bien différentes. La plus fréquente présente un intérêt particulier dans les pays à forte fécondité : *est-ce qu'une baisse de la mortalité infantile peut entraîner,* dans des délais assez brefs, *une baisse de la fécondité* ? Mettre une dizaine d'enfants au monde est une nécessité lorsque 25 à 30 % des nouveau-nés disparaissent dès la première année. Une telle fécondité peut, au contraire, devenir défavorable lorsque tous ou presque survivent et que, parallèlement, la période d'éducation improductive s'allonge. Mais outre que l'évolution de la fécondité nous semble davantage conditionnée par l'élévation de l'âge d'entrée dans la vie active, sa sensibilité à une baisse de la mortalité infantile ne paraît pas devoir être

immédiate. L'évolution de la fécondité dépend avant tout de celler des mentalités et c'est sans doute davantage à la génération suivante, sur la descendance des enfants plutôt que sur celle de la mère, qu'un effet peut être attendu.

Notre propos est en quelque sorte inverse et concerne plus spécialement les pays à faible fécondité : le décès d'un enfant en bas âge entraîne-t-il un surcroît de fécondité ? Autrement dit, *est-ce qu'un couple qui perd un enfant tend à le "remplacer" ?* et même, de façon plus précise : *est-ce qu'un couple qui, en l'absence de tout décès infantile aurait eu n naissances en a n + 1 du fait du décès précoce d'un enfant ?*

Les populations très fécondes ne peuvent guère faire l'objet d'une telle question. Imaginons en effet un couple qui ne pratique aucune contraception. Sa fécondité, que l'on se situe ou non après le décès d'un enfant, sera la même, puisqu'elle sera de toute façon "maximum" et uniquement liée à l'âge de la femme. Il faut certes nuancer ce propos : s'il est très précoce, et si la durée habituelle d'allaitement est longue, le décès peut provoquer une réduction du "temps mort" et donc un surcroît de fécondité, mais théoriquement du moins (1), aucune volonté de "remplacement" n'intervient dans ce phénomène avant tout physiologique.

L'effet de "remplacement" concerne donc essentiellement les populations à faible fécondité et nous tenterons ici de le mettre en évidence à partir des données de l'enquête française de 1962 sur la structure des familles (2).

Dans cette enquête, réalisée dans le cadre du recensement général de la population de 1962, on a observé un échantillon de 240.000 femmes non célibataires âgées de moins de 70 ans. Parmi elles, 92.000 correspondaient à des familles complètes, c'est-à-dire, au sens de cette enquête, des couples dont la femme s'est mariée avant 45 ans en premier mariage et qui ne sont pas dissous lorsque la femme atteint son 45e anniversaire ; le nombre d'enfants d'une famille complète est le nombre d'enfants légitimes nés vivants avant le 45e anniversaire de la femme (on néglige ainsi les enfants nés au delà) ; compte tenu du champ de l'enquête, les familles complètes correspondent à des femmes nées de 1892 à 1916. La fécondité observée est donc surtout celle des familles de l'entre-deux guerres. Elle s'établit à 2,29 enfants en moyenne.

Pour chacune des femmes de l'échantillon, on dispose :

– de l'année de naissance de la femme,

– de la catégorie socio-professionnelle de son mari ;

et, pour chacun de leurs enfants :

– de sa date de naissance

– de son sexe,

– de son rang,

– de son âge éventuel au décès.

Il convient de noter que cette enquête rétrospective a sensiblement sous-estimé des décès d'enfants en bas âge. Lorsque l'on compare le taux de mortalité infantile établi dans l'enquête avec celui que donnent les statistiques de l'état civil pour la même période, on constate une omission de près de 30 % des enfants décédés avant l'âge d'un an ; cependant il ne semble pas que ce biais soit de nature à infirmer notablement les conclusions qui suivent.

A partir de ces données, nous pouvons tenter de saisir la notion de remplacement par deux voies d'approche :

– mesurer la probabilité pour un enfant d'être suivi d'un autre, selon qu'il est ou non décédé ;

– examiner l'intervalle entre une naissance et la suivante selon qu'elle a été suivie ou non d'un décès.

Nous nous heurtons immédiatement à un *problème méthodologique fondamental.* Lorsqu'on mesure pour une même catégorie de femmes, la fécondité consécutive à une naissance non suivie d'un décès avant un certain âge et celle qui suit une naissance suivie d'un décès avant cet âge, peut-on attribuer l'écart observé à un surcroît de fécondité résultant d'une volonté de remplacement de l'enfant décédé ?

D'une part, il est vrai que l'enfant décédé peut être décédé après la naissance de son suivant, ce

(1) En fait, même dans des populations à très forte fécondité, le décès d'un enfant en bas âge a toute chance de provoquer une volonté de remplacement, mais celle-ci ne peut guère augmenter la fécondité.

(2) J.C. Deville. "Structure des familles, enquête de 1962". Les Collections de l'I.N.S.E.E., série D, n° 13/14, I.N.S.E.E. Paris, 1972, 344 p. Voir aussi : G. Calot et J.C. Deville. "Nuptialité et fécondité selon le milieu socio-culturel". *Economie et statistique* n° 27, I.N.S.E.E., octobre 1971.

qui introduit, le cas échéant, une difficulté qu'on peut lever en s'en tenant aux enfants qui sont décédés avant l'âge d'un an ; mais surtout, la question qui se pose est de savoir si le surcroît de fécondité résulte d'une augmentation de fécondité consécutive au décès ; il se peut en effet que les familles dont l'enfant de rang n est décédé avant l'âge d'un an soient sélectionnées, du point de vue de la fécondité, par une relation sous-jacente entre fécondité et mortalité infantile.

De fait, si l'on compare les différents milieux sociaux, la mortalité infantile et la fécondité (au moins jusqu'à un certain niveau de l'échelle sociale pour cette dernière) diminuent à mesure que le niveau de vie s'élève. Cette simple corrélation révèle une liaison sous-jacente entre fécondité et mortalité infantile.

Autrement dit, même en prenant la précaution de mesurer la fécondité postérieure à une naissance selon que celle-ci est suivie ou non d'un décès avant l'âge d'un an, et de retenir pour ce faire des catégories aussi homogènes que possible – par exemple du point de vue du milieu social – *il est vraisemblable que les familles qui se trouvent sélectionnées par le décès à moins d'un an soient également sélectionnées du point de vue de leur fécondité. Dans ce cas, le surcroît de fécondité observé tient pour une bonne part à ce simple phénomène de sélection et il est difficile de mesurer l'incidence du phénomène de remplacement.* En dépit de la force de cet argument, il reste intéressant, au moins sur le plan descriptif, de mesurer ce surcroît de fécondité.

Nous nous proposons donc, dans un premier temps, de mesurer, en fonction des diverses caractéristiques disponibles, la probabilité pour un enfant donné d'être suivi d'un autre, selon qu'il est décédé ou non avant l'âge d'un an, puis d'étudier la distribution des intervalles entre la naissance d'un enfant de rang n et celle de l'enfant de rang $n+1$ selon que l'enfant de rang n est décédé ou non avant l'âge d'un an. Il nous restera à compléter cette analyse par des suggestions sur les données souhaitables pour une meilleure approche du phénomène de remplacement.

I – Estimation de la "surfécondité" par les probabilités d'agrandissement

Au sein des 92.000 familles complètes, on a observé environ 200.000 naissances vivantes dont 62 % ont été suivies d'une naissance vivante ultérieure. La même proportion calculée pour les enfants non décédés est de 61 %, celle calculée aussi bien sur l'ensemble des enfants décédés que sur ceux décédés avant l'âge d'un an ou après l'âge d'un an est de 74 %. On peut en déduire un indice de "surfécondité" consécutive au décès qui est ici égal à $\frac{74\,\% - 61\,\%}{61\,\%} = 22\,\%$. Ce n'est qu'un indicateur très global et fruste de la volonté de remplacement. Il convient évidemment de l'appliquer à des catégories de familles les plus homogènes possible du point de vue de la fécondité. Un premier pas vers une meilleure précision consiste à travailler par rang de naissance. La comparaison repose alors sur ce qu'il est convenu d'appeler les "probabilités d'agrandissement" (1).

A) Probabilités d'agrandissement selon le rang

Les probabilités d'agrandissement n'ont pas été calculées de la façon habituelle par dérivation de la répartition des familles complètes selon le nombre d'enfants. Pour les enfants de rang n, on a déterminé la proportion de ceux d'entre eux qui étaient suivis d'au moins un enfant cadet, ce qui permet de distinguer selon que l'enfant de rang n est ou non décédé.

Le tableau I présente les probabilités d'agrandissement (pour les rangs $n = 1$ à 6) pour les catégories suivantes d'enfants de rang n :

1. tous les enfants de rang n (colonne e)
2. enfants de rang n décédés avant leur premier anniversaire (colonne d)
3. enfants de rang n non décédés avant leur premier anniversaire (colonne a), dont :
   a) enfants non décédés avant l'enquête (colonne b)
   b) enfants décédés entre leur premier anniversaire et la date de l'enquête (colonne c)
4. tous enfants de rang n décédés avant l'enquête (colonne f).

La catégorie 1 (colonne e) donne la mesure moyenne des probabilités d'agrandissement pour la population observée et donc de la fécondité des familles appartenant à notre échantillon. La catégorie 3a (colonne b) représente la fécondité consécutive à une naissance non suivie d'un décès et donne ainsi une approche de la fécondité sans phénomène de "remplacement". Mais elle écarte, comme on l'a déjà

(1) L. Henry. "Démographie, analyse et modèles". Larousse, Paris, 1972, 341 p. (on se reportera notamment aux pages 117 et 118).

TABLEAU I – REPARTITION DES ENFANTS DE RANG *n* SELON QU'ILS SONT DECEDES OU NON AVANT LEUR PREMIER ANNIVERSAIRE ET SELON QU'ILS ONT ETE OU NON SUIVIS D'UN AUTRE. FAMILLES COMPLETES (1).

Rang	Non décédé dans la première année			Décédé dans la première année de vie	Total général	Total des décédés
	Total (a)	Non décédé au moment de l'enquête (b)	Décédé après le premier anniversaire (c)	(d)	(e)	(f)
Enfants suivis d'un autre (1)						
1	48 132	44 899	3 233	2 827	50 959	6 060
2	28 319	26 426	1 893	1 772	30 091	3 665
3	16 367	15 369	998	1 085	17 452	2 083
4	9 643	9 080	563	691	10 334	1 254
5	5 854	5 502	352	515	6 369	867
6 et +	9 266	8 838	428	939	10 205	1 367
Total	117 581	110 114	7 467	7 829	125 410	15 296
Total enfants (2)						
1	70 267	66 163	4 104	3 336	73 603	7 440
2	49 149	46 475	2 674	2 434	51 583	5 108
3	29 033	27 630	1 403	1 610	30 643	3 013
4	16 835	16 054	781	1 018	17 853	1 799
5	9 889	9 440	449	744	10 633	1 193
6 et +	15 606	14 995	611	1 384	16 990	1 995
Total	190 779	180 757	10 022	10 526	201 305	20 548
Probabilités d'agrandissement : (1) x 1 000/(2)						
1	685	679	788	847	692	815
2	576	569	708	728	583	718
3	564	556	711	674	570	691
4	573	566	721	679	579	697
5	592	583	784	692	599	727
6 et +	594	589	700	678	601	685
	616	609	745	744	623	744

(1) Descendance de femmes mariées en premier mariage, encore mariées et âgées de 45 à 70 ans lors de l'enquête.

noté, le cas des enfants décédés après la naissance de leur cadet et peut de ce fait accentuer le biais dû à la liaison probable entre famille nombreuse et mortalité. Elle sous-estime légèrement la fécondité "en l'absence de remplacement". C'est l'inverse pour le total de la catégorie 3 (colonne a), qui néglige quant à elle le "remplacement" possible des enfants décédés à plus d'un an puisqu'elle nous indique la fécondité consécutive à une naissance non suivie d'un décès avant un an mais peut-être suivie d'un décès après un an. De ce point de vue, la vérité doit donc se trouver entre les deux. De toute manière, en raison de l'importance de la part relative de la catégorie 3a (qui se trouve incluse tant en 3 qu'en 1), les probabilités d'agrandissement diffèrent assez peu pour ces trois catégories (figure 1). De l'ordre de 68 ou 69 % pour le rang 1, elles tombent à 57-58 % pour le rang 2 et à 56-57 % pour le rang 3, puis remontent progressivement jusqu'à 58-60 % pour le rang 5 (les valeurs pour les rangs "6 ou plus" ayant moins de signification en raison de l'hétérogénéité de rang). La partie descendante de ces courbes, du rang 1 au rang 3 (on pourrait dire du rang 0 au rang 3 si on avait fait figurer l'intervalle protogénésique) traduit la diminution de fécondité à mesure de l'agrandissement de la famille qui affecte la majorité des familles françaises. Mais la remontée aux rangs suivants reflète la proportion croissante des familles plus fécondes dans l'ensemble des familles étudiées.

Quel que soit le rang, les probabilités d'agrandissement sont nettement plus fortes dans tous les cas où l'enfant de rang *n* est décédé que dans le cas contraire. Mais selon que l'on examine les enfants décédés avant ou après leur premier anniversaire, l'écart varie différemment.

Dans le premier cas (décès infantiles seuls), la probabilité d'agrandissement tombe de 85 % à 73 % puis à 67 %, du rang 1 aux rangs 2 et 3, et remonte légèrement aux rangs 4 (68 %) et 5 (69 %). Si on

compare ces chiffres à ceux obtenus pour les enfants non décédés avant un an, la "surfécondité" oscille alors entre 17 et 26 %, le maximum étant atteint par les enfants de rang 2 (Tableau II).

Cet écart est beaucoup plus irrégulier si l'on compare l'ensemble des enfants de rang *n* décédés aux enfants de rang *n* non décédés et plus encore si l'on compare à ce dernier les seuls enfants de rang *n* décédés après leur premier anniversaire. Dans ce dernier cas, l'écart passe en effet de 16 % au rang 1 à 24 % au rang 2, puis à 27-28 % aux rangs 3 et 4 pour atteindre brutalement 34 % au rang 5. Ces proportions exagèrent fortement, pour les rangs 3 et 5, la "surfécondité" recherchée. En effet, c'est dans les familles nombreuses, où il y a une plus forte mortalité, que le décès d'enfants de rang *n* postérieur à la naissance d'enfants de rang *n* + 1 a le plus de chance de perturber nos indices. Pour les rangs 6 et plus, cependant, la perturbation paraît moins forte. C'est peut-être parce que, à partir de rangs très élevés, on arrive d'une part à des familles fécondes et plus homogènes et d'autre part à des enfants encore trop jeunes lors de l'observation pour avoir eu le temps de décéder après une nouvelle naissance vivante.

De toute façon, les indices portant sur les décès de plus d'un an sont très fortement biaisés. C'est aux proportions du tableau II qu'il faut se référer.

Elles donnent à penser que le décès d'un enfant en bas âge entraîne un surcroît de fécondité de l'ordre de 20 à 25 % et que ce phénomène atteint son maximum lorsque l'enfant décédé est de rang 2 (tableau II).

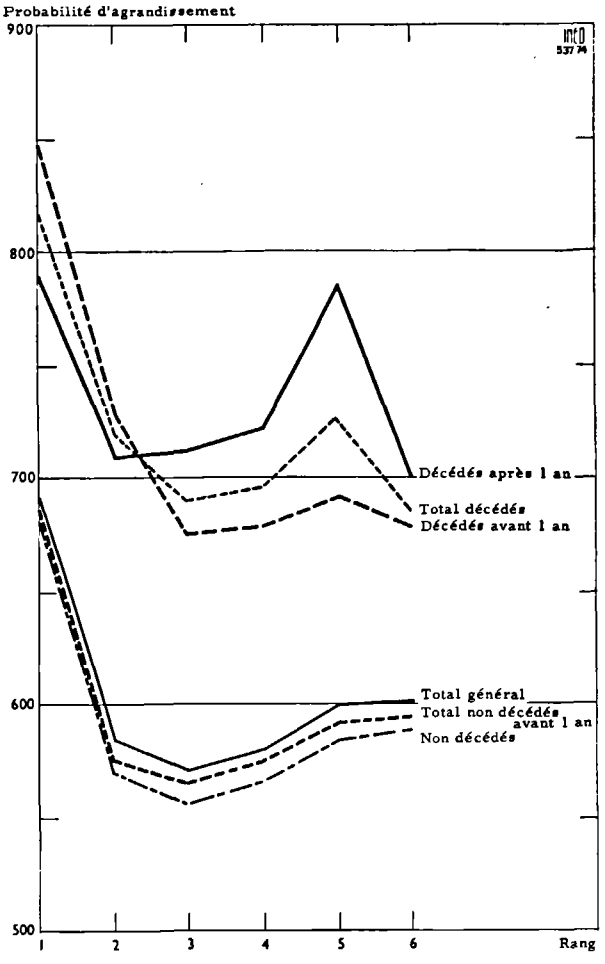

Figure 1 – Probabilités d'agrandissement selon le rang et la survie de l'enfant.

TABLEAU II – ECART ENTRE PROBABILITES D'AGRANDISSEMENT SELON QUE L'ENFANT DE RANG *n* EST DECEDE OU NON AVANT SON PREMIER ANNIVERSAIRE

Rang	Probabilité d'agrandissement			Surfécondité observée	
	Enfant de rang *n* décédé avant un an (1)	Enfant de rang *n* non décédé avant un an (2)	Enfant de rang *n* non décédé avant l'enquête (3)	1ère mesure 100 ((1) – (2))/(2)	2ème mesure 100 ((1) – (3))/(3)
1	847	685	679	24	25
2	728	576	569	26	28
3	674	564	556	20	21
4	679	573	566	18	20
5	692	592	583	17	19

Mais nous devons aussitôt nuancer cette affirmation car :

1) nous n'avons pas, pour un rang donné, éliminé le biais dû à la corrélation entre fécondité et mortalité infantile ;

2) nous ne pouvons pas comparer la surfécondité d'un rang à l'autre. Plus le rang est élevé, plus la population étudiée est féconde, et donc plus le champ possible de la "surfécondité" se restreint. Il n'est donc pas surprenant que la surfécondité diminue du rang 2 au rang 5 ; mais cela n'indique pas forcément une diminution, avec le rang, de la volonté de remplacement de l'enfant décédé. La plus grande "surfécondité" au rang 2 qu'au rang 1 peut au contraire correspondre à une réalité.

La perte d'un premier enfant peut amener des couples à se réfugier dans le modèle de la famille

sans enfant tandis que la perte d'un deuxième enfant, dont la venue avait manifesté la volonté (et la possibilité) de ne pas s'en tenir à l'enfant unique entraîne un plus vif désir de remplacement. Mais le tableau II ne donne en ce sens qu'une indication, pas une mesure.

Pour tenter d'échapper à la première difficulté, il faut constituer des groupes aussi homogènes que possible quant à la fécondité. L'enquête de 1962 nous permet de prendre en compte la catégorie socio-professionnelle du père.

B. Probabilités d'agrandissement par rang et par catégorie socio-professionnelle du père

Le tableau III compare pour chaque catégorie socio-professionnelle (C.S.P.) du père, la probabilité d'agrandissement de rang *n* selon que l'enfant de rang *n* est décédé avant son premier anniversaire ou encore en vie au moment de l'enquête (1). Les différences de fécondité entre C.S.P. sont importantes. La seconde partie du tableau (enfants de rang n non décédés) en donne une bonne idée. La probabilité d'agrandissement varie, au rang 1, de 588 pour les cadres moyens, à 775 pour les salariés agricoles. La surfécondité mesurée à l'intérieur d'une C.S.P. a toute chance d'être un meilleur indice du phénomène de "remplacement".

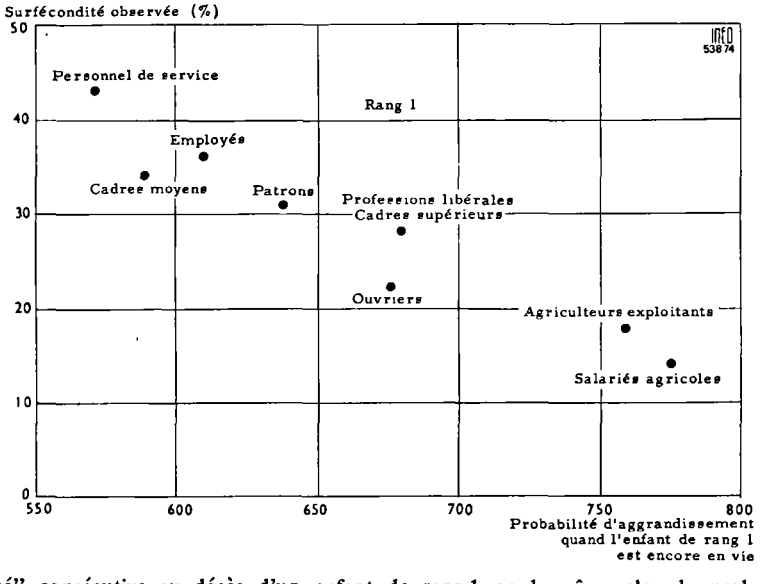

Figure 2 – "Surfécondité" consécutive au décès d'un enfant de rang 1 en bas âge selon la probabilité d'agrandissement observée quand l'enfant est encore en vie, par catégorie socio-professionnelle du père.

TABLEAU III – PROBABILITES POUR UN ENFANT DE RANG *n* D'ETRE SUIVI D'UN AUTRE SELON QU'IL EST DECEDE AVANT SON PREMIER ANNIVERSAIRE OU ENCORE EN VIE AU MOMENT DE L'ENQUETE (1), PAR CATEGORIE SOCIO-PROFESSIONNELLE DU PERE.

Catégorie socio-professionnelle	Probabilité d'agrandissement										Surfécondité observée [(a) – (b)] x 100/(b)				
	l'enfant de rang *n* est décédé avant un an (a)					l'enfant de rang *n* est encore en vie (b)									
	n = 1	2	3	4	5	*n* = 1	2	3	4	5	*n* = 1	2	3	4	5
Agriculteurs exploitants	897	750	664	685	742	760	630	597	584	603	18	19	11	17	23
Salariés agricoles	882	801	750	806	730	775	653	638	686	642	14	23	18	17	14
Patrons du commerce et Industrie	836	690	657	611	596	638	497	470	501	486	31	39	40	22	23
Prof. libérales et cadres sup.	869	679	595	452	529	679	535	529	482	508	28	27	12	–6	4
Cadres moyens	788	701	605	600	545	588	467	426	424	504	34	50	42	42	8
Employés	828	695	703	671	545	609	511	492	534	566	36	36	43	26	–4
Ouvriers	829	740	677	703	711	677	582	582	588	595	22	27	16	20	20
Total	847	728	674	679	692	679	569	556	566	583	25	28	21	20	19

(1) On sait que cette comparaison exagère sans doute légèrement la "surfécondité" recherchée, mais il nous a paru plus simple de ne présenter ici qu'une des deux bornes proposées au tableau II.

(1) Pour être tout à fait rigoureux, on aurait dû utiliser la même fourchette qu'au tableau II, en considérant aussi le cas de tous les enfants non décédés avant un an, mais la différence est si faible qu'il nous a semblé inutile d'encombrer davantage le tableau III.

En revanche, les comparaisons entre catégories socio-professionnelles sont délicates. Plus une C.S.P. est féconde, plus la "surfécondité" observée est faible. Cette relation est très nette aux rangs 1 (figure 2), 2, 3 et 4, et si elle n'est pas vérifiée au rang 5 c'est sans doute en raison du petit nombre d'observations dont on dispose pour ce rang. Elle n'est en fait que la transposition, sur un autre plan, du lien déjà constaté entre "surfécondité" et rang. La "surfécondité" varie en fonction de la loi de fécondité qui prévaut dans la C.S.P., mais cela n'indique pas nécessairement que la "volonté de remplacer" un enfant décédé varie avec la catégorie socio-professionnelle.

Faut-il attribuer plus de sens aux variations par rang de la "surfécondité" pour une C.S.P. donnée (figure 3) ? Cette question est encore plus complexe. La prise en compte de la C.S.P. introduit, il est vrai, un facteur d'homogénéité mais, afin de limiter l'effet des variations aléatoires, le découpage retenu ici ne pouvait être que très grossier et les différences entre femmes d'une même catégorie trop larges. Les résultats de l'enquête "familles" font en effet apparaître de grandes disparités, à l'intérieur d'une même catégorie, selon la profession, l'âge au mariage, le niveau d'instruction, le degré d'urbanisation, etc.

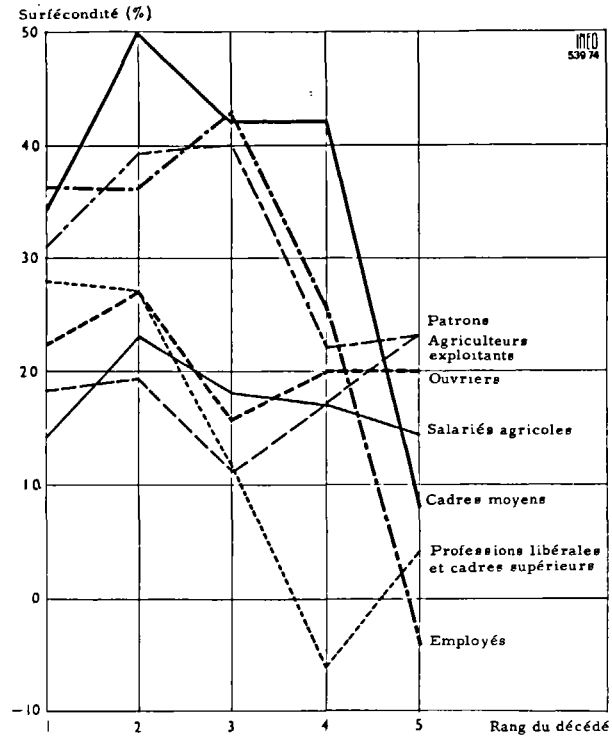

Figure 3 – "Surfécondité" consécutive au décès d'un enfant en bas âge selon le rang de naissance du décédé et la catégorie socio-professionnelle du père.

Le biais introduit par la sélection des familles touchées par la mortalité infantile ne doit donc pas être totalement effacé et il demeure qu'en passant d'un rang à l'autre, on passe aussi à des groupes de familles de plus en plus fécondes.

C. Probabilités d'agrandissement selon le rang et le sexe de l'enfant

Le rapport de masculinité à la naissance étant largement indépendant du comportement fécond des couples, il est en revanche possible, avec les données dont nous disposons, de déceler l'influence éventuelle du sexe du décédé sur la "surfécondité" consécutive à un décès. Sans obtenir une mesure exacte du remplacement, on peut obtenir les termes d'une comparaison.

Le tableau IV donne les probabilités d'agrandissement selon la survie et le sexe de l'enfant de rang *n*. Que ce dernier soit décédé avant un an ou non, la probabilité qu'il soit suivi d'une autre naissance est indépendante de son sexe. Le rapport des deux probabilités oscille en effet entre 0,98 et 1,02 quand l'enfant est encore en vie, entre 0,96 et 1,04 lorsqu'il est mort en bas âge. Ces fluctuations paraissent purement aléatoires et, si elles sont plus fortes dans le second cas, c'est que nos observations sont moins nombreuses. Pour les mêmes raisons, *les indices de "surfécondité" consécutive au décès ne diffèrent pas significativement selon que le décédé est un garçon ou une fille* (figure 4).

TABLEAU IV – ECART ENTRE PROBABILITES D'AGRANDISSEMENT SELON QUE L'ENFANT DE RANG *n* EST DECEDE AVANT SON PREMIER ANNIVERSAIRE OU ENCORE EN VIE AU MOMENT DE L'ENQUETE ET SELON LE SEXE DE L'ENFANT DE RANG *n*

Rang	Probabilité d'agrandissement						Surfécondité observée %	
	Enfant de rang *n* décédé avant un an			Enfant de rang *n* non décédé avant l'enquête				
	S.M.	S.F.	SM/SF	S.M.	S.F.	SM/SF	S.M.	S.F.
1	849	844	101	684	672	102	24	26
2	739	712	104	566	570	99	31	25
3	665	685	97	555	556	100	20	23
4	687	668	103	558	572	98	23	17
5	691	692	100	582	582	100	19	19
6 et +	666	694	96	586	592	99	14	17

Ce résultat n'est pas sans intérêt. On ne sait pas, en effet, quelles conséquences aurait la possibilité pour les couples de choisir le sexe de leurs enfants, mais toute préférence marquée pour l'un ou l'autre sexe pourrait évidemment déséquilibrer la structure de la population. Si une telle préférence existait, on devrait probablement constater chez les couples ayant perdu un enfant en bas âge une volonté de remplacement différente selon le sexe de cet enfant, ce qui n'est pas le cas sur la base des données présentées plus haut.

Cette "indifférence" au sexe est-elle le fruit d'une compensation entre des préférences contraires selon le milieu social ? Il ne semble pas. En effet, les fluctuations de nos indicateurs par C.S.P. paraissent purement aléatoires.

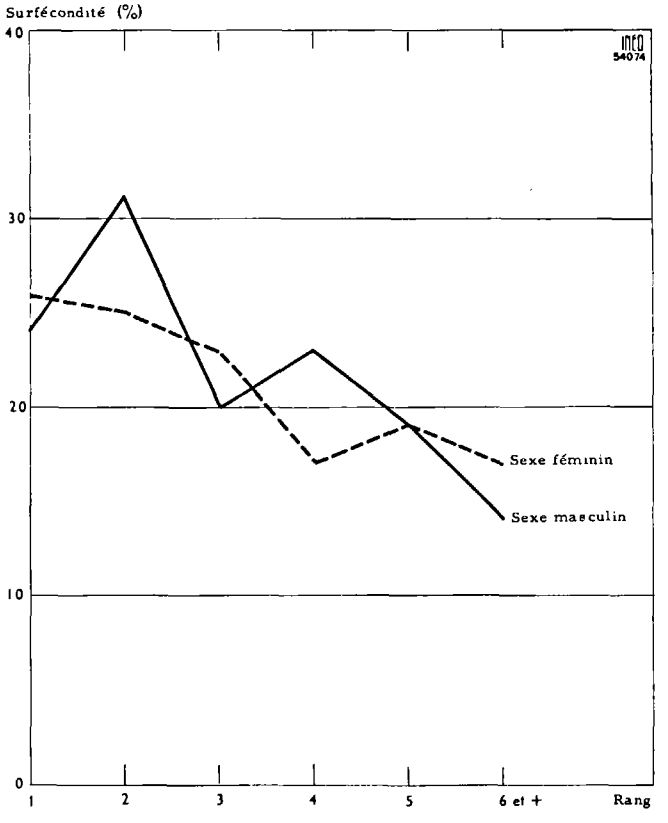

Figure 4 – "Surfécondité" consécutive au décès d'un enfant selon son rang et son sexe.

D. Probabilités d'agrandissement selon le rang et le groupe d'années de naissance de la mère

Le champ d'observation dont nous disposons pour les familles complètes porte sur les générations féminines nées de 1892 à 1916. Il est un peu trop étroit pour comparer l'évolution dans le temps de nos indices avec celle de la fécondité (Tableau V). Quelques remarques s'imposent cependant.

Nous ne retiendrons que les rangs 1 et 2 afin d'éviter les trop petits nombres d'observations. Alors que les probabilités d'agrandissement en l'absence de décès augmentent sensiblement d'un groupe de générations à l'autre (1), tant pour le rang 1 que pour le rang 2, l'indice de "surfécondité" diminue au rang 1 et augmente au rang 2.

TABLEAU V – PROBABILITES POUR UN ENFANT DE RANG *n* D'ETRE SUIVI D'UN AUTRE SELON QU'IL EST DECEDE AVANT SON PREMIER ANNIVERSAIRE OU ENCORE EN VIE AU MOMENT DE L'ENQUETE, PAR GROUPE DE GENERATIONS DE LA MERE

Générations	Probabilité d'agrandissement										"Surfécondité" observée 100 x [(a) – (b)]/(b)				
	L'enfant de rang *n* est décédé avant un an (a)					L'enfant de rang *n* est encore en vie (b)									
	n = 1	2	3	4	5	*n* = 1	2	3	4	5	*n* = 1	2	3	4	5
1892-99	835	699	651	647	689	658	545	540	553	586	27	28	21	17	18
1900-04	838	698	662	684	610	659	563	573	569	595	27	24	16	20	3
1905-09	848	750	669	690	700	669	573	561	586	585	27	31	19	18	20
1910-14	865	749	693	686	744	709	579	553	558	572	22	29	25	23	30
1915-16	872	812	750	714	780	734	609	550	547	558	19	33	36	31	40
	847	728	674	679	692	679	569	556	566	583	25	28	21	20	19

(1) La fécondité des générations est passée en France par son minimum pour les générations nées vers 1895 et elle n'a cessé d'augmenter pour les générations postérieures entrant dans le champ de l'enquête.

Ainsi, pour le rang 1, l'évolution de la "surfécondité" pourrait provenir du défaut déjà évoqué de notre indice ; mais pour le rang 2, ce défaut ne peut qu'atténuer la tendance constatée qui doit donc correspondre à une réalité. *La volonté de remplacer un enfant décédé de rang 2 a augmenté d'un groupe de générations à l'autre, quand la fécondité augmentait.*

On retrouve là l'idée, déjà émise, du refus de l'enfant unique par des couples qui ont perdu en bas âge un enfant de rang 2. Ce refus se serait renforcé en période de hausse de la fécondité, ce qui paraît normal.

La figure 5 ne nous donne, en revanche, aucune certitude sur l'évolution de la "surfécondité" au rang 1. On ne sait pas, en effet, ce qui, dans la tendance observée, tient à l'évolution du phénomène étudié et ce qui tient au défaut de l'indice employé.

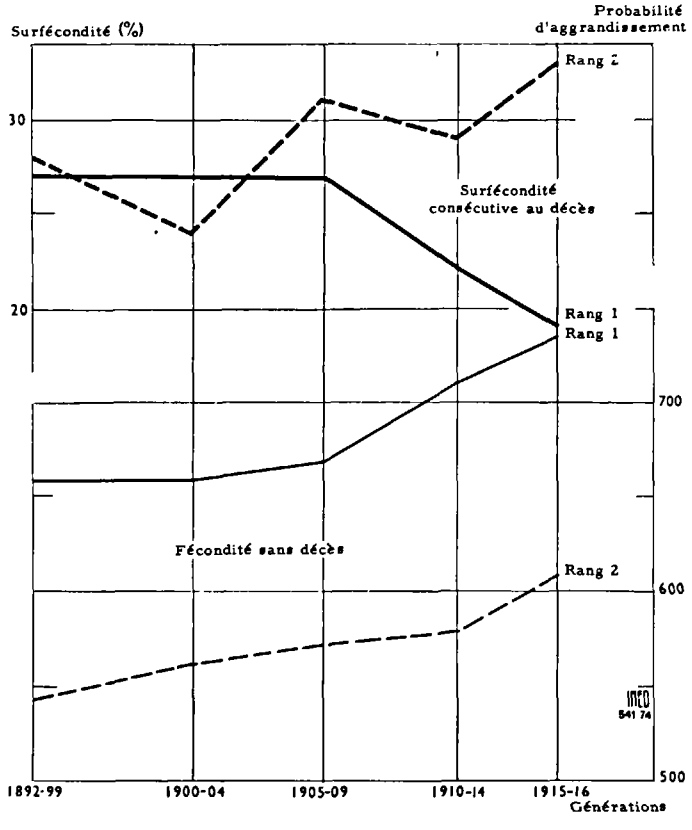

Figure 5 – Evolution comparée (par groupe de générations de mères) de la fécondité et de la "surfécondité" consécutive au décès d'un enfant de rang 1 ou 2.

II – Estimation de la "surfécondité" à l'aide de l'intervalle de temps moyen entre naissances

On peut penser qu'une certaine "volonté de remplacement" d'un enfant décédé en bas âge se traduit par un raccourcissement de l'intervalle de temps qui sépare la naissance de cet enfant de la naissance de l'enfant suivant, lorsqu'il y en a un. Pour les raisons exposées précédemment, nous nous contenterons d'examiner le cas des enfants décédés avant 1 an et de le comparer à celui des enfants survivants à la date de l'enquête.

Après le décès d'un enfant, par maladie ou accident, avant son premier anniversaire, ses parents peuvent avoir des attitudes différentes, variant selon la cause du décès, le rang de l'enfant décédé et le nombre total d'enfants qu'ils désirent. Ils réaliseront généralement leur souhait, par exemple en ayant rapidement un nouvel enfant.

Pour chiffrer cela, nous avons calculé l'intervalle de temps moyen écoulé entre une naissance de rang n et la naissance suivante selon que l'enfant de rang n est décédé avant 1 an ou encore en vie au moment de l'enquête, pour des catégories de familles complètes caractérisées par leur nombre final d'enfants. On notera que ces catégories sont homogènes du point de vue de la fécondité totale, ce qui élimine l'objection formulée ci-dessus (partie I) quant au biais introduit par la liaison mortalité infantile-

fécondité. Le tableau VI présente les résultats obtenus pour les familles de tailles finales 2,3,4,5 et 6 enfants. Les deux dernières colonnes donnent les écarts absolus et relatifs entre les moyennes figurant dans les colonnes (a) et (b), exprimées en années, dixièmes et centièmes d'années.

TABLEAU VI – INTERVALLE DE TEMPS MOYEN ECOULE ENTRE UNE NAISSANCE DE RANG *n* ET LA NAISSANCE SUIVANTE, SELON QUE L'ENFANT DE RANG *n* EST DECEDE AVANT 1 AN OU ENCORE EN VIE AU MOMENT DE L'ENQUETE

Nombre final d'enfants de la famille	Rang	L'enfant de rang *n* est :		Ecart absolu	Ecart relatif
		décédé avant 1 an (a)	encore en vie (b)	(a) – (b)	100 × [(b) – (a)]/(b)
2	1	3,17	4,14	0,97	23
3	1	2,43	3,35	0,92	27
3	2	3,39	4,19	0,80	19
4	1	2,16	2,77	0,61	22
4	2	2,48	3,43	0,95	28
4	3	3,26	4,06	0,80	20
5	1	1,83	2,44	0,61	25
5	2	2,33	2,88	0,55	19
5	3	2,64	3,33	0,69	21
5	4	3,18	3,90	0,72	18
6	1	1,58	2,13	0,55	26
6	2	1,94	2,48	0,54	22
6	3	2,35	2,76	0,41	15
6	4	2,55	3,06	0,51	17
6	5	3,04	3,71	0,67	18

On sait que les décès infantiles surviennent pour la plupart au cours des premiers mois et même des premières semaines de la vie, soit, en moyenne, environ 3 mois après la naissance pour les enfants concernés par cette étude. A cette période moyenne de 3 mois (ou 0,25 année), s'ajoute le temps nécessaire pour que le couple retrouve son équilibre et exprime, s'il le désire et s'il ne l'a pas déjà fait auparavant, sa volonté d'avoir un autre enfant. Malgré cela, la naissance suivante est observée, dans toutes les conditions de rang et de taille finale de la famille (à une seule exception près), avec 6 mois à 1 an d'avance sur le calendrier moyen des familles qui n'ont pas été frappées par le décès d'un enfant âgé de moins d'un an. L'écart est surtout important, et voisin de l'année, dans les familles de 2,3 et 4 enfants lorsque l'enfant décédé est, respectivement, le premier, le premier ou le second, le second ou le troisième. Lorsque l'intervalle moyen est, normalement, assez court, il ne peut pas être réduit dans de fortes proportions. C'est ce qu'on observe par exemple dans les familles de 4 enfants, intervalle 1ère naissance – 2e naissance, de 5 enfants, intervalles 1ère naissance – 2e naissance et 2e naissance – 3e naissance, etc.

L'écart relatif apporte donc une information supplémentaire et il est remarquablement stable (compris entre 15 et 28) ; ainsi, en cas de décès infantile, le raccourcissement de l'intervalle moyen entre naissances est généralement de l'ordre du quart ou du cinquième.

Compte tenu du nombre assez faible d'observations dont nous disposons dans le cas où l'enfant est décédé avant 1 an, nous ne commenterons pas les différences constatées entre les écarts relatifs bien que celles-ci correspondent convenablement aux idées et aux objectifs, en matière de constitution de la famille, qu'on peut prêter aux couples, selon la situation où ils sont déjà parvenus et la situation qu'ils atteindront.

Plus que l'écart entre les moyennes, les différences entre les répartitions soulignent une certaine volonté de remplacement car elles mettent en évidence le rapprochement de la naissance, et donc de la conception de l'enfant suivant, lorsque l'enfant considéré est mort avant 1 an. Faute de temps, nous avons dû nous limiter provisoirement au cas des familles ayant finalement deux enfants (Tableau VII et figure 6).

En cas de décès, la répartition des naissances de rang 2 est très fortement modifiée : *les naissances surviennent beaucoup plus tôt* et *le surcroît de natalité s'observe surtout entre 0,8 et 2 ans,* ce qui était tout à fait prévisible. Par exemple, alors qu'environ 20 % des naissances de rang 2 arrivent entre 1 an et 2 ans après la 1ère naissance si le premier enfant est encore en vie à la date de l'enquête (cas 1), ce pourcentage s'élève à 31 % en cas de décès avant 1 an (cas 2), soit une augmentation de moitié.

TABLEAU VII – REPARTITION DES NAISSANCES DE RANG 2 SELON LE TEMPS ECOULE DEPUIS LA NAISSANCE PRECEDENTE, SELON QUE L'ENFANT DE RANG 1 EST ENCORE EN VIE A LA DATE DE L'ENQUETE OU DECEDE AVANT 1 AN
(répartition pour 1 000 naissances de rang 2, temps exprimé en années et centièmes d'année)

	0,00 à 0,09	0,10 à 0,79	0,80 à 0,99	1,00 à 1,49	1,50 à 1,99	2,00 à 2,99	3,00 à 4,99	5,00 à 8,99	9,00 ou plus	Total
Nombre absolu (1)	236	424	266	1 824	1 978	3 184	4 939	5 409	746	19 006
Fréquence	12	22	14	96	104	168	260	285	39	1 000
Nombre absolu (2)	25	14	25	125	131	178	184	126	17	825
Fréquence	30	17	30	151	159	216	223	153	21	1 000

(1) L'enfant de rang 1 est encore en vie à la date de l'enquête.
(2) L'enfant de rang 1 est décédé avant 1 an.

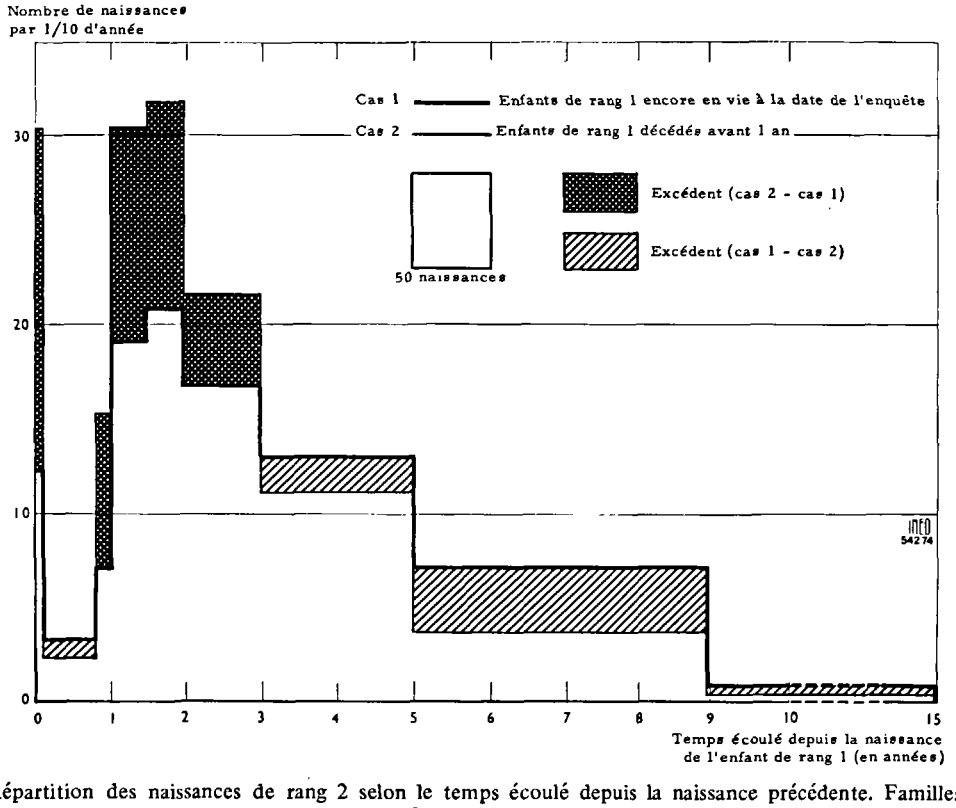

Figure 6 – Répartition des naissances de rang 2 selon le temps écoulé depuis la naissance précédente. Familles "complètes" ayant eu, au total, 2 enfants. (pour 1 000 naissances de rang 2)

Le fort surcroît de naissances observé au cours du premier dixième d'année provient de la méthode de codification : il traduit la mortalité plus forte des jumeaux...

L'étude des répartitions représentées figure 6 complète donc l'information fournie par les moyennes (Tableau VI) ; nous avons étendu cette étude à d'autres catégories de familles et obtenu des résultats tout à fait analogues.

III – Données nécessaires à une meilleure approche du phénomène

Tout au long de cette étude, nous nous sommes heurtés à deux obstacles :

– la liaison entre mortalité infantile et fécondité,

– la dépendance à l'égard de la fécondité des variables (rang de naissance, C.S.P.) que l'on aurait souhaité croiser avec le phénomène étudié.

Les deux obstacles, en fait, se résument en un seul et même problème : sélectionner pour chaque groupe de familles affectées par la mortalité infantile, un groupe témoin de familles exemptes de mortalité infantile, mais de fécondité égale à celle que le premier groupe aurait eue en l'absence de mortalité.

Les données utilisées ne permettent pas d'y parvenir. On sait donc seulement qu'*il existe une "surfécondité" consécutive à la mort d'un enfant en bas âge,* mais on n'a pu

– ni en mesurer l'intensité,

– ni faire de comparaisons efficaces d'un groupe à l'autre (sauf quant au sexe de l'enfant et, très partiellement, quant à la génération de femmes concernées).

Il nous semble qu'il serait possible d'aller plus loin en constituant des groupes de familles plus homogènes quant à la fécondité.

Deux critères nous paraissent utiles dans la mesure où ils permettent a priori une sélection des familles en fonction de la fécondité :

– l'âge au mariage de la mère,

– la durée écoulée entre l'enfant considéré et le précédent.

Un croisement de ces facteurs serait encore plus efficace, mais risque de nous conduire très vite à de trop petits nombres d'observations.

Les tableaux nécessaires viennent d'être obtenus et nous fournissent les résultats suivants :

– l'âge de la femme à son mariage n'est pas un facteur qui joue sur le niveau de "surfécondité".

– en revanche, en fonction du temps écoulé depuis la naissance précédente (ou le mariage, si on considère le premier enfant), la surfécondité varie beaucoup : plus la naissance précédente est ancienne, plus la "surfécondité" est importante. Ceci peut être observé pour chaque rang de naissance. La comparaison entre les rangs 1 et 2 conduit à mettre en doute le sens de la différence précédemment observée (cf. pages 9 et 10) entre les surfécondités à ces rangs : ici, à chaque durée, la différence est inverse ! Toutefois, on peut affirmer à juste titre que l'intervalle entre mariage et 1ère naissance n'est pas de même nature que celui entre 1ère et 2e naissances et ainsi de suite. Il est possible qu'un classement en fonction du seul intervalle mariage-1ère naissance aurait été plus efficace.

On pourrait aussi améliorer l'approche de la "surfécondité" consécutive au décès d'un enfant en bas âge, en considérant non plus la fécondité après la naissance d'un enfant décédé en bas âge, mais la fécondité après le décès en bas âge d'un enfant.

Pour ce faire, il faut considérer des femmes de même parité et comparer, à chaque durée écoulée depuis la naissance du dernier enfant, la fécondité sans décès (ou avant le décès éventuel) à la fécondité après un décès. Ceci devrait être fait, bien entendu, pour des groupes de femmes homogènes quant à leur fécondité. Une telle analyse dépasse à première vue les possibilités de l'enquête "familles" de 1962.

INFLUENCE OF CHILD MORTALITY ON FERTILITY IN THE EUROPEAN DEMOGRAPHIC TRANSITION : RESULTS FROM AGGREGATE DATA

P. C. MATTHIESSEN
Professor, Statistical Institute,
University of Copenhagen

SUMMARY

The present paper tries to evaluate the preliminary results obtained from the Princeton European Fertility Project. This project is based on data on the aggregate level, namely the level of childbearing and a number of economic, social and demographic factors in each of the 700 provinces in Europe from the time of the French Revolution until the end of the fertility decline. As the project is not yet concluded, it has only been possible to include results from the following eight European countries: Germany, United Kingdom, Denmark, Belgium, France, Portugal, Italy and Russia.

The results from these countries made it clear that no firm conclusions can be drawn on the relationship between child mortality and marital fertility in Europe during the demographic transition. Comparing the different countries, the results are often contradictory.

Only some of the countries disclosed a clearly positive correlation between mortality and fertility before the fertility decline. Even these countries could not provide firm evidence that local pre-decline populations "adjusted" fertility to mortality levels. Both variables could have been dependent on other factors.

Further, it is evident from the analysis that a decline in child mortality is not a necessary prerequisite for the occurrence of a decline in fertility. Both Germany and Belgium gave examples of a limitation of birth which preceded the mortality decline, in Belgium by 25 years or more.

It seems also possible to have a strong decline in infant mortality without any decrease in fertility. The infant mortality rate in Sweden decreased from about 200 per thousand before 1800 to 130 per thousand in 1871 – 80 without any decline of fertility.

The main difficulty in obtaining information on the relationship between these two variables from European data is caused by the fact that fertility depends on many factors and their interplay. The relationship between child mortality and fertility is observed in situations where many other factors are also acting upon fertility. For this reason alone, the correlation between the two variables can be rather slight. This element is especially important in the European case, where the changes in child mortality occurred as an integral part of the economic and social transformation of society, and where it is clear that the response of different populations to changes in external factors was not the same.

Therefore, fertility decline can occur in combination with very different levels of infant mortality. It happens that a fertility decline could occur, when infant mortality was as high as 221 per thousand (Germany). On the other hand, the decline of fertility in Norway did not begin before infant mortality was as low as 76 per thousand. But it should be stressed that in all countries, a strong and sustained decline in fertility has not occurred without a substantial reduction in infant mortality.

In many ways, the application of the European experience to the present situation in the developing countries calls for a good deal of caution. The change of child mortality in Europe took place simultaneously with many economic and social factors, which completely transformed the society. Here, one could speak of a kind of parallellism, between the change of child mortality and other factors, which makes it difficult to isolate the influence of mortality on fertility and would also diminish the independent role to be played by mortality.

In the developing countries, child mortality has declined much faster than in Europe. In many instances, it has been ahead of the economic and social transformation of society. In these countries, mortality will have a greater possibility of playing an independent role in influencing fertility. On the other hand, we do not yet know to what extent mortality will act upon fertility, without simultaneous transformation of society. To this important question, the European data can yield no answer.

RÉSUMÉ

Dans la présente communication nous essayons d'examiner la valeur des résultats fournis par le projet de Princeton sur la fécondité en Europe. Ce projet s'appuie sur des données d'ensemble pour estimer la fécondité en relation avec divers facteurs économiques, sociaux et démographiques dans chacune des 700 provinces européennes depuis la Révolution française jusqu'à la fin du déclin de la fécondité. Comme cette vaste enquête n'est pas terminée, on n'a pu utiliser que les résultats portant sur les 8 pays suivants : Allemagne, Royaume-Uni, Danemark, Belgique, France, Portugal, Italie et Russie.

Pour ces pays, il apparaît clairement qu'on ne peut parvenir à des conclusions sûres à propos de la relation entre la mortalité des enfants et la fécondité légitime au cours de la transition démographique. Si on compare ces différents pays, les résultats sont souvent contradictoires.

Dans quelques pays seulement, une corrélation manifestement positive est apparue entre la mortalité et la fécondité avant le déclin de celle-ci. Cependant, même dans ces pays, on n'a pu prouver de manière irréfutable que, dans les populations, avant le déclin, la fécondité s'adaptait à la mortalité. Ces deux variables en effet, dépendaient peut-être d'autres facteurs.

En outre, cette analyse prouve que le recul de la mortalité n'est pas une condition nécessaire pour qu'apparaisse le déclin de la fécondité. L'Allemagne et la Belgique en donnent un bon exemple car la limitation des naissances y a précédé le déclin de la mortalité (de 25 ans ou plus en Belgique).

Il semble également possible d'avoir une forte baisse de la mortalité infantile sans que, pour autant, apparaisse une diminution de la fécondité. En Suède, le taux de mortalité infantile est passé de 200 pour 1000 avant 1800 à 130 pour 1000 en 1871-1880 sans que se produise une baisse de la fécondité.

S'il est si difficile d'étudier la relation entre ces deux variables à partir des données européennes, c'est parce que la fécondité dépend de nombreux facteurs et de leurs effets réciproques. La relation entre la mortalité des enfants et la fécondité apparaît dans des situations où de nombreux autres facteurs agissent également sur la fécondité. Pour cette raison seulement, la corrélation entre les deux variables peut être très faible. Il en va particulièrement ainsi dans le cas de l'Europe où l'évolution de la mortalité des enfants était liée aux transformations économiques et sociales et où manifestement les populations réagissaient de

manière différente aux changements qui survenaient dans les conditions extérieures.

Par conséquent, une baisse de la fécondité peut se produire lorsque la mortalité des enfants se trouve à des niveaux fort différents. Par exemple, en Allemagne, elle est apparue alors que la mortalité infantile était encore à 221 pour 1000. Au contraire, en Norvège le déclin de la fécondité n'a guère commencé avant que la mortalité infantile soit tombée à 76 pour 1000. Mais il convient de souligner que dans tous les pays, un déclin important et continu de la mortalité ne s'est guère produit sans une forte baisse de la mortalité infantile.

A bien des égards, il convient de se montrer très prudent si on essaie d'appliquer ce qui s'est passé en Europe à ce qui se passe actuellement dans les pays en voie de développement. La baisse de la mortalité infantile en Europe s'est produite en même temps que de nombreux changements économiques et sociaux qui transformaient complètement la société. On pourrait tout au plus parler d'un parallélisme entre l'évolution de la mortalité infantile et d'autres facteurs, de sorte qu'il est difficile d'isoler l'influence de la mortalité sur la fécondité. Le rôle indépendant joué par la mortalité s'en trouve de ce fait diminué.

Dans les pays en voie de développement, la mortalité des enfants a baissé beaucoup plus vite qu'en Europe. Dans de nombreux cas, elle a précédé les transformations économiques et sociales de la société. Dans ces pays, le rôle de la baisse de la mortalité sur celle de la fécondité se fera sentir davantage indépendamment des autres facteurs. Par contre nous ne savons pas encore dans quelle mesure l'évolution de la mortalité influencera celle de la fécondité si elle ne s'accompagne pas d'une transformation de la société. Les données européennes ne peuvent fournir de réponse à ces questions importantes.

RESUMEN

Este documento trata de evaluar los resultados preliminares obtenidos a través del Programa de Estudios de la Fecundidad Europea realizado por la Universidad de Princeton. Este proyecto está basado en el análisis de datos en el nivel global, principalmente sobre la fecundidad y varias características económicas, sociales y demográficas de cada una de las setecientas provincias de Europa, desde la época de la Revolución Francesa hasta el término de la transición de la fecundidad. Debido a que el proyecto no está terminado sólo fue posible incluir los resultados correspondientes a los siguientes ocho países europeos :

Alemania, Reino Unido, Dinamarca, Bélgica, Francia, Portugal, Italia y Rusia.

Los resultados obtenidos para estos países permiten afirmar desde ya, que no es posible extraer conclusiones definitivas acerca de las relaciones entre la mortalidad de la niñez y la fecundidad marital en Europa, durante la época de transición demográfica. Más aún, al comparar los diferentes países los resultados son a menudo contradictorios.

Sólo algunos de los países revelaron una correlación claramente positiva entre mortalidad y fecundidad antes de la declinación de la fecundidad. Pero aún esos países no pueden proporcionar una evidencia segura de que en las poblaciones locales anteriores a la declinación, la fecundidad se "ajustara" a la mortalidad. Ambas variables podrían haber dependido de otros factores.

Más aún, del análisis se desprendre, con bastante evidencia, que la reducción de la mortalidad no es necesariamente un requisito anticipado para que ocurra la baja de la fecundidad. Tanto Alemania como Bélgica proporcionan ejemplos de reducción de la natalidad con anterioridad a la baja de la mortalidad. En el caso de Bélgica, con veinticinco años o más de anticipación.

Incluso parece también posible que se haya producido una profunda reducción de la mortalidad infantil sin ninguna disminución de la fecundidad. La mortalidad infantil en Suecia disminuyó desde alrededor de 200 por mil con anterioridad a 1800, hasta el 13 por mil en 1871-1880 sin declinación alguna de la fecundidad.

La dificultad principal para obtener información acerca de las interrelaciones entre estas dos variables, a partir de los datos europeos, reside en el hecho de que la fecundidad depende de muchas variables y de su juego recíproco. Las relaciones entre la mortalidad de la niñez y la fecundidad es observada en situaciones en las cuales muchos otros factores están actuando sobre la fecundidad. Sólo por esta razón, la correlación entre estas dos variables puede ser más bien débil. En el caso europeo esta circunstancia es especialmente importante, ya que en esta región los cambios en la mortalidad de la niñez ocurrieron como una parte integrante del conjunto en el proceso de transformaciones económicas y sociales de la sociedad. Aquí también se observa con claridad que las distintas poblaciones no reaccionan de la misma forma frente a los cambios de los factores externos.

Más aún, la declinación de la fecundidad puede ocurrir en combinación con muy diferentes niveles de mortalidad infantil. En el caso de Alemania, la fecundidad experimentó una disminución cuando la mortalidad infantil era sumanente elevada, 221 por mil. En cambio, en Noruega, la disminución de la fecundidad no empezó sino cuando la mortalidad infantil había alcanzado un nivel relativamente bajo, 76 por mil. Pero debe ser destacado que en todos los países no ha ocurrido una profunda y substancial disminución de la fecundidad sin una substancial disminución de la mortalidad infantil.

Por muchos motivos deben tomarse muchas precauciones si se quiere aplicar la experiencia europea a la actual situación de los países en desarrollo. El cambio de la mortalidad infantil se produjo en Europa simultáneamente con una variedad de factores económicos y sociales que transformaron completamente la sociedad. Aquí puede hablarse de una especie de paralelismo entre el cambio de la mortalidad infantil y de los demás factores. Esto hace difícil aislar la influencia de la mortalidad sobre la fecundidad y puede incluso disminuír el rol independiente que debe haber jugado la natalidad.

En los países en desarrollo, la mortalidad infantil ha disminuído mucho más rapidamente que en Europa. En muchos casos ha ido a la cabeza de la transformación económica y social de la sociedad. En estos países la mortalidad tendrá una mayor posibilidad de jugar un rol independiente de influenciar la fecundidad. Por otra parte, no sabemos todavía hasta que punto la mortalidad puede actuar sobre la fecundidad, sin una transformación simultánea de la sociedad. A esta importante pregunta los datos europeos no pueden entregar una respuesta.

Introduction

The theme indicated in the title of the paper belongs to the classical ones in demography. Although a good deal of research has been devoted to clarify this relationship, no conclusive answer has been attained so far. The present paper is somewhat narrow in coverage, as it will only evaluate the preliminary results obtained from the Princeton European Fertility Project. This project was planned about 10 years ago, under the direction of Professor Ansley Coale at the Office of Population Research in Princeton. It intended "to examine in some detail the decline of fertility in Europe since the time of the French Revolution. The purpose of the project is to record the fall in the rate of childbearing in each of the more than 700 provinces of Europe in terms of a uniform set of indexes and to determine, as well as possible, the social and economic conditions under which the decline occurred" [1]. Hence, the Princeton European Fertility Project is based on aggregate data and the results used in the following constitute only a small part of it. (1).

(1) I would like to express my gratitude to the participants in the Princeton European Fertility Project for being cooperative in providing me with information on their part of the project. I have had access to still unpublished manuscripts and some of the participants have produced research notes exclusively for the present paper. Professor Ansley J. Coale has been kind enough to read a preliminary draft and make valuable comments. Any error and misinterpretation are my own responsibility.

Through these data we will investigate such questions as : Is there any evidence that local pre-decline populations "adjusted" fertility to mortality levels ?

Is a decline in child mortality a necessary prerequisite for the occurrence of a decline in fertility ?

Is a sizeable decline of child mortality enough to produce automatically a decline in fertility ?

What can be said about the time lag between child mortality and fertility ?

Evaluating the results of the project in relation to such questions represents a rather difficult job. As the Project is not yet finished, the choice of countries to be included in the present paper has not been determined by any kind of logic. One has simply had to use the research that is finished or semi-finished until now. The great variability in the amount and quality of the data from country to country has necessitated a distinctive type of analysis for investigating the relationship between mortality and fertility. Another difficulty is caused by the fact that the results are not conclusive.

Due to lack of data, it has not been possible to calculate child mortality by province in all cases (e.g. defined as the mortality loss until age 15). Instead, infant mortality is used. This is defined as the ratio of the number of infant deaths to the number of live births during the same time period. The application of infant mortality instead of child mortality should not influence the outcome of the analysis, as there usually is a strong association between infant and child mortality.

For all provinces, the level of fertility is measured by an index of overall fertility and of marital fertility. The first index is defined as the ratio of the total number of births in the province to the number that would be born if *all* females at each age bore children at the rate of the most fertile population on record. The index for marital fertility is defined as the ratio between the total number of legitimate births in the province and the number that would be born if married females at each age bore children at the rate of the most fertile population on record.

The population used as the most fertile population on record is that of the married Hutterite women. The Hutterites are a religious sect – living in USA – which does not practise any form of birth control.

Before we turn our attention to the results from the individual countries, we will briefly consider the ways in which a decline in child mortality could influence the level of fertility.

Involuntary

When extended breastfeeding is the usual practice, the death of a child can interrupt the period of nursing. This leads to a shorter period of suppressed ovulation. Hence, a decrease in child mortality can prolong the period of nursing and in this way suppress fertility. Even in absence of extended breastfeeding, the survival of a new born infant may lead to lower fertility, if it induces a change in the sexual behavior of the parents. The frequency of sexual intercourse may decrease due to overburdening of the mother and/or a change in sleeping arrangements [3] . Such involuntary effects of a change in child mortality are translated into a change of fertility with a lag of no more than a year or two. However, it has also been shown that even a very substantial change in infant mortality will only lower the level of fertility by a small amount.

Voluntary

While involuntary effects will make themselves felt in all populations, voluntary effects are of course restricted to populations practising birth control. The idea is that in these populations, the families wish to obtain a certain number of *surviving* children. In case of a decline in child mortality, this number of surviving children can be obtained through fewer births. According to this hypothesis the decline of mortality – other things being equal – will be compensated for by a similar decrease in fertility.

However, some problems do appear when we try to make such a hypothesis subject to a numerical verification. Comparing the fertility and mortality decline, it is not specified until which age the mortality decline should be calculated. During the decline of fertility and mortality other factors influencing the desired number of surviving children will also change. We do not know how long it will take the parents to realize that a decline of mortality has occurred. So all in all it is difficult in advance to state a time lag from a decline of mortality to a subsequent limitation of births. A time lag of five to ten years has been assumed [2].

Societal

Reduced mortality can also have a more indirect effect on fertility by causing an acceleration of population growth, and inducing an increase in the pressure of population on resources. Such an effect would be most pronounced in an agricultural society, under conditions of minimal changes in technology and industrial organizations, and without extensive opportunities for migration. The time lag between the decline of mortality and fertility would be substantial, but difficult to specify. In this case the proportion of ever married females and the age at marriage can act as important fertility determinants.

Review of Countries

Germany [2]

The association between the level of mortality and fertility in Germany before the fertility decline is rather slight. A comparison of infant mortality (1875-80) and fertility (1878-82) in 64 areas reveals a positive correlation coefficient of only .50. Comparing mortality and fertility of legitimately born infants only changes the value of the correlation coefficient to .44. An analysis of the 34 administrative areas of Prussia (part of Germany) showed a very slight association between legitimate infant mortality and fertility in the period 1875-1912, when rural and urban population were not considered separately. For example, the coefficient of correlation between infant mortality in 1875-1880 and marital fertility in 1878-1882 is – .04. The corresponding correlation between infant mortality in 1896-1900 and marital fertility 1898-1902 was zero. A calculation of the correlation between the two variables separately for urban and rural populations revealed a weak inverse association for urban areas and a weak positive association for rural areas. In most cases the numerical value of the correlation coefficient was below .10.

A study of the German States Bavaria, Baden and Hessen in the 1870's and 1880's disclosed a rather strong positive correlation between infant mortality and marital fertility. These states were characterized by a high infant mortality. It is quite likely that much of this relationship was associated with the large differences in the extent and duration of breastfeeding within these states. In the many areas in which nursing was unusual and even when the practice was of very short duration, marital fertility was high because of short interbirth intervals, and infant mortality was high because of improper diets for young infants. [3].

When one analyses the timing and change, the national data for Germany reveals a very strong parallel between the two variables, both variables start to decline at the end of the 19th century. But, the data for individual provinces do not show a parallel movement of the two variables. In half of the areas, a decline in fertility of 10 per cent preceded a reduction of infant mortality of the same amount with an average time lag of about 9 years. In the other half of the provinces, infant mortality began to decline earlier than fertility, with an average difference in timing of about 11 years. In one area the two declines were approximately simultaneous.

Experiences in the provinces also revealed a positive association both between the amount of decline of the two variables, and the dates of the onset of the two declines. The association between the dates of the onset of both declines is strongest in areas where both variables have high values. It is also stronger in urban areas than in rural areas.

A comparison of the two variables before their decline with their level in 1932-34 reveals that for Germany over 40 per cent of the fertility decline was offset by mortality declines.

United Kingdom [9]

For England and Wales a very low positive association is observed between the two variables in 1891 and 1901 (.08 and .22 respectively). When marital fertility data for 1911 are compared with infant mortality in 1901 (a decade time lag), the correlation coefficient increases somewhat, but is still low (.34). The correlation coefficients for Scotland are also low (–.28 in 1891 and .06 in 1901). In the 1911 marital fertility data lagged on 1901 infant mortality, it is .12. When trying to explain the fertility level by simultaneous correlation with such variables as female illiteracy, proportion urban, proportion in agriculture, ethnic variables and infant mortality, one finds that mortality is not an important factor in England and Wales. In the Scottish data, infant mortality seems to be one of the stronger explanatory variables in such a multiple regression analysis.

Denmark [8]

A preliminary analysis of data from Denmark does not give any evidence that a decline in infant mortality leads to a limitation of birth. This seems to be true both for Denmark as a whole, and for the individual provinces. Further, there is no clear positive association between the level of infant mortality and marital fertility before the decline of fertility after 1890.

Belgium [5]

This study considers whether the infant mortality decline preceded the drop in marital fertility in the 9 provinces of Belgium. Here we find that in three of the provinces marital fertility had gone down by about 40 per cent of its 1870 or 1880 levels before infant mortality began to decline after 1895. In three other provinces the decline amounted to about 30 per cent. Only one province revealed a clear decline in infant mortality before a limitation of births.

An analysis of the level of infant mortality and marital fertility in the arrondissements of Flanders (N° 22) and Wallonia (N° 19) around 1890, 1900 and 1910 disclosed a very slight association in both parts of

Belgium. The same is true, when we introduce a time lag, by comparing the two variables on different dates. Especially in Flanders, low levels of infant mortality tend to be associated with higher levels of marital fertility.

In Flanders, there was a very weak positive association between the amount of decline in the two variables in the period 1880-1910, with values for the correlation coefficient being below .25: In Wallonia the correlation was negative. Further, in both Flanders and Wallonia the fall in marital fertility tended to happen fastest in arrondissements with a high level of infant mortality.

These observations are in contradiction with the expected direction of associations.

A multiple regression analysis was carried out to explain the pattern of marital fertility decline in Belgium's arrondissements. The calculation of the standardized regression coefficients showed that such variables as industrialization, urbanization, secularization and the presence of linguistic minorities seem to have much greater explanatory power than does infant mortality.

France [*10,11*]

A comparison between the average expectation of life at birth and the fertility in 82 departments of France in the first half of the 19th century, discloses a clear association in the expected direction (Table 1).

There is no evidence that changes in infant mortality brought about a decline in fertility.

TABLE 1 – CORRELATION COEFFICIENTS BETWEEN THE EXPECTATION OF LIFE AT BIRTH AND VARIOUS MEASURES OF FERTILITY : THE CRUDE BIRTH RATE, I_f (GENERAL FERTILITY) AND I_g (MARITAL FERTILITY), DURING THE FIRST HALF OF THE 19th CENTURY, SELECTED DATES. 82 DEPARTEMENTS OF FRANCE.

	Expectation of life at birth in					
	1801/05	1811/15	1821/25	1831/35	1841/45	1851/55
CBR in :						
1801-1805	*–.380*	–.600	–.714	–.650	–.768	–.660
1811-1815	–.474	*–.648*	–.768	–.653	–.694	–.591
1821-1825	–.366	–.590	*–.760*	–.644	–.724	–.677
1831-1835	–.305	–.434	–.697	*–.631*	–.706	–.672
1841-1845	–.262	–.373	–.657	–.579	*–.715*	–.648
1851-1855	–.276	–.376	–.662	–.592	–.708	*–.638*
I_f in 1831	–.327	–.389	–.624	*–.522*	–.580	–.637
1836	–.254	–.375	–.601	*–.529*	–.621	–.657
1841	–.230	–.375	–.614	–.529	*–.652*	–.675
1846	–.276	–.408	–.657	–.562	*–.671*	–.688
1851	–.286	–.412	–.673	–.588	–.685	*–.699*
I_g in 1831	.039	–.033	–.219	*–.253*	–.361	–.451
1851	.071	–.126	–.309	–.340	–.500	*–.563*

Note : Coefficients were underlined when fertility and mortality were measured at the same date.

Portugal [*6*]

For Portugal the analysis of the association between the two variables was carried out for the census years 1911, 1930 and 1960, and the country was divided into 22 districts. The Portuguese fertility decline before 1911 was slight.

Considering the zero order correlation coefficients between marital fertility and infant mortality the association goes in the expected direction in 1911 and 1960, although it is rather slight in 1911 (Table 2). In 1930 the association is slightly negative.

Based on three "independent" variables : infant mortality, illiteracy and per cent employed in agriculture, the partial and multiple correlation coefficients are computed. The partial correlation coefficients between fertility and mortality (and primary activity) are higher than the corresponding zero order coefficients. They have the expected sign and are statistically significant.

The correlation between deviations from regional means (four regions) in 1930 and 1960 displays a weaker association between fertility and mortality. Both partial correlation coefficients show a negative sign.

TABLE 2 – ZERO ORDER. PARTIAL, AND MULTIPLE CORRELATION COEFFICIENTS BETWEEN MARITAL FERTILITY AND THREE SOCIO-ECONOMIC VARIABLES. PORTUGAL : 1911, 1930 and 1960.

Year	Type of Correlation	Infant Mortality	Illiteracy	Per cent employed in Agriculture
1911	Zero-order	+.319	+.239	+.498[a]
	Partial	+.659[a]	+.151	+.684[a]
	Multiple		.759	
1930	Zero-order	(–.090)	+.204	+.566[a]
	Partial	+.331[a]	(–.257)	+.626[a]
	Multiple		.647	
1960	Zero-order	+.699[a]	(–.163)	+.123
	Partial	+.849[a]	(–.704)	+.567[a]
	Multiple		.864	

Note : Data in Parentheses have signs contrary to expectation.
[a]Significant at the .01 or .05 level.

TABLE 3 – MARITAL FERTILITY, ZERO ORDER "STATIC" CORRELATION COEFFICIENTS WITH INFANT MORTALITY. ITALY : 1881 TO 1961.

	1881	1911	1931	1951	1961
North and Center	(–.261)	.454	.507	.569	.385
South and Islands	(–.255)	.033	(–.169)	.115	.312

Note : Data in parentheses have signs contrary to expectation.

TABLE 4 – MARITAL FERTILITY. PARTIAL AND MULTIPLE "STATIC" CORRELATION COEFFICIENTS WITH SELECTED SOCIO-ECONOMIC VARIABLES. ITALY : 1881 TO 1961.

		1881	1911	1931	1951	1961
North and Center	Proportion Married	–.386[a]	–.149	–.596[a]	–.773[a]	–.361[a]
	Infant Mortality	(–.087)	.523[a]	.581[a]	.527[a]	.266[a]
	Ruralization	.280[a]	.143	.248[a]	(–.166)	(–.246)[a]
	Industrialization	(.390)[a]	(.032)	(.133)	–.153	–.180
	Male Illiteracy	(–.236)[b]	.177	.421[a]	.506[a]	.151
	Urbanization	–.283[a]	–.022	–.046	–.444[a]	–.368[a]
	Multiple Correlation Coefficient	.749	.625	.801	.882	.627
South and Islands	Proportion Married	(.470)[a]	–.530[a]	–.578[a]	–.766[a]	–.823[a]
	Infant Mortality	–.424)[a]	.330[b]	.356[a]	.307[b]	.390[a]
	Ruralization	.091	.292[b]	.140	(–.032)	(–.146)
	Industrialization	–.107	(.301)[b]	(.261)	(.179)	–.064
	Male Illiteracy	.000	.336[b]	(–.108)	.349[a]	.492[a]
	Urbanization	(.449)[a]	–.187	–.427[a]	–.029	–.043
	Multiple Correlation Coefficient	.631	.572	.714	.792	.886

Note : Data in parentheses have signs contrary to expectation.
[a]Significant at .01 level
[b]Significant at .05 level

TABLE 5 – PERCENTAGE CHANGE IN MARITAL FERTILITY, ZERO ORDER "DYNAMIC" CORRELATION COEFFICIENTS WITH PERCENTAGE CHANGE IN INFANT MORTALITY. ITALY : 1881-1911 TO 1951-1961.

	1881-1911	1911-1931	1931-1951	1951-1961
North and Center	(–.051)	.313	.264	.098
South and Islands	.166	.196	(–.095)	(–.060)

Note : Data in parentheses have signs contrary to expectation.

TABLE 6 – PERCENTAGE CHANGE IN MARITAL FERTILITY, PARTIAL AND MULTIPLE "DYNAMIC" CORRELATION COEFFICIENTS WITH PERCENTAGE CHANGE IN INFANT MORTALITY. ITALY : 1881-1911 TO 1951-1961.

		1881-1911	1911-1931	1931-1951	1951-1961
North and Center	Proportion Married	(.078)	(.175)	–.209	–.305[a]
	Infant Mortality	.131	.360[a]	.397[a]	123
	Ruralization	.591[a]	.199	(–.286)[a]	(–.012)
	Industrialisation	–.111	(.309)[a]	–.090	–.322
	Male Illiteracy	(–.198)	.210	.602[a]	.524[a]
	Urbanization	(.087)	(.019)	–.109	–.055
	Multiple Correlation Coefficient	.692[a]	.495[a]	.665[a]	.601[a]
South and Islands	Proportion Married	–.071	–.357[a]	(.366)[b]	–.244
	Infant Mortality	.100	.193	.032	.218
	Ruralization	.154	.237	(–.011)	.283
	Industrialization	(.179)	(.213)	–.236	–.491[a]
	Male Illiteracy	.046	(–.011)	–.511[a]	.271
	Urbanization	.098	(.048)	(.004)	–.306
	Multiple Correlation Coefficient	.287	.434	.628[b]	.589

Note : Data in parentheses have signs contrary to expectation.
[a]Significant at .01 level.
[b]Significant at .50 level.

Italy [7]

The results here are based on data from approximately 90 provinces in 1881, 1911, 1931, 1951 and 1961. When analyzing the level and decline of fertility, the country is divided into a northern and a southern part. In Italy there is no substantial fertility decline before 1881. The factors included in the analysis of marital fertility are : Proportion married, infant mortality, ruralization, industrialization male illiteracy and urbanizatnion.

These factors are correlated with marital fertility at each of the selected five dates. Considered separately, infant mortality is positively correlated with marital fertility, excluding the year 1881 and the southern part of the country in 1931 (Table 3). But the correlation coefficient is in no case above .60. In the multivariate analysis, infant mortality constitutes, together with "proportion married" and "illiteracy", the factors with the greatest explanatory power (Table 4).

Changes in marital fertility between each of the five dates are also correlated with the corresponding changes in the five factors indicated. Considered separately, infant mortality moves in most cases, in the same direction as marital fertility, although the correlation is slight (Table 5). In the multivariate analysis, changes in infant mortality and illiteracy are those most closely correlated with changes in marital fertility (Table 6).

Russia [1]

In the study of Russia, data are compiled "on a number of characteristics of the 50 provinces of European Russia, including literacy, proportion of the population dependent on agriculture, infant mortality

at different dates, estimated expectation of life at birth in 1897, proportion classified as peasant in 1897, number of libraries per capita, and estimated crop yields. When the provinces are listed in order of their infant mortality rates in 1886-1897, there is a clear gap between the 20 provinces with an infant mortality of less than 230 per thousand and 30 provinces with an infant mortality of over 250 per thousand. The low infant mortality group is almost exactly the same (it differs only by including province, 12, the province of the Don) as the list of provinces with less than 50 per cent Great Russians, and also is virtually coincident with the provinces that experienced a reduction of marital fertility of more than ten per cent, 1897-1926. Low infant mortality is readily accepted as an element, possibly contributing to a reduction of fertility, and the geographical pattern of low infant mortality suggests that the association of change in I_g (marital fertility) with proportion other than Great Russian is produced by the intervening variable, the level of infant mortality. However, we have found in exploratoy multivariate analysis that the relation of the change in I_g (marital fertility) to the proportion. Great Russians remains strong when other variables are held constant, while the relation to mortality is greatly diminished when account is taken of other variables. It seems probable that among the many social and cultural traits common to the part of Russia that was predominantly Great Russian, there were some that inhibited a decline in marital fertility".

Conclusion

The reporting of these results should make it clear that no firm conclusions can be drawn on the relationship between child mortality and marital fertility in Europe during the demographic transition. Comparing the different countries, the results are often contradictory ; and it should also be remembered, that the applied method of analysis has its limitations. Dealing with aggregate data we extend the correlations to individuals, although there are examples wich have shown the fallacy of such ecological procedures. The interpretation of the correlation coefficients assume furthermore a linear relation between the variables, an assumption which is seldom tested. Nonetheless the preliminary analysis carried out within the project has made it possible to answer some of the questions raised in the present paper.

Only some of the countries disclosed a clearly positive correlation between mortality and fertility before the fertility decline. Even these countries could not provide firm evidence that local pre-decline populations "adjusted" fertility to mortality levels. Both variables could have been dependent on other factors. Further, a lower fertility level could also generate a more moderate mortality level [3], [10].

It is evident from the analysis that a decline in child mortality is not a necessary prerequisite for the occurrence of a decline in fertility. In half of the provinces in Germany, the fertility decline occurred about 9 years sooner than the decline of mortality. Belgium too gave examples of a very substantial limitation of births which preceded the mortality decline, this time by 25 years or more.

Whether a sizeable decrease in child mortality is enough to produce, automatically, a decline in fertility is difficult to answer, when the term "sizeable" has not been quantified. But it should be mentioned that the infant mortality rate in Sweden decreased from about 200 per thousand before 1800 to 130 per thousand in 1871-80 without any decline of fertility.

The problems concerning the time lag between child mortality and fertility decline become less interesting if there is no evidence of a systematic decline of child mortality preceding the change of fertility. When this succession did appear in German Provinces, the time lag was on the average 11 years.

The main difficulty in obtaining information on the relationship between these two variables from European data is caused by the fact that fertility depends on many factors and their interplay. The relationship between child mortality and fertility is observed in situations where many other factors are also acting upon fertility. For this reason alone, the correlation between the two variables can be rather slight. This element is especially important in the European case, where the changes in child mortality occurred as an integral part of the economic and social transformation of society, , and where it is clear that the response of different populations to changes in external factors was not the same.

Therefore, fertility decline can occur in combination with very different levels of infant mortality. This is shown more fully on table 7, which compares some European countries at the time, when fertility had started to decline. The date of decline is defined as the time when marital fertility had undergone a 10 per cent decline from its highest value, never to recover its previous level. It appears that a fertility decline could occur when infant mortality was as high as 221 per thousand (Germany). But the table also shows that the decline of fertility in Norway did not begin before infant mortality was as low as 76 per thousand, not to mention Ireland, which is atypical.

But it should be stressed, that in all the countries a strong and sustained decline in fertility has not occurred without a substantial reduction in infant mortality.

In many ways, the application of the European experience to the present situation in the developing

TABLE 7 – DEMOGRAPHIC AND SOCIO-ECONOMIC INDICES AT TIME OF FERTILITY DECLINE. SELECTED COUNTRIES OF EUROPE (BORDERS OF THE TIME)

	Date of Decline by 10 %	Marital fertility before decline (I_g)	Index of Proportion Married (I_m)	Overall Fertility (I_f)	Infant Mortality (per thousand)	% of Male Labor Force in Agriculture	% Rural d)	% in Towns 20 000+	% in Cities 100 000+	% Illiterate in Census f)	% Illiterate among Recruits	% Illiterate at Marriage g)
France	(Before 1830)	(>.64)	.50[a]	.27[a]	ca.185[b,c]	> 70	83[c]	< 7	< 3	–	> 53	–
Belgium	1882	.82	.44	.35	161	30	56	22	11	30	15	–
Switzerland	1885	.73	.44	.29	165	33	78	9	0	–	2	–
Germany	1890	.78	.50	.39	221	38	68	21	11	–	1	–
England and Wales	1892	.68	.48	.31	149	15	28	57	35	–	–	7
Sweden	1892	ca.74	.42	.31	102	49	81	11	8	–	0	–
Scotland	1894	.75	.42	.31	124	13	27	49	32	–	–	4
Netherlands	1897	.85	.45	.35	153[c]	29	26	42	25	–	6	3
Denmark	1900	.63	.47	.32	131	42	61	23	15	–	0	–
Norway	1904	.75	.42	.30	76	37	72	18	10	–	–	–[h]
Austria	1908	.68	.51	.36	205	40	–	19	11	21	–	–
Finland	1910	.70	.46	.31	114	66	85	9	5	44	–	–
Italy	1911	.68	.54	.36	146	46	38	28	11	39	–	29
Bulgaria	1912	ca.70	ca.74	ca.45	159	70	82	7	2	60	18	49
Spain	1918	.64	.51	.30	158	66	45	26	12	46	–	–
Ireland	1929	.71	.35	.23	69	48	73	20	14	–	–	2

–No data available, a) in 1851, b) average of figures given for 1815-27 by Bourgeois-Pichat, op. cit., c) children dead after registration only, d) in communities of less than 5 000, or legal definition, e) in 1836, f) both sexes, 10+ or 15+, g) able to sign their name, both sexes, h) essentially no illiteracy by 1900, See UNESCO, *op. cit.*, p. 173.
Source : [4].

countries calls for a good deal of caution. The change of child mortality in Europe took place simultaneously with many other factors. Here, one could speak of a kind of parallellism, between the change of child mortality and other factors, which makes it difficult to isolate the influence of mortality on fertility and would also diminish the independent role to be played by mortality.

In developing countries child mortality has declined much faster than in Europe. In many instances, it has been ahead of the economic and social transformation of society. In these countries, mortality will have a greater possibility of playing an independent role in influencing fertility. On the other hand, we do not yet know to what extent mortality will act upon fertility, when it is not followed by a simultaneous transformation of society. To this question, the European data can yield no answer.

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THE EFFECT OF CHILD MORTALITY EXPERIENCE ON SUBSEQUENT FERTILITY : AN EMPIRICAL ANALYSIS OF PAKISTAN AND BANGLADESH DATA *

A. K. M. Alauddin CHOWDHURY
Cholera Research Laboratory, Dacca
Atiqur Rahman KHAN
National Postpartum Family Planning Programme, Dacca
Lincoln C. CHEN
The Population Council

SUMMARY

In this paper is presented an empirical analysis of the effects, behavioral and biological, of child mortality experience on subsequent fertility in two South Asian Islamic nations. Data for the investigation come from retrospective pregnancy histories of 2 910 currently married women interviewed in the Pakistan National Impact Survey (1968-69) and from longitudinal vital registration data (1966-1970) of 5 236 women residing in a rural area of Bangladesh collected by the Cholera Research Laboratory. The aim of this study was to assess the importance of the child-replacement motivational response to child death experience when biological effects have been controlled adequately.

A common approach employed previously has been to examine cumulative fertility according to child death experience. In Pakistan and Bangladesh, a consistently positive relationship was demonstrated between the number of everborn children and child deaths. This method however does not exclude the inverse relationship, the influence of fertility on mortality, nor does it dissect out behavioral from biological effects. Utilizing a measure of subsequent fertility, live birth-to-live birth intervals, the study further illustrates another common pitfall. Since the risk of infant death, which abbreviates birth intervals, is associated with the reproductive history of a mother, women with child mortality experience are more likely to experience briefer intervals due to the biological effect of subsequent infant death. Behavioral influences therefore may be observed by considering only those birth intervals with survivorship of the first birth of an interval.

With these limitations controlled, very little, if any, behavioral influences were noted in the Pakistan and Bangladesh data. Median birth intervals in Pakistan varied from 35.3 to 41.2 months, increasing with parity. Within each parity group, no consistent difference was observed between women with and without previous child loss. In Bangladesh the median birth interval for all women with a surviving infant was 37.2 months. This was shortened to 24.1

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months by an infant death. When intervals with infant deaths were excluded, little or no behavioral influence was detected among women at the same parity but with varying levels of previous child loss.

The analysis projected that elimination of infant mortality in Bangladesh would exert a biological effect on fertility through prolonging the average period of postpartum sterility. The magnitude of the depressant effect however was only 1.6 percent. This modest effect moreover was counterbalanced by an increase of net reproduction due to better survivorship of infants.

RÉSUMÉ

Dans cette communication est présentée une analyse empirique des effets, tant sur le plan du comportement que sur celui de la biologie, de l'expérience de la mortalité des enfants sur la fécondité ultérieure dans deux pays islamiques de l'Asie du Sud. Les données utilisées pour cette recherche proviennent de l'histoire génésique rétrospective de 2910 femmes actuellement mariées qui ont été interviewées pour l'enquête nationale du Pakistan (1968-69) et des données longitudinales tirées de l'état civil (1966-1970) et portant sur 5236 femmes vivant dans une zone rurale du Bangladesh. Ces dernières données ont été recueillies par le Laboratoire de recherche sur le choléra. Le propos de cette étude était d'examiner dans quelle mesure un décès d'enfant provoque le désir de remplacer celui-ci par une autre naissance, lorsque les effets biologiques sont contrôlés de manière adéquate.

Une méthode couramment employée jusqu'ici consiste à examiner la fécondité cumulée en tenant compte des décès d'enfants qui sont survenus. Au Pakistan et au Bangladesh, on a trouvé une relation manifestement positive entre le nombre des naissances et celui des décès d'enfants. Cependant, ce procédé n'exclut pas la relation inverse, l'influence de la fécondité sur la mortalité et il ne permet pas de distinguer les effets biologiques de ceux qui tiennent au comportement. En utilisant une mesure de la fécondité ultérieure, les intervalles entre naissances vivantes, l'étude permet en outre de mettre en garde contre un piège bien connu. Comme le risque de décès d'enfants qui diminuent les intervalles entre naissances, est associé à l'histoire génésique des mères, chez les femmes qui ont perdu des enfants les intervalles inter-génésiques sont en général plus courts du fait de l'effet biologique du décès ultérieur de l'enfant. L'influence du comportement ne peut donc être analysée qu'au moyen des intervalles entre naissances à partir de la naissance d'un enfant qui a survécu.

Si on tient compte de ces divers facteurs, d'après les données du Pakistan et du Bangladesh, l'influence des comportements est très faible ou même inexistante. Les intervalles médians entre naissances au Pakistan vont de 35,3 à 41,2 mois. Ils augmentent avec le rang de naissance. Pour un rang de naissance donné, on n'a observé aucune différence entre les femmes qui ont perdu des enfants et celles qui n'en ont pas perdu. Au Bangladesh, l'intervalle médian pour l'ensemble des femmes dont l'enfant a survécu est de 37,2 mois. Il tombe à 24,1 mois lorsque l'enfant est mort. Si on exclut les intervalles dans le cas d'un décès d'enfant, l'influence du comportement pour un rang de naissance donné est faible ou négligeable mais le niveau varie selon le nombre de décès.

D'après une projection tirée de l'analyse, l'élimination de la mortalité infantile au Bangladesh exercerait un effet biologique sur la fécondité en augmentant la période moyenne de stérilité consécutive à l'accouchement. Cependant, cette baisse ne serait que de 1,6 %. Elle serait d'ailleurs largement compensée par une augmentation du taux net de reproduction du fait de la survie d'une proportion plus élevée d'enfants.

RESUMEN

En este documento se presenta un análisis empírico de los efectos, conductuales y biológicos, de la experiencia de la mortalidad de la niñez sobre la

fecundidad subsiguiente, en dos naciones islámicas del Asia del Sur. Los datos para la investigación fueron obtenidos de las historias obstétricas retrospectivas de 2910 mujeres actualmente casadas interrogadas en la Encuesta Nacional de Pakistán (1968-1969) y de los datos del registro de hechos vitales llevados en forma longitudinal, entre los años 1966 y 1970, de 5236 mujeres residentes en el area rural de Bangladesh y recolectados por el Laboratorio de Investigaciones sobre el Cólera. El propósito o de este estudio era ponderar la importancia de la respuesta motivacional, tendiente a reemplazar un niño muerto, cuando los efectos biológicos han sido adecuadamente controlados.

El método común empleado con anterioridad consistía en examinar la fecundidad acumulada según la experiencia de la muerte de un niño. En Pakistán y Bangladesh se encontró una asociación coherente y positiva entre el total de nacimientos y la mortalidad de la niñez. Este método, sin embargo, no excluye la relación inversa, la influencia de la fecundidad sobre la mortalidad, no diferenciando tampoco los efectos conductuales de los efectos biológicos. Utilizando la medición de la fecundidad subsiguiente, la relación entre los nacidos vivos y los intervalos entre nacimientos, el estudio ilustra además otro tipo de equívoco. Desde que el riesgo de experimentar la pérdida de un niño, que acorta los intervalos entre nacimientos, es asociado con la historia reproductiva de una madre, las mujeres que han tenido la experiencia de perder un hijo son más propensas a tener intervalos más breves debido al efecto biológico de la subsiguiente muerte infantil. Por lo tanto las influencias conductuales deben ser observadas considerando solamente aquellos intervalos entre nacimientos en que ha existido la sobrevivencia del primer nacimiento por un intervalo.

Una vez controladas estas limitaciones, las influencias conductuales que se pudieron apreciar con los datos de Pakistán y Bangladesh, fueron muy escasas por no decir nulas. Los intervalos medios entre nacimientos en Pakistán variaban entre 35,3 a 41,2 meses, aumentando con la paridad. En cada grupo de paridad, no se encontraron diferencias coherentes entre mujeres con y sin previas pérdidas de hijos. En Bangladesh el intervalo medio entre nacimientos para todas las mujeres con un niño sobreviviente fue de 37,2 meses. Este intervalo medio disminuyó a 24,1 meses cuando había una defunción infantil. Cuando se excluyen los intervalos en que hay una defunción infantil, la influencia conductual observada entre mujeres con la misma paridad, pero con niveles variables de pérdidas anteriores de hijos, fue muy pequeña o nula.

El análisis evidenció que la eliminación de la mortalidad infantil en Bangladesh ejercía un efecto biológico sobre la fecundidad a través de la prolongación del período medio de esterilidad post-partum. La magnitud del efecto depresivo, sin embargo, fue sólo de un 1,6 por ciento. Por otra parte, este modesto efecto fue contrapesado por un aumento de la tasa neta de reproducción debida a una mayor sobrevivencia de los niños.

Introduction

The inter-relationship between mortality and fertility is considered one of the most significant areas of policy-oriented population research. Indeed, knowledge regarding one aspect of this complex relationship has already proven to be useful in shaping population policy. In the past two decades, the adoption and implementation of many national family planning programs, despite potential opposition, have been based, at least in part, on research documenting the adverse consequences of excessively high fertility on health and mortality (1). Such information has also provided a key policy rationale for the participation of health scientists, administrators, and health ministries in population control programs.

Research findings regarding the reverse relationship, the consequences of mortality on fertility, however, are much less conclusive. As a result, population policies based upon the effects of mortality on fertility are less secure and far more controversial. Some have argued that child mortality experience is an important determinant of fertility and, as such, the reduction of child mortality may be a precondition for successful population control efforts. The conclusion that follows is that population resources directed toward achieving demographic goals may be invested with high cost-effectiveness in mortality control programs (2).

Substantive support of such conclusions, it is argued, comes from research validating the "child survival hypothesis". This term has been used to denote various proposals regarding the effect of mortality on reproductive attitudes and behavior. Poor child survivorship, it is proposed, inflates desired family size, causes couples in compensation to overshoot their reproductive goals, and acts as a barrier to contraceptive practice (3). These effects of mortality on reproductive behavior conceivably may operate at either the community (macro) or individual (micro) levels (4). At the community level child mortality experience may shape the reproductive norm and behavior of a community overall, while among individual couples, previous child deaths may affect fertility differentials between individual couples. These effects obviously need not be mutually exclusive ; if present, they would be expected to reinforce each other.

Previous investigations on the "child survival hypothesis" have been at both the macro and micro levels. Using cross-sectional data, several investigators have reported that lower regional death rates are correlated with lower levels of fertility or that the decline of the death rate when lagged several years has substantial negative effects on the birth rate (5). One difficulty with these macro studies however is an inability to isolate the effect of mortality on fertility. Correlations of these two variables between regions or communities could be due to the reverse effects : the well-documented adverse effects of high fertility on mortality. Most researchers therefore have focused on the micro level, studying differential fertility of individual couples according to child mortality experience. Commonly employing retrospective pregnancy histories, several researchers in Egypt, Turkey, India, and Taiwan have found higher fertility among women with previous child deaths as compared with counterparts with no child death experience (6). These investigators then have concluded that the observed differentials in fertility were due to a child-replacement motivational response on the part of women with child death experience.

The difficulty with this conclusion is that the reproductive consequences of child loss are far more complex than simply attitudinal and behavioral. Death of infants also may abbreviate postpartum lactational amenorrhea, a period of temporary sterility, thereby exposing a woman to the risk of conception earlier than if the child had survived. Breastfeeding is nearly universal in rural areas of low-income countries and cessation of breastfeeding has been documented to have profound effects on fertility (7). This mechanism is more direct and more biological in character than attitudinal or behavior effects. Many previous researchers have neglected to control for this biological mechanism. Those that have recognized this difficulty have rarely adequately isolated behavioral from biological mechanisms.

In this paper is presented an empirical analysis of the effects, both behavioral and biological, of child mortality experience on subsequent fertility in two South Asian Islamic cultures with moderately high levels of child mortality. Data for the investigation come from two sources : retrospective pregnancy histories of a national probability sample of currently married women interviewed in the Pakistan National Impact Survey (1968-69) and longitudinal vital registration data of rural women followed from 1966 to 1970 by the Cholera Research Laboratory (CRL) in a rural population laboratory in Bangladesh (8). The analysis attempts : to illustrate how inadequate methodological treatment of data may lead to conflicting results ; to dissect out possible behavioral effects from biological influences ; to quantitate the relative magnitude of these two mechanisms ; and to discuss the implication of these research findings for future research.

Data Sources and Methods

Table 1 presents some selected characteristics of the two sets of data employed in this study. The Pakistan data come from the National Impact Survey conducted in 1968-69. The survey was an extended KAP type of survey containing detailed information regarding retrospective pregnancy histories, demographic and socioeconomic characteristics, and family planning knowledge, attitude, and practice of female respondents. The sampling frame of the survey consisted of all households in Pakistan (formerly the West Wing of Pakistan) excluding tribal areas. A national probability sample was obtained by a two-stage procedure, stratifying for urban and rural residence. Altogether about 2 500 households were selected. This paper examines the reproductive pattern of 2 910 currently married women under the ages of 55 years interviewed in the selected

TABLE 1 – SELECTED CHARACTERISTICS OF THE PAKISTAN AND BANGLADESH STUDIES

Study Characteristics	Pakistan	Bangladesh
Methodology	Retrospective	Prospective
Population	National	120 000
Residence	Urban/rural	Rural
Sample size	2 910	5 236
Time covered	1960-68	1966-70

households. To minimize errors introduced by recall lapse of distant events, only pregnancy histories from 1960 to 1968 are considered in this analysis. More extensive discussions of the methodology and validity of the Impact Survey data have been reported elsewhere (9).

The Bangladesh data come from the vital registration system maintained by the Cholera Research Laboratory in a rural population of about 120 000 persons residing in Matlab thana, Comilla District. A census of this population was completed in early 1966 and beginning on 1 May 1966, the registration of all births, deaths, and migrations was instituted by trained CRL field staff. Detailed information regarding the CRL data collection procedures has been reported earlier (10). The data employed in this investigation come from longitudinal observation of 5 263 women who delivered a live birth during the year 1966-67 (1 May 1966 – 30 April 1967). Subsequent birth and child death reports occurring to these women and their children during a four year period of observation, 1 May 1966 to 30 April 1970, were matched by computer. This represented an average observation period of 42 months per woman. Because of coding, punching, and matching errors, however, 27 cases were excluded from this study. The analysis therefore is confined to 5 236 women with reasonably complete information.

Despite the differing nature of the data from Pakistan (retrospective) and Bangladesh (prospective), an attempt is made here to treat these data in a similar methodological fashion. The basic concept underlying this analysis is birth interval dynamics (11). A birth interval is simply the time between successive births. After a pregnancy termination a woman typically experiences a period of temporary sterility, characterized by postpartum amenorrhea. With the onset of postpartum menses and ovulation, the woman again becomes at risk to pregnancy. This period is terminated by a conception which marks the beginning of gestation. At the completion of the pregnancy, one birth interval is completed and another has begun. The length of an average birth interval is important because it is a direct measure of fertility. Birth interval lengths are related to fertility in a reciprocal manner ; long intervals equal low fertility and vice versa.

Because of probable under-reporting and under-registration of fetal wastages, only live birth-to-live birth intervals are considered in this study. Two types of birth interval data are presented. The first are mean intervals from one live birth to the next. This is computed simply by averaging all intervals where a live birth has been followed by another during the period of observation. Mean intervals are biased toward brevity since intervals where a live birth is not followed by another during the observation period (longer intervals) are excluded. This bias is minimized by employing life tables to compute median birth intervals. The life table technique, as employed by Potter, considers all intervals regardless of whether they terminate or not during the period of observation (12). Appendix I contains an illustrative computation of a life table of live birth-to-live birth intervals during 1960-68 for parity 1 Pakistani women who had no previous child deaths.

Before proceeding further, it is important to recognize that the computed intervals in Pakistan differ from those of Bangladesh. Using retrospective pregnancy histories, Pakistan birth intervals were obtained by following *live births* during 1960-68 to either the next live birth or to the time of interview. Thus, one Pakistani woman may have several intervals included in this analysis. In Bangladesh, on the other hand, *women* were followed from one live birth to either the next or to the study cut-off. One Bangladesh woman therefore may contribute only one interval to this analysis. This distinction is important because interval lengths may depend on the method of computation. Following the classification of Wolfers, Pakistan findings reported here relate to birth-interval-births while Bangladesh data relate to birth-interval women (13).

Results

Because the relationship of mortality to fertility may vary between geocultural regions experiencing differing levels of mortality and reproductive performance, it seems worthwhile to begin by reviewing briefly the demographic setting of the two populations under study. This is presented in Table 2 which shows selected fertility, mortality and contraceptive usage measures for Pakistan and Bangladesh.

As the data indicate, these two nations had moderately high levels of fertility. The crude birth rates were 39 and 46 per 1 000 for Pakistan and Bangladesh, respectively (14). The total fertility rates were nearly identical, slightly over 6 live births per woman. These populations also had moderately high levels of mortality. Both crude death rates were about 15 per 1 000 and the infant mortality rates were above 120 per 1 000 live births. The childhood (1-4 years) death rate in Bangladesh was about 25 per 1 000.

The fertility and mortality indices of these two populations therefore were very similar. An average woman experienced about 6 live births over a reproductive life time. Of these births, about 12 percent died in infancy and another 10 percent between the ages of 1 and 4 years. Altogether only slightly more than 75 percent of all live births survived beyond the first 5 years of life.

Data in Table 2 also show that these two populations have been highly resistant to fertility control efforts. Despite an intensive nationwide family planning program beginning in 1965, contraceptive usage rates in 1968-69 were so low that these populations could be considered essentially noncontracepting societies. The

prevalence of ever and current contraceptive use in Pakistan were only 11.2 and 5.2 percent, respectively (15). The corresponding figures for Bangladesh were 6.4 and 3.7 percent (16). While an examination of the causes responsible for these low usage rates is beyond the scope of this paper, it has been advanced that high levels of child mortality may have been one critical impediment to effective fertility control efforts. This hypothesis is the issue that will be addressed in this paper.

TABLE 2 – SELECTED FERTILITY, MORTALITY, AND CONTRACEPTIVE USAGE RATES IN PAKISTAN AND BANGLADESH STUDY POPULATIONS

Rates	Pakistan	Bangladesh
Fertility		
Crude birth rate[a]	39.0	45.7
Total fertility rate[b]	6.4	6.2
Mortality		
Crude death rate[a]	15.0	15.3
Infant mortality rate[c]	120.8	127.5
1-4 year death rate[a]	–	25.8
Contraceptive usage		
Ever use[d]	11.2	6.4[e]
Current use[d]	5.2	3.7[e]

a. Per 1 000 population
b. Births per woman
c. Per 1 000 live births
d. Percent of eligible women
e. National estimates

TABLE 3 – AVERAGE NUMBER OF EVERBORN CHILDREN BY AGE OF WOMAN AND NUMBER OF CHILD DEATHS IN PAKISTAN AND MATLAB, BANGLADESH

Number child deaths	Age of woman					
	15-24	25-29	30-34	35-39	40-49	All
			Pakistan			
0	1.1	2.8	4.0	4.5	4.7	2.4
1	2.4	3.9	5.2	5.5	6.1	4.5
2	3.6	4.8	6.0	7.2	7.0	6.2
3+	4.4	6.0	6.8	8.4	8.9	7.9
			Bangladesh			
0	1.8	3.6	4.9	5.7	5.6	2.6
1	3.3	5.0	5.9	6.6	7.2	4.7
2	4.6	5.9	7.1	7.6	8.6	6.2
3+	6.3	7.4	8.6	9.4	10.4	8.3

TABLE 4 – MEDIAN BIRTH INTERVAL IN MONTHS BETWEEN PARITIES (i) AND (i + 1) ACCORDING TO PARITY AND PREVIOUS CHILD DEATH EXPERIENCE IN PAKISTAN

Parity (i)	Median interval in months		
	No child death	Child death	Difference
1	36.6	31.4	5.2
2	36.0	34.1	1.9
3	37.3	35.5	1.8
4	38.9	34.5	4.4
5	38.5	37.8	0.7
6	39.7	38.8	0.9
7	41.0	39.7	1.3

A common analytical method employed in several earlier studies has been to examine cumulative fertility of women with and without child death experience. This is shown in Table 3. In this table is presented the average number of everborn children according to the age of the mother and the number of previous child deaths for the Pakistan and Bangladesh data separately. Within each age group, those with child death consistently demonstrated higher cumulative fertility, and the greater the number of deaths the higher the fertility. This positive relationship holds within all age groups and within each set of national data. In all groups, the number of everborn children is higher in Bangladesh than Pakistan. This is due to the selection procedure employed with the Bangladesh data. The Bangladesh study population was disproportionately weighted toward high fecundity since only those women producing a live birth in 1966-67 were included, rather than a sample representative of all currently married women, as was the case in Pakistan.

Several researchers utilizing data and methodological treatment similar to those in Table 3 have concluded that the observed positive relationship validated the "child survival hypothesis (17)". As discussed in the introduction, this is clearly insufficient evidence, for several reasons. Firstly, the influence of fertility on mortality has not been eliminated ; thus, the observed relationship could be due to high fertility causing high mortality, rather than the reverse. Secondly, while mortality experience may lead to higher cumulative fertility, the cause could be biological and not behavioral, as it is so often assumed. In universally breastfeeding societies early child death shortens lactational amenorrhea, thereby exposing a woman to the risk of pregnancy earlier than if the child had survived. Thus, one is unable to attribute the observed effects to behavioral differentials alone.

Some of these problems may be reduced by moving from cumulative fertility to subsequent fertility. One useful measure of subsequent fertility is the average time required between successive live births. Table 4 shows the median birth interval required to progress from parities (i) to ($i + 1$) among Pakistani women, separated according to parity and child mortality experience. These median values were obtained by life table computations. As the data suggest, live births on an average require about three years. With several minor exceptions, the median time required to produce live births increases with parity. This is expected given the known effects of age parity on reproductive performance. At the same parity, however, median intervals were briefer for women with child mortality experience. This relationship holds at all parities and is highly significant statistically.

The relationship also holds when the Bangladesh data are examined in a similar manner. This is shown in Table 5 where mean birth intervals between parities (i) and ($i + 1$) of Bangalee women are computed according to parity and the number of living children. Women at the same parity level but with fewer living children obviously have experienced higher child mortality than their counterparts with more living children. It is important to note that the birth intervals shown in Table 5 are mean intervals ; that is they are the average of only closed intervals, including only women who produced a second live birth before the end of the observation period. Median intervals computed by the life table technique substantiate the relationship shown in this table and are not presented for the sake of clarity.

Paralleling the findings among Pakistani women, Table 5 shows that within each parity group those Bangalee women with fewer living children (higher previous child loss) experienced briefer mean intervals progressing from parities (i) to ($i + 1$). These data too therefore suggest a positive relationship between child death experience and subsequent fertility.

TABLE 5 – MEAN BIRTH INTERVAL IN MONTHS BETWEEN PARITIES (i) AND ($i + 1$) ACCORDING TO PARITY AND NUMBER OF LIVING CHILDREN FOR WOMEN PRODUCING A BIRTH IN 1966-67 IN MATLAB THANA, BANGLADESH

Parity ($i - 1$)	No. living children among parity ($i - 1$)	Mean interval (months)	Parity ($i - 1$)	No. living children among parity ($i - 1$)	Mean interval (months)
1	0	19.6	5	0-2	26.4
	1	29.6		3	29.2
				4	30.7
2	0	19.6		5	29.9
	1	28.4	6+	0-2	23.5
	2	30.5		3	29.6
3	0-1	25.8		4	29.7
	2	29.3		5	30.0
	3	30.0		6+	30.2
4	0-2	27,8			
	3	28.4			
	4	30.5			

TABLE 6 – MEDIAN BIRTH INTERVAL IN MONTHS BETWEEN PARITIES (*i*) AND (*i* + 1) ACCORDING TO PARITY AND PREVIOUS CHILD DEATH EXPERIENCE IN PAKISTAN (EXCLUDING THOSE WOMEN WITH PARITY (*i*) CHILD DEATH)

Parity (*i*)	Median interval in months		
	No child death	Child death	Difference
2	36.0	35.3	0.7
3	37.3	36.0	1.4
4	38.9	34.9	4.0
5	38.5	38.1	0.4
6	39.7	39.9	−0.2
7	41.0	41.2	−0.2

TABLE 7 – MEAN BIRTH INTERVAL IN MONTHS BETWEEN PARITIES (*i*) AND (*i* + 1) ACCORDING TO PARITY, NUMBER OF LIVING CHILDREN, AND SURVIVORSHIP OF PARITY (*i*) BIRTH DURING INFANCY FOR WOMEN PRODUCING A BIRTH IN 1966-67 IN MATLAB THANA, BANGLADESH

Parity (*i* – 1)	No. living children among parity (*i* – 1)	Mean interval in months between parities (*i*) and (*i* + 1)			
		Infant death of parity (*i*)		No infant death of parity (*i*)	
		months	(no.)	months	(no.)
0-1	0-1	19.5	(100)	25.0	(947)
2-3	0-1	20.5	(31)	30.4	(241)
	2-3	20.1	(40)	29.9	(552)
4-5	0-1	–	(1)	29.6	(20)
	2-3	22.4	(39)	30.9	(350)
	4-5	22.0	(30)	30.1	(269)
6+	0-1	–	(1)	–	(4)
	2-3	20.8	(18)	29.5	(96)
	4-5	18.5	(34)	30.0	(263)
	6+	20.5	(15)	29.0	(129)
All		20.3	(309)	27.8	(2871)

Intervals based on less than 15 observations are not computed.

TABLE 8 – MEDIAN BIRTH INTERVAL IN MONTHS BETWEEN PARITIES (*i*) AND (*i* + 1) ACCORDING TO PARITY, NUMBER OF LIVING CHILDREN, AND SURVIVORSHIP OF PARITY (*i*) BIRTH DURING INFANCY FOR WOMEN PRODUCING A BIRTH IN 1966-67 IN MATLAB THANA, BANGLADESH

Parity (*i* – 1)	No. living children among parity (*i* – 1)	Median interval in months between parities (*i*) and (*i* + 1)				
		Infant death of parity ( )		No infant death of parity (*i*)		Difference
		months	(no.)	months	(no.)	(months)
0-1	0-1	21.6	(162)	36.6	(1434)	13.0
2-3	0-1	21.5	(36)	34.3	(341)	12.8
	2-3	24.0	(55)	34.4	(849)	10.4
4-5	0-1	–	(3)	37.6	(39)	–
	2-3	22.5	(49)	35.9	(563)	13.4
	4-5	26.5	(41)	36.4	(468)	9.9
6+	0-1	–	(1)	–	(9)	–
	2-3	25.0	(27)	41.1	(191)	16.1
	4-5	30.0	(61)	41.9	(544)	11.9
	6+	27.5	(29)	44.2[a]	(334)	16.7
All		24.1	(464)	37.2	(4772)	13.1

a. Extrapolated value. Intervals based on less than 15 observations are not computed.

The difficulty with the analysis shown in Tables 4 and 5 is that the dependent variable (subsequent fertility) interacts with the independent variable (previous child loss) in a manner to produce a positive relationship that may not necessarily be due to behavioral differentials (18). The confounding factor again is biological. Any infant deaths of the parity (i) birth, as discussed previously, would result in briefer birth intervals between parities (i) and ($i + 1$). If infant deaths of parity (i) births were proportionately distributed between women with and without previous child loss, this phenomenon would not present any problems. The risk of infant death however is highly associated with the reproductive history of a mother. Several competent studies have shown that one of the best predictors of infant mortality is the survivorship history of infants of the same mother (19). For reasons that are not entirely clear, some women are successful childbearers and others not so. It would be expected therefore that those women with high levels of previous child loss would also have more child deaths of parity (i) births. Disproportionately more parity (i) deaths in the child mortality groups would be expected to result biologically in briefer birth intervals. This then could account for the observed differentials of fertility, rather than a child-replacement motivational response.

The biological and behavioral effects of child mortality experience on subsequent fertility are finally dissected out and separated in Tables 6,7, and 8. Table 6 presents the median birth interval of Pakistani women from parities (i) to ($i + 1$), but all intervals where there is death of the parity (i) birth are excluded. Biological influences have been thereby eliminated and whatever difference is observed can be attributed to behavioral effects. In contrast with Table 4, however, the differences of median birth intervals between women with and without child death experience have essentially disappeared. Women with previous child loss in parities 2 through 5 have slightly briefer median intervals (higher fertility) but the relationship is reversed in the last two parity groups. Statistically, the differences are not significant.

Similar results were found among Bangalee women. The construction of Table 7 is identical to that of Table 5 except mean intervals were separated according to survivorship of parity (i) births. Intervals with infant deaths of parity (i) births are displayed separately. When intervals with infant deaths (biological effects) are excluded no behavioral effect whatsoever is observed. Within each parity group, there was no difference of mean birth intervals between women with varying numbers of living children.

The absence of a child-replacement motivation response on subsequent fertility is also shown in Table 8, where median rather than mean birth intervals are computed for Bangalee women. Again, within each parity group, there was no difference of median birth intervals between women with varying levels of child death experience. The group which may be an exception is parity 6 or more, where median birth intervals decreased with fewer numbers of living children. One is tempted to conclude that these differences are due to behavioral effects, confirming the "child survival hypothesis". Two limitations, unfortunately, qualify this conclusion. Firstly, one median value for those with 6 or more living children was not computed directly. Because of the brevity of the observation period, the median interval of women with 6 or more living children is an extrapolated value. Secondly and more importantly, there are additional biases in the data which would tend to produce the relationship shown among parity 6 or more women. This is the age composition of women with varying numbers of living children. Women at parity 6 or more but with only 2-3 living children have had at least 3-4 previous child deaths. At each death, these women would be expected to have progressed to the next parity faster than women without such deaths. Thus, women in this parity-living children group would be expected to be more youthful than their counterparts with more living children. Natural fecundity of younger women is higher than older women and differences in age composition could have resulted in the observed differences in median birth intervals. An analysis of age of women at parity 6 or more showed this to be precisely the case. The average age of women with 3 or less living children in this parity group was 30.8 years. This figure is nearly 5 years younger than the average age of women with 6 or more living children (35.2 years).

Even accepting a small behavioral effect among parity 6 or more women, the overall patterns of birth intervals in Tables 6,7 and 8 are fairly conclusive. With biological effects adequately controlled, very little, if any, behavioral effects are detectable. In the sociocultural context of these two South Asian societies at moderately high levels of fertility and mortality, there is no evidence that child death experience generates a child-replacement motivational response ; or, if attitudinal or behavioral modifications do occur, they are not sufficiently strong to be reflected by actual reproductive performance.

Another important finding is the relative magnitude of biological versus behavioral effects. The median birth interval for all Bangalee women whose parity (i) birth died during infancy was 24.1 months. The corresponding interval for women without infant mortality was 37.2 months. Thus a difference of 13.1 months is attributable to the biological effects of infant death, interruption of lactation, and earlier onset of postpartum ovulation and vulnerability to conception. Behavioral effects, on the other hand, only caused at the extreme, a difference of 3.1 months. This difference was observed among Bangalee women at parity 6 or more.

The difference of 13.1 months due to infant mortality fits very well with previous studies on birth interval components in the rural population of Matlab, Bangladesh (20). The median length of postpartum

amenorrhea with a surviving breastfed child was reported to be about 17 months. Neonatal infant deaths abbreviated this period to only 2 months, while postneonatal infant deaths shortened postpartum amenorrhea to about 6 months. With approximately 60 percent of all infant deaths occurring in the neonatal period and virtually universal breastfeeding of all surviving children, the observed difference of 13.1 months in this study fits precisely with data reported earlier on the length of postpartum sterility in Matlab, Bangladesh.

Discussions

Several qualifications to the findings reported here deserve comment. First, the relationship between child mortality and fertility, as noted in the introduction, is bidirectional. Mortality influences fertility but in turn is also affected by it. Thus, while we have attempted to isolate and quantitate one direction of this relationship, mutual interactions are possible and have not been excluded entirely. Secondly, not all potential behavioral effects are assessed. The child-replacement response could operate primarily at the macro level, profoundly influencing a community's overall attitude towards births and deaths. This analysis has only examined fertility differentials between individual couples ; these are micro level effects. It is possible that the magnitude of macro effects are sufficiently powerful to obscure fertility variations due to child death within a community. Thirdly, the exclusion of fetal wastage information may lead to bias. If fetal wastages were more common among women with child death experience, then their intervals between live birth would be disproportionately lengthened by the time required for fetal losses. This would tend to reduce whatever behavioral effects were actually present. Available evidence suggest that the error introduced by this bias is probably not large. Yerushalmy, for example, has shown that previous child death experience is not associated with the subsequent risk of fetal wastage (21). Previous fetal wastage, and not child mortality, is associated with the probability of future fetal loss. Finally, in our effort to isolate biological effect, it is possible that some effects due to behavior were reduced. In Tables 6, 7, and 8 those women experiencing infant deaths of parity (*i*) births were either excluded altogether (Table 6) or separated (Tables 7 and 8). Yet, one could postulate that the child-replacement motivational response would be strongest with the birth immediately following a death event. This initial and possibly more powerful response was not measured in this analysis. Only the motivational response to deaths prior to the parity (*i*) death was assessed.

The advantages of the methodology employed in this study however appeared to effectively counterbalance these limitations. This analysis is the first to utilize unusually reliable longitudinal data and the first to apply birth interval dynamics to a study of this relationship. Moreover, it has demonstrated that life table treatment of both retrospective and prospective data yielded very similar findings. Another advantage has been the study's focus on actual reproductive performance as the dependent variable. Unlike several research efforts previously, it does not rely upon qualitative measures such as fear index or desired family size, variables that are difficult to measure in non-industrialized societies (22).

Overall, the Pakistan and Bangladesh data presented in this study make a convincing case against the importance of the child-replacement motivational response, particularly when magnitude of the behavioral effects are compared with biological effects. In Bangladesh, infant death shortened median birth interval from 37.2 to 24.1 months, a difference of 13.1 months. The largest behavioral response, ignoring the age problems discussed earlier, was only 3.1 months for parity 6 or more women. For all women combined, the behavioral response was essentially absent.

There is however a suggestion that mortality control programs could reduce fertility through a biological mechanism. Better survivorship of infants would facilitate lactation and prolong the period of postpartum sterility, and thus the entire birth interval. The magnitude of this fertility-depressant effect can be crudely projected in the following manner. Given an infant mortality rate of 125 per 1 000 and assuming the Bangladesh birth intervals shown in Table 8, the average birth interval in a population would be 35.6 months. This average is obtained by weighing the intervals of all women by the proportion of infant deaths and survivors. Keeping all other factors constant, an elimination of all infant deaths would lengthen this average interval by 1.6 months to 37.2 months. This is equivalent to reducing fertility by 4 percent, a modest effect by any standard (23).

It is important to point out that this fertility-reducing effect of better infant survivorship is more complex when viewed in terms of population growth rates. While fertility would be reduced, survivorship, a central element of net reproduction, would be improved. From the perspective of a population replacing itself into the next generation, reduced mortality of infants would have dual effects : a reduction of fertility but better survivorship of those infants who are born. Computation of these competing effects is beyond the scope of this paper, but the outcome of these dual changes would result in a reduction of fertility but an overall increase of net reproduction.

Perhaps the most important contribution of this paper has been its illustration of how various methodological approaches may lead to conflicting results and fallacious conclusion. The weakness of using

cumulative fertility as the dependent variable has been shown. Indices of subsequent fertility are useful only if the biological effects of infant deaths are identified and controlled, because of the strong association between child mortality experience and future child loss. Moreover age differences between subgroups of women at the same parity need to be considered. The choice of the dependent variable and how fertility is to be measured are crucial decisions in any future research effort.

The birth interval is a useful measure for avoiding many of these pitfalls. Moreover, future studies dissecting out actual components of birth intervals (postpartum amenorrhea, the waiting time to conception, gestation, and the time required for fetal wastage) would permit a more precise quantification of mortality effects on fertility. The biological mechanism would operate primarily through the length of postpartum sterility while child-replacement motivational response would be expected to affect primarily the conception rate of women at risk to pregnancy.

In essentially noncontracepting populations, such as those in South Asia, the common expectation that behavioral responses would be reflected by higher than normal conception rates among women at risk to pregnancy (or briefer birth intervals) may be too simplistic. Because contraceptive usage is essentially absent, regularly ovulating women in these societies already have high conception rates. Thus, even if women with child loss were to desire consciously to replace child loss and to act accordingly, it would be very difficult for them to achieve very much faster rates of conception than normal women. The changes therefore would have to come from women without child loss, who having achieved their desired family size would prolong their birth intervals by contraception.

This dilemma is illustrated in the following hypothetical situations relating desired family size to reproductive capacity in any given population. If desired family size were to greatly exceed reproductive capacity, then, even if the behavioral response were significant, it would be impossible to detect. Toward the end of their reproductive years, women with no child loss would still continue to produce offspring as rapidly as possible because their reproductive goals had not yet been attained. If reproductive capacity were to greatly exceed desired family size, mothers with and without child mortality at some points would both contracept and prolong their intervals. This is only likely to occur in industrialized societies where mortality levels are already low, where most women are already contracepting, and where the validity of the "child survival hypothesis" is less important for policy formulation. Only if fertility and mortality levels were such that women with child loss were unable to attain their desired family size and women without such losses were capable of exceeding their reproductive goals would the difference in birth intervals between the two groups be significant and easily measured. Under these hypothetical circumstances, the behavioral effect would probably be observed among high parity women, where the gap between desired and actual family size would be largest between women with varying child mortality experience.

This conceptual framework of course assumes, perhaps too simply, that the motivational response is determined by gaps between desired and actual family size. It further assumes that women who attain their family size before completing their reproductive years would deliberately act to reduce their fertility and contraceptive methods were readily available to them. As Coale recently concluded from studies of historical populations, fertility control in a society may remain at low levels even under circumstances where individuals were to perceive it to their advantage to have fewer children unless fertility control were within the calculus of choice of individual couples and means to contracept were known and available to a population (24). Empirical studies from varying geocultural regions, at differing levels of fertility and mortality, and with varying levels of contraceptive usage therefore would be useful in any attempt to understand the effects of mortality on fertility. Even with these efforts, however, the conceptual and methodological barriers to a comprehensive and conclusive investigation of this relationship remain formidable.

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APPENDIX 1 – LIFETABLE COMPUTATIONS OF THE BIRTH INTERVAL IN YEARS BETWEEN PARITIES 1 AND 2 BIRTHS AMONG PAKISTANI WOMEN WITH NO CHILD DEATH EXPERIENCE, 1960-68

Number of Years After the First Child birth	Number Who Had First Child at Time 0 and Were Under Observation at Time X Without Having Had the Second Child	Number Withdrawn from Observation Between Time X and X + 1	Adjusted Number at Risk of Second Birth at Time X	Number Who Had Second Child Between Time X and X + 1	Probability of Having the Second Child Between X and X + 1	Estimated Number Without Second Child by Time X Out of an Initial 1 000 Who Had First Child at Time 0
X	O_x	W_x	O'_x	b_x	$1\,000\,q_x$	l_x
	1	2	3	4	5	6
0	840	99	790.5	5	6.3	1 000
1	736	66	703	79	112.4	993.7
2	591	58	562	233	414.6	882.0
3	300	40	280	164	585.7	516.3
4	96	14	89	45	505.6	213.9
5	37	6	34	15	441.2	105.8
6	16	3	14.5	4	275.9	59.1
7	9	4	7	0	0	42.8
8	5	4	3	1	333.3	42.8

INFLUENCE OF INFANT AND CHILD MORTALITY ON FERTILITY IN INDIA *

R. D. AGRAWAL
Senior Research Officer, Vital Statistics Division
Office of the Registrar General, India – New Delhi

SUMMARY

In recent years, many scholars have postulated a relationship between infant and child mortality and fertility, particularly in connection with the fertility decline during the demographic transition. The position in this respect is not very clear because of absence of empirical data on the subject for most of the countries, as well as due to the inter-play of a number of factors, e.g., physiological, sociological, religious, on the reproductive behaviour of the people. The situation is all the more complex in a developing country like India, where reliable estimates of birth and death rates and infant and childhood mortality were not available until very recently. Nevertheless, based on the available data, some positive relationship seems to exist between high infant mortality and higher fertility, in the Indian sub-continent. In view of the continuing high mortality in India, especially in ages 0-5 years, till very recently, the predominant social norm of having three or four children was not considered inconsistent with a much higher number of live births. Rather, the high infant and childhood mortality rates in the past were conducive to motivation for higher fertility. One basic reason for this has been that in the Indian socio-cultural setting, when the chances of survival of the children are slender, couples opt for large families in the hope that at least a few would survive to adulthood. There is also a predominant male bias among both men and women in India. A family is not considered complete unless the couple have at least one or two surviving sons.

Even when these infant and childhood mortality rates have declined considerably, the change has not immediately become evident to people and their perception continues to be coloured by past experience. As this gap between knowledge of the current situation and behaviour is not bridged, the result is larger families because of higher survival rates. Accordingly, there is an increased realisation on the part of demographers in India and elsewhere that studies should be undertaken about the beliefs and opinion of parents regarding infant and child mortality, as part of surveys and field studies of birth control and related topics, along with an attempt to collect detailed data that would enable study of relationship of infant and childhood mortality on level of fertility. The Indian Sample Registration System and the Fertility Survey conducted in a sub-sample of SRS villages as well as other local studies are expected to throw light on this important subject in the near future.

* The views expressed in this paper are of the author and not necessarily of the Registrar General's Office or of the Government of India.

RÉSUMÉ

Ces dernières années, de nombreux chercheurs ont émis l'hypothèse selon laquelle il existe une relation entre la fécondité et la mortalité infantile et celle des enfants, en particulier lors du déclin de la fécondité au cours de la transition démographique. Les idées sur ce point ne sont pas très claires car on manque de données empiriques pour la plupart des pays. En outre, de nombreux facteurs, physiologiques, sociologiques et religieux exercent une influence sur le comportement génésique. La situation est particulièrement complexe dans un pays en voie de développement comme l'Inde où, jusqu'à ces dernières années, il n'y avait pas d'estimations dignes de confiance des taux de natalité et de mortalité ainsi que de la mortalité infantile et de celle des enfants. Cependant, si on se fonde sur les données dont on dispose, il semble y avoir une relation positive entre une forte mortalité infantile et une fécondité élevée dans le sous-continent indien. Du fait de la forte mortalité qui jusqu'à récemment s'est maintenue en Inde, en particulier de 0 à 5 ans, la norme sociale prédominante d'avoir 3 ou 4 enfants impliquait un nombre beaucoup plus élevé de naissances par couple. En fait, le taux élevé de mortalité infantile et de mortalité des enfants motivait les couples à avoir une forte fécondité. Une raison fondamentale à cet état de choses est que dans le contexte socio-culturel de l'Inde, lorsque les probabilités de survie des enfants sont faibles, les couples tiennent à avoir de grandes familles dans l'espoir que quelques-uns de leurs enfants parviendront à l'âge adulte. Il y a également une grande préférence en faveur des garçons, tant chez les pères que chez les mères. Une famille n'est pas considérée comme complète tant qu'il n'y a pas au moins un ou deux fils survivants.

Même lorsque ces taux de mortalité infantile et de mortalité des enfants ont beaucoup baissé, ce changement n'a pas été immédiatement perçu et on continue à réagir comme par le passé. Tant que la prise de conscience de cette transformation ne s'est pas produite, la dimension des familles augmente du fait de la plus forte proportion des enfants qui survivent. C'est pourquoi les démographes, en Inde et ailleurs, pensent, de plus en plus, qu'il conviendrait de poser des questions sur les croyances et les opinions des parents à l'égard de la mortalité infantile et de celle des enfants dans les enquêtes et les recherches sur le terrain qui ont trait à la limitation des naissances et aux sujets de ce genre. Il faudrait aussi, par la même occasion, rassembler des données qui permettent d'analyser la relation entre la mortalité infantile et la mortalité des enfants et la fécondité. Le système indien d'état civil par sondage et l'enquête sur la fécondité faite sur un sous-échantillon de villages ainsi que quelques monographies devraient mieux nous renseigner sur ce sujet important dans un proche avenir.

RESUMEN

Muchos investigadores han afirmado, en años recientes, que existe una relación entre la mortalidad infantil y de la niñez, y la fecundidad, a raíz principalmente, de la declinación de la fecundidad en el curso de la transición demográfica. Sin embargo, este problema no está totalmente resuelto, debido en parte a la falta de datos empíricos sobre el tema en la mayoría de los países, y también al juego recíproco de muchos factores sobre la conducta reproductiva de una población, como por ejemplo características fisiológicas, sociológicas, religiosas, etc. Más compleja es aún la situación en un país en desarrollo como la India, donde las tasas de natalidad y de mortalidad infantil y de la niñez, han sido estimadas de una manera confiable sólo a partir de hace muy pocos años. Sin embargo, incluso sobre la base de la información disponible, parecen existir algunas inter-relaciones positivas entre la alta mortalidad infantil y la fecundidad en este sub-continente. La alta mortalidad existente por mucho tiempo en la India, principalmente la alta mortalidad de los niños de 0 a 5 años, situación que se mantenía hasta hace muy poco, justificaba la norma social predominante de

que un número de tres o cuatro niños no era contradictorio con un número mucho mayor de nacidos vivos. Por el contrario las altas tasas de mortalidad infantil y de la niñez existentes en el pasado eran mas bien una motivación para la alta fecundidad. Una razón básica que explica este hecho es que en el marco tradicional socio-cultural indú, cuando las probabilidades de sobrevivencia de los niños eran escasas, las parejas optaban por tener muchos hijos con la esperanza de que algunos sobrevivieran hasta la edad adulta. Más aún, también existe un sesgo en cuanto a la preferencia de los hijos hombres, lo que hace que no se considere como completa una familia, a menos que existan uno o dos sobrevivientes del sexo masculino.

Incluso cuando la mortalidad infantil y de la niñez disminuyó de una manera muy importante, la población no percibió inmediatamente este cambio y continuó influenciada por la experiencia del pasado. De tal manera que se ha producido un desfase entre el conocimiento de la situación presente y la conducta, teniendo como consecuencia familias mucho más numerosas debido a las mayores tasas de sobrevivencia. Al mismo tiempo se ha producido una conciencia creciente entre los demógrafos de la India y de otras partes, acerca de la necesidad de estudiar las creencias y opiniones de los padres sobre la mortalidad infantil y del niño, como una parte de encuestas e investigaciones de terreno referentes al control de la natalidad y otros temas conexos, lo que permitirá también reunir información para estudiar la influencia de la mortalidad infantil y de la niñez sobre la fecundidad. Es posible pensar que en el próximo futuro se lograran importantes avances en relación a estos temas tan importantes. El Sistema Nacional de Registros por Muestreo, así como la Encuesta de Fecundidad realizada utilizando una sub-muestra de aldeas de tal sistema, serán de gran utilidad para tal propósito. Otros estudios locales contribuirán en el mismo sentido.

The study of infant and child mortality has been attracting world-wide attention mainly because of the considerable depletion of each human generation during the relatively short period of the first nine months of gestation and the first few years of life. The scope of these studies has been confined largely to the quantitative aspects of infant and child mortality and the factors associated with their high levels. In recent years, many scholars have postulated a relationship between child mortality and fertility, particularly in connection with the fertility decline during the demographic transition. At the same time, it is recognised that association of infant and child mortality with the level of fertility is not as clear as its relation to general mortality. In many parts of the world, high fertility rates are reported to be associated with high mortality rates, while low fertility is said to go along with low mortality (1). In a cross-sectional study making use of data for 41 nations pertaining to the 1950's, Heer (2) found that fertility was positively associated with infant mortality. A study by Shafick Hassan (3) in Egypt supported the contention that the experience of infant and childhood mortality tends to raise fertility. One principal reason given for this positive relationship is that parents want to be certain of having a specified minimum number of children survive to maturity. It is advocated that where the average mortality of offspring is high, the variance in mortality will also be large. Hence the desire for a minimum number of surviving children might elevate fertility in high mortality areas to such a degree that the net reproduction rate and the annual rate of natural increase might be greater there than in areas where mortality was low (Heer & Smith) (4). Ridley *et al* (5) found that in societies where the post-partum non-susceptible period is prolonged owing to the wide-spread practice of lactation, intervals between births are longer when the preceding child survives. Consequently, in their opinion, improved survival of infants may be expected to reduce the number of births. There is also an increased realisation that reduction of infant and child mortality is one necessary pre-condition for acceptance of the idea of a small family, particularly in societies which for many reasons continue to attach major importance to male offspring and their survival.

The subject has received comparatively less attention in India and many other developing countries where there has been more emphasis on fertility measurement and family planning evaluation. According to Kuthiala (6), demographic theory has invariably taken fertility and mortality to be more or less independent variables while the fact, considering the developing countries, is that mortality and natality are highly linked for "average man". It is therefore argued that this "critical level of mortality" may prove to be a big aid for controlling population growth. Many other demographers (7) have advocated further investigation and clarification of the possible contributions of declining mortality, particularly infant and child mortality, to changes in natality. The scope of this paper is to test the hypothesis of a possible relationship between infant and child mortality and fertility in the Indian sub-continent, based on the available evidence.

Limitations

In a recent study in Taiwan, Rutstein (8) tried to assess the possible influence of child mortality on fertility by testing a hypothesis through multiple classification analysis of replies to three special questions on attitudes towards child mortality from a sample of husbands. The hypothesis was :

1) The death of a child induces a desire to replace the lost child that results in an increased probability of having an additional birth. Or, as a substitute, (1a), the death of a male child alone induces a desire for replacement.

2) Fear of the death of a child (or the death of a male child) induces couples to have more children than otherwise they would have. A corollary of hypothesis (2) is that couples are motivated to have more than enough additional children as "insurance" to offset the death of a child (over-replacement).

Not much empirical data are readily available in India on a country-wide basis to enable use of a similar analytical approach though the position is gradually improving. Some of the studies that have been carried out had limited geographical coverage and inadequate sample or were diagnostic and descriptive in nature. As such, it seems difficult to generalise the results with a fair degree of certainty. Nevertheless, based on these local studies and the available experience, a broad attempt has been made to establish a possible relationship between child and infant mortality and fertility in India. These findings are proposed to be supplemented by empirical data expected to flow from special fertility surveys in sub-samples of the Sample Registration System (SRS) units, planned at regular intervals by the office of the Registrar General, India.

Indian setting

India is the second most populous country in the world with a population of 548 million in 1971 and an annual geometric growth rate of 2.2 per cent during 1961-71. Its population at present is estimated at 580 million. India has more than 14 per cent of the world's population although her land area constitutes only a little more than 2 per cent of the world's. India's population lives in over half a million villages and about 3,000 towns and cities. The overall density of population is nearly 178 persons per square km. Nearly 20 per cent of the population is classified as urban, though the level of urbanisation varies much among individual States.

India has an age-structure with a broad base typical of developing countries. About 42 per cent of population is below 15 years, 52 per cent in the age-group 15-59 years, and only 6 per cent in the age-group 60 years and above. In absolute terms, we have over 230 million children. The youthful nature of India's population is evident from the fact that over 58 per cent of its people are below 25 years in age.

In the country as a whole, there are more males than females, the number of females per 1,000 males being 930 in 1971. Roughly 50 per cent of the population is unmarried, 43.5 per cent married and about 6 per cent widowed.

When India attained independence in 1947, the country already had a large population which was rising very fast as a result of a dramatic fall in the death rate. As a welfare State, India's development efforts were right from its inception directed at striking a balance between the creation of the base for a fast economic growth and providing for the minimum welfare needs of its vast population. Family planning was included as an integral part of the successive five-year plans, essentially as a welfare measure.

India's achievements in different fields have been quite remarkable in the post-independence period. Even then, the per capita increase in income and availability of essential commodities has been marginal, primarily owing to the runaway growth of its population (10).

PAST LEVELS AND TRENDS IN MORTALITY AND FERTILITY

Historically, India has a long tradition of collection of vital statistics. But for several reasons, the instruments of measurement of mortality, morbidity and fertility have not been very defendable till very recently. Accordingly, much of the analysis for the past is based on the estimates worked out by the census actuaries. Table 1 gives the vital rates for India since the beginning of this century.

Though it would not be scientific to regard any one set of figures as final and more correct than the others, it is obvious that the decline in general mortality (including child and infant mortality) has been much sharper than the corresponding decline in birth rates. The rapid decline in mortality is partly attributed to the fact that after 1921 the government was able to organise more effectively the control of famines and

epidemics which were the two major causes of high mortality up to the mid-thirties. It seems more probable that emphasis on public health activities like eradication of malaria, anti-tuberculosis campaign, maternity and child welfare, environmental hygiene and expansion of curative services, coupled with the use of modern advances in medicine, have accelerated the decline in mortality, especially after independence. The major contribution to this rapid decline in the general mortality is that of infant and childhood mortality as revealed by table 2. On the other hand, birth rates in India have remained more or less steady, though there has been a noticeable decline after the introduction of an intensive family planning programme from the mid-sixties. Obviously, the rapid decline in mortality has not been accompanied by a corresponding decrease in fertility. This is reflected in the accelerated growth of population during the last three decades and a widening gap between births and deaths (Chart I). There is reason to believe that rapid declines in mortality, particularly infant and child mortalitv, have not materially affected the traditional outlook of having a larger family, especially in the rural areas.

TABLE 1 – ESTIMATES OF BIRTH AND DEATH RATES IN INDIA (rate per 1 000 pop.)

Decade	Crude birth rate		Crude death rate	
	Reverse-survival method	Quasi-stable method	Reverse-survival method	Quasi-stable method
1	2	3	4	5
1901-11	49.2	52.4	42.6	46.8
1911-21	48.1	n.a.	47.2	n.a.
1921-31	46.4	50.8	36.3	40.4
1931-41	45.2	46.2	31.2	33.5
1941-51	39.9	43.1	27.4	30.0
1951-61	40.9	40.4	22.0	20.9
1961-71	41.1	40.0	18.9	17.8

Source : *Country Statement, World Population Conference, Bucharest.* August 1974, p. 56(*9*)

Figures for 1961-71 are based on one per cent sample and are provisional. The figures are based on improved methodology and are not strictly comparable with the earlier figures. If no adjustment is made of under-enumeration of certain young age-groups, as in the case of earlier figures, the comparable figures of birth and death rates for the decade 1961-71 would be 39.2 and 17.0 respectively.

TABLE 2 – MORTALITY INDEX FOR INDIA (1911-61)

Age-group (years)	1911	1921	1931	1941	1951	1961
1	2	3	4	5	6	7
			Males			
0-4	100	109	89	79	67	50
5-9	100	96	67	54	81*	34
10-19	100	150	73	75*	83*	34
20-29	100	127	78	65	62	33
30-39	100	113	88	62	64	47
40-49	100	105	94	59	71	66
50-59	100	101	97	72	88	80
60-69	100	98	97	75	101	88
70+	100	100	100	100	100	100
			Females			
0-4	100	102	86	77	74	52
5-9	100	85	60	50	92*	42
10-19	100	158	86	93*	70	36
20-29	100	132	107	81	59	38
30-39	100	119	109	77	80	76
40-49	100	127	108	76	80	76
50-59	100	104	100	77	83	80
60-69	100	92	93	74	92	81
70+	100	100	100	100	100	100

* Doubtful pattern of improvement in mortality

Source : Kumidini Dandekar, *Mortality and longevity in India during 1901-61*, Census Centenary Seminar, New Delhi (October 1972)(11).

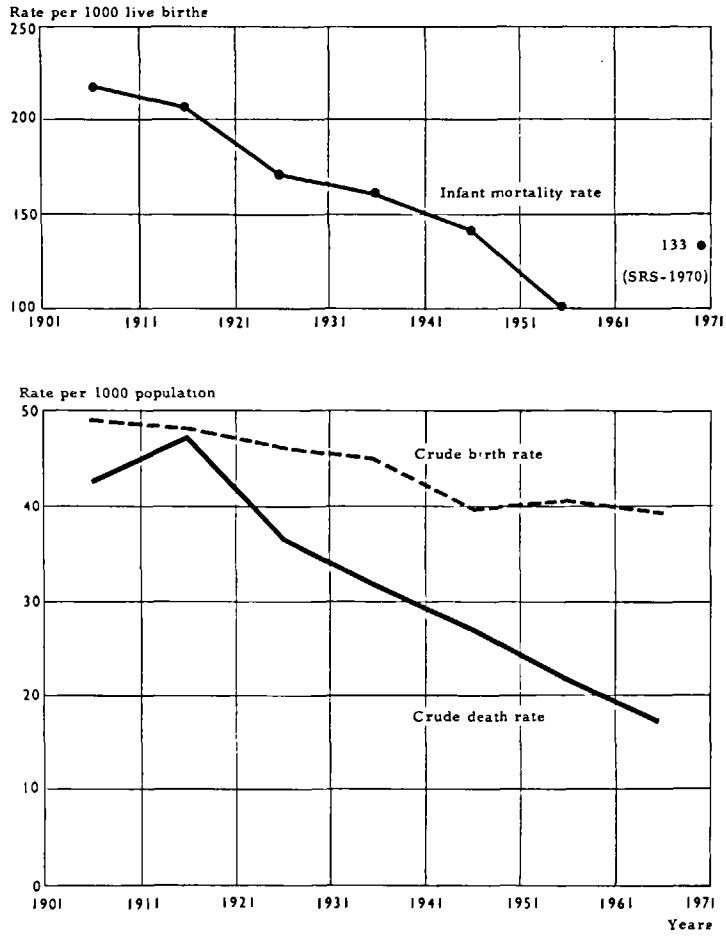

Chart I. – Demographic transition in India (1901-1971)

The motivational efforts by the government in recent years have definitely made a dent in births of a higher order, but by and large, the pace of fertility decline has been slow. There is an increasing realisation that emphasis on the small family norm, spread of education particularly among women, and postponement of marriages, would help in bringing down fertility more rapidly in the foreseeable future. Increased urbanisation may also possibly result in the lowering of birth rate by loosening family ties and a questioning attitude towards time-honoured customs and traditions favouring a large family.

Infant mortality

The infant mortality rate (IMR) is regarded as one of the most sensitive and reliable indicators not only in regard to mortality conditions of a country but also modernisation and socio-economic development. Unfortunately, data for estimating infant mortality in India were not very defendable as in the case of crude birth and death rates, in respect to their completeness and coverage. Varying estimates of IMR are available from different sources, e.g., civil registration, National Sample Survey (NSS) and other *ad-hoc* studies. Lately, the SRS has yielded very useful estimates and the position is expected to improve further. By and large, the estimates up to the mid-sixties cannot be taken to indicate a realistic picture of IMR in India because of the large-scale deficiencies in the registration of both births and deaths. Nevertheless, they afford a broad comparison of health conditions obtaining in the first half of this century and those in recent years.

A more reliable indicator of the decline in infant mortality is given by the probability of death at age '0', used by census actuaries from time to time and presented in table 4. These too point to a rapid decline in infant mortality during the last 30 years, as compared to a steady level of birth rates.

Estimates of IMR for recent periods, based on comparatively more reliable data, are presented in table 5.

Though the IMR figures over the past several decades are not strictly comparable, one obvious conclusion is that infant mortality has at least been halved during the last decade as compared to levels

TABLE 3 – INFANT MORTALITY RATES IN INDIA (1901-60) (Per 1 000 live births)

Period 1	IMR 2	Period 3	IMR 4
1901-05	215	1931-35	174
1906-10	228	1936-40	161
1911-15	204	1941-45	161
1916-20	219	1946-50	134
1921-25	174	1951-55	113
1926-30	178	1956-60	98

Based on 5-yearly average of registration data.

Source : 1. S. Chandra Sekhar. *Infant mortality in India 1901-1955*, Allen & Unwin London (1959) p. 95 (*12*).

2. S.K. Kuthiala, "On critical level of mortality for natality decline", *Demography India.* (December 1973) p. 256 (*6*).

TABLE 4 – PROBABILITY OF DEATH AT AGE '0' AND CORRESPONDING CRUDE BIRTH RATE IN INDIA

Decade	Probability of death at age '0'		Crude birth rate (per 1 000 pop.)
	Males	Females	
1	2	3	4
1901-11	290.0	284.5	49.2
1911-21	N.A.	N.A.	48.1
1921-31	248.7	232.3	46.4
1931-41	N.A.	N.A.	45.2
1941-51	190.0	175.0	39.9
1951-61	153.0	138.0	41.7
1961-71	135.0	130.0	41.1

Source : Registrar General India. *The Population of India* (1974), pp. 10 and 42 (*13*).

TABLE 5 – INFANT MORTALITY RATE IN INDIA FOR RECENT YEARS
(Per 1 000 live births)

Source 1	Rural 2	Urban 3	Overall 4
NSS			
14 round (July 1958-June 1959)	146	N.A.	N.A.
17 round (Sept. 1961-July 1962)	111	81	N.A.
18 round (Feb. 1963-Jan. 1964)	126	90	N.A.
19 round (July 1964-Jan 1965)	115	79	N.A.
20 round (July 1965-Aug. 1966)	108	67	N.A.
SRS			
1968	137	N.A.	N.A.
1969	140	N.A.	N.A.
1970	133	86	125
1971	131	81	122

Source : 1. NSS reports (14)
2. *Sample Registration Bulletin* (April 1974) (15).

obtaining at the beginning of the century. Examination of data available from varied sources serves to indicate that the current level of infant mortality rates in India is between 120 and 140. This is no doubt a remarkable achievement, but compared to rates of below 20 in the advanced countries, India's infant mortality is still very high. This is attributed to the fact that in India, exogenous causes which have largely been controlled in the advanced countries, still account for a substantial proportion of infant deaths.

Infant deaths by components

In the context of comparatively high level of infant mortality in India, it seems pertinent to study these rates by their major components, viz., neo-natal (occurring during the first four weeks) and post-neonatal (29 days to 12 months), attributed to endogenous and exogenous factors respectively. The position about earlier

TABLE 6 – INFANT MORTALITY BY COMPONENTS IN INDIA (per 1 000 live births)

Source	Neo-natal	Post-neonatal	Infant mortality
1	2	3	4
	Rural		
NSS 19 round (July 1964-June 1965)	63 (55.3)	51 (44.7)	114 (100.0)
NSS 21 round (July 1966-June 1967)	61 (54.5)	51 (45.5)	112 (100.0)
SRS 1968	74 (54.1)	63 (45.9)	137 (100.0)
SRS 1969	75 (53.5)	65 (46.5)	140 (100.0)
	Urban		
NSS 19 round (July 1964-June 1965)	45 (56.3)	35 (43.7)	80 (100.0)
NSS 21 round (July 1966-June 1967)	44 (56.4)	34 (43.6)	78 (100.0)

Source : 1. NSS Reports (*14*)
2. *Infant Mortality in India.* SRS Analytical Series (1971)(*16*)
Figures within brackets indicate percentage distribution.

TABLE 7 – INFANT MORTALITY BY AGE AND SEX IN RURAL INDIA (SRS 1968 and 1969)

Year	Sex	Total infant mortality	Neo-natal		Post-neonatal	
			< 7 days	7-28 days	29 days-6 months	7-12 months
1	2	3	4	5	6	7
		Rate per 1 000 live births				
1968*	all infants	137	43	31	39	24
	males	136	46	33	36	21
	females	138	40	28	43	27
1969**	all infants	140	43	32	43	22
	males	132	44	30	38	20
	females	148	41	35	48	24
		Percentage distribution				
1968	all infants	100.0	31.6	22.5	28.5	17.4
	males	100.0	33.8	24.6	26.2	15.4
	females	100.0	29.3	20.3	30.9	19.5
1969	all infants	100.0	30.6	22.9	30.5	16.0
	males	100.0	33.6	22.2	28.8	15.4
	females	100.0	27.7	23.6	32.2	16.5

* Excludes Bihar, Haryana, Himachal Pradesh, Madhya Pradesh, Nagaland, Orissa, Tamil Nadu and West Bengal and union territories.

** Excludes Bihar, Himachal Pradesh, Madhya Pradesh, Nagaland, Orissa, West Bengal and union territories.

Source : 1. *Infant mortality in India,* SRS Analytical Series No. 1 (1971)(*16*)
2. "Recent trends in infant mortality in India", *Sample Registration Bulletin,* (July-December 1972) (*17*).

decades is not very clear. Nevertheless, based on registered data used by Chandra Sekhar (12), it was found that during the period 1921-39, about 47-48 per cent of all infant deaths were under one month, 28-30 per cent between 1 and 6 months, and 22-23 per cent between 6 and 12 months. Thus nearly 50 per cent of infant mortality in any year was taking place in the first month of the infant's life. Data for more recent periods show a slight improvement in the post-neonatal mortality, though the figures for pre- and post-independence periods are not strictly comparable.

A clearer picture of infant mortality by age and sex for rural India is available from SRS data for the years 1968 and 1969 (The data for subsequent years is under tabulation and analysis).

Childhood mortality

Infants and children are considered to be the most vulnerable group for deaths, particularly in the developing countries. In India, death rate among children (0-14 years) has been very high. According to 1964 registration data, which of course are grossly deficient, about 18.3 per cent of total deaths were of infants less than one year, 17.2 per cent of children between 1 and 4 years, 5.4 per cent between 5 and 9 years and 2.9 per cent in age-group 10-14 years, making a total of 43.8 per cent of total deaths. The percentage was slightly higher in rural areas (44.5) as against 41.1 for urban. A more reliable picture emerges from SRS data presently available for a limited number of years.

The position of childhood mortality for males and females available for 1968 and 1969 is given in table 9.

The age-specific death rates (Table 10) indicate further the levels and trends in infant and childhood mortality over the last three decades.

Apparently, as judged by age-specific death rates and the mortality index given in Table 2, infant and childhood mortality in India has been drastically reduced. But their levels are still very high. The causes of this profuse wastage of human lives are not satisfactorily described by the existing statistics. By and large, the

TABLE 8 – PROPORTION OF CHILDHOOD DEATHS TO TOTAL DEATHS IN INDIA (SRS 1968-71)

Period	Age at death (years)				Total 0-14 years
	< 1	1-4	5-9	10-14	
1	2	3	4	5	6
			Rural		
1968	54.7		4.7	1.6	61.0
1969	52.8		4.9	1.8	59.5
1970	28.9	18.6	4.6	1.7	53.8
1971	28.4	18.6	4.4	1.9	53.3
			Urban		
1969	49.0		5.0	1.7	55.7
1970	25.2	13.7	3.7	1.4	44.0
1971	24.4	15.4	3.9	1.9	45.6

Data for 1970 and 1971 are provisional, being based on a limited number of states. Detailed tabulations are in hand.

TABLE 9 – PROPORTION OF CHILDHOOD DEATHS IN INDIA BY SEX (SRS 1968 and 1969)

Age at death (years)	Rural				Urban (1969)	
	Males		Females		Males	Females
	1968	1969	1968	1969		
1	2	3	4	5	6	7
0-4	53.7	50.5	55.8	55.0	47.1	50.9
5-9	4.6	4.5	4.7	5.2	4.2	5.9
10-14	1.6	2.1	1.7	1.6	2.0	1.5
0-14	59.9	57.1	62.2	61.8	53.3	58.3

Source : As for table 7.

TABLE 10 – AGE-SPECIFIC DEATH RATES IN INDIA FOR YOUNGER AGE-GROUPS

Age-group (years)	Census actuaries		SRS		
	1941-51	1951-61	1968 Rural	1969 Rural	1969 Urban
1	2	3	4	5	6
			Males		
0-1	190.00	153.22	59.12	58.32	43.16
1-4	135.21	83.53			
5-9	74.62	30.91	5.53	5.79	3.67
10-14	58.45	17.92	2.26	2.99	1.85
			Females		
0-1	175.00	138.26	66.82	70.16	47.06
1-4	174.85	100.23			
5-9	84.01	37.88	6.26	7.71	5.45
10-14	53-61	19.69	2.60	2.72	1.56

Source : 1. S.K. Rao, P.S. Mahapatra and P.S. Bhatia, *Mortality in India in relation to prospects of fertility decline.* CFPI Technical paper 10 (1970) (*18*).
2. Registrar General, India, *Measures of fertility and mortality in India,* SRS Analytical Series No. 2 (1972) (*19*).

high infant mortality is attributed to multiple causes including genetic and environmental factors, which operate differentially during the neo-natal and post-neonatal periods. Based on sample studies carried out in India, Sundar Rao (20) has summarised the major causes of high infant mortality in this country to include the comparatively younger age of the mother ; shorter time-interval between births ; primitive customs and habits ; shortage of trained personnel like mid-wives, health visitors, etc. ; poor environmental sanitation ; larger family size. The main causes of death in early childhood are those characteristic of the post-neonatal period of infancy, where infectious disease and malnutrition assume greater importance and their inter-action with acute infections, enhances the clinical severity of infectious processes and mortality. Multiple causal factors, however, operate as usual in the Indian setting, some primarily biological, others social or cultural. After the second year, death rates decline progressively to lower levels, although with varying promptness, under the influence of specific environmental features. According to Jain (21), the conditions underlying the high levels of infant and child mortality in India are rooted in the factors which account for the under-developed state of the country's economy. Inadequacy of resources prevents quick improvement in health and education. In his opinion, therefore, it may not be possible to bring down infant and childhood mortality to the level obtaining in advanced countries, though some reduction from the present level is not ruled out.

INFANT AND CHILDHOOD MORTALITY IN RELATION TO FERTILITY

As indicated earlier, this particular aspect of infant and childhood mortality has remained almost unexplored in most of the developing countries including India. Nevertheless, within the limited framework and based on a few local studies, a broad analysis has been attempted here.

Attitudes towards desired family size

An important determinant of fertility performance in a society is the norm prevalent in that society with regard to family and family size. Such a norm corresponds to the number of children considered optimum for maximising the ability of the family unit to achieve the socially-valued goals. Available experience shows that in the Indian socio-cultural environment, there has been a relatively strong relationship between high child and infant mortality and a larger family size. In view of the continuing high mortality in India, especially in ages 0-5 years, till very recently the predominant social norm of having three or four children per couple was not considered inconsistent with a much higher number of live births. Rather, the

high infant and child mortality rates in the past were conducive to motivation for high fertility. The Indian situation in this respect is thus summarised by Rele and Bhande (22) :

"When the chances of survival of the children are slender, couples opt for large families in the hope that at least a few would survive to adulthood. When these mortality rates decline, the change does not immediately become evident to people and their perception continues to be coloured by past experience. As this gap between knowledge of the current situation and behaviour is not bridged, the result is larger families because of higher survival rates... The traditional pattern of the family is also not conducive to fertility control. The joint family encourages higher fertility as the biological parents may not be called upon to provide the basic needs of the children born, as the family is jointly responsible for all the children born in the family".

According to Jain (21) also, Indian couples hesitate to adopt terminal methods of family limitation in view of the comparatively high mortality of the first five years of life. In an all-India family planning survey conducted by the Operations Research Group (ORG), Baroda, it was found that the terminal method was acceptable to most of the couples only when they had at least two living children. On the other hand, nearly 42 per cent of those using non-terminal methods had started using family planning before having three living children.

TABLE 11 – PRACTICE OF FAMILY PLANNING BY NUMBER OF LIVING CHILDREN IN INDIA

Category of contraceptors	Percentage of couples with number of living children						
	None	1	2	3	4	5	Total
1	2	3	4	5	6	7	8
Terminal methods	1.00	1.94	10.64	19.87	23.48	43.07	100.00
Non-terminal methods	5.81	15.01	20.77	18.74	13.31	26.36	100.00

Source : Demographic Research Centre, Baroda, *Baroda Reporter* (August 1973), p. 9 (*23*).

In another study in Baroda district, it was observed that the mean number of living children after which men resorted to sterilisation in Baroda city was 4.02. The corresponding mean number of living children in the rural areas of Baroda district was found to be 3.94 children, whereas the mean number of live births to the urban and rural cohorts were found to be 5.05 and 5.43 respectively. The higher difference in the mean number of live births and the number of living children in the rural cohorts was attributed to higher mortality in the rural area compared with that in urban areas (23).

One obvious but interesting result of the follow-up survey of sterilised spouses (ORG) was that there was a predominant male bias among both men and women who had accepted sterilisation. There was hardly one per cent of the sterilised women who had only female children. On the other hand, a substantial proportion of tubectomy as well as vasectomy cases had only male children living.

About 87 per cent of sterilised females and 89 per cent of sterilised males had children of both sexes before accepting the method.

TABLE 12 – PERCENTAGE DISTRIBUTION OF LIVING CHILDREN BY SEX FOR VASECTOMY AND TUBECTOMY CLIENTS

Living children	Percentage	
	Tubectomy cases	Vasectomy cases
1	2	3
All males	11.6	11.2
All females	1.0	–
Mixed		
More males than females	45.2	33.7
More females than males	23.6	26.5
Equal males and females	18.5	28.6

Source : Demographic Research Centre, Baroda, *Baroda Reporter*, (August 1971), p. 4 (*24*).

TABLE 13 – AVERAGE NUMBER OF CHILDREN BORN ALIVE PER WOMAN OF UNBROKEN MARRIAGE DURING THE REPRODUCTIVE AGE

Survey	Average number of children	
	Rural	Urban
1	2	3
Bengal Survey (1947-49)		
Ballygunj (Upper middle class)	–	5.7
Beniatola (Lower middle class)	–	6.2
Singur	7.3	–
Gokhale Institute of Politics & Economics Surveys		
Poona (1951-52)	6.4	6.4
Poona (1956)	–	5.9
Nasik (1952-54)	6.2	6.6
Kolaba (1953-54)	6.1	5.8
Satara North (1952-54)	6.3	6.1
U.N. & Govt. of India Mysore Survey		
Bangalore city (1952)	–	6.2
Rural areas (1952)	6.0	–
NSS		
2 and 4 rounds-couple fertility (1951-52)	5.9	5.9
16 round – family planning schedule (1960-61)	–	6.5
17 round (1961-62)	4.7	4.9
Surveys by Registrar General, India, Maternity data of 1951 census		
Tranvancore-Cochin	6.6	6.4
East Madhya Pradesh	6.1	6.3
West Bengal	6.0	–
Sample census of births and deaths in seven districts of U.P. (1952-53)	6.2	–
Registration data (1961)	–	6.6
Post-census survey 1961 for currently married women (43+)		
Assam	4.3	5.0
Jammu & Kashmir	4.7	4.9
Kerala	6.0	5.7
Madhya Pradesh	5.7	5.9
Mysore (now Karnataka)	4.7	5.1
Punjab	5.6	5.7
Rajasthan	4.1	4.5
Delhi	6.4	5.7
Gujarat	5.0	5.1
Uttar Pradesh	4.2	4.4
Others		
Kanpur and Lucknow surveys (1951)	–	7.8
Patna survey (1956)	–	5.9
Delhi survey (1958-60)	7.1	–
Greater Bombay fertility survey (1966)	–	4.6
Central India survey (1958)	6.3	6.6 } 7.1 }
ORG – Family planning practices survey (45 years+)	6.0	–

Source : *The Population of India*, Registrar General's office, New Delhi (1974), pp. 14-15 (*13*).

NSS 16 round results relate to women aged 47 years and above.
NSS 17 round results relate to couples married during 1921-30.

As the mean age at marriage of this cohort was around 16, the results may pertain to women aged 44 years and above. Thus the results are only broadly comparable.

Registrar General's survey relates to women who had at least one child-birth and who remained married on census day.

Actual fertility behaviour in terms of average number of children

One possible but important indicator of a positive relationship between infant and child mortality and fertility could be the average number of children born per woman of unbroken marriage during the reproductive age. When infant and child mortality is comparatively high, there is reason to believe that couples would prefer to have a larger number of children to "insure" against heavy loss. In India, the average number of children born to women with unbroken marriages during their reproductive span, as reported by different studies, is shown in Table 13.

These studies show that during 1947-60, the average number of children was varying between 5.9 and 7.3 in rural and between 5.7 and 7.8 in urban areas. These figures also indicate that rural-urban differentials with regard to completed family size were minimal. Though extensive data is not available on literacy and fertility, education seems to have a positive effect on fertility behaviour. According to the results of 16 round of NSS, among women 47 years and over with unbroken marriages, illiterate women or women with primary education had, on average, 6.6 children ; those who had completed middle school education 5.0, those with a high school education 4.6 ; and those who had been to university 2.0. The average number of children after 1960 seems to have come down slightly, but there have not been many studies at the national level to throw light on this. According to SRS data, the average number of children born alive to current mothers in the almost completed fertile age-group 40-44 years for rural India came to 6.5 and 6.4 during 1968 and 1969 respectively. This of course differs from the completed fertility in that it refers only to one particular section of women of the reproductive age-group having current births (19). Detailed information on this aspect is likely to emerge from the fertility survey conducted by Registrar General's office during 1972 in sub-samples of SRS units, data in respect of which are currently under tabulation and analysis.

Effects of improved infant survival on inter-birth interval

The study of the interval between births in a non-contraceptive population furnishes important information on family growth and on variables that affect the principal components of spacing of births. It has also an important bearing on our present study. It is argued that a child death shortens the average inter-birth interval by as much as a year or more and that in a population where family-size goals are fixed at a level short of the biological maximum, the loss of a child may lead to a decision to replace it. Alternatively, awareness of community mortality levels may produce an anticipation of child loss and an adjustment of fertility goals (Preston) (25). In a study made by Ridley *et al* (5) it was established that in the presence of a long period of post-partum non-susceptibility, decreased infant mortality may considerably lengthen birth intervals and depress the natality of intact marriages. Accordingly, improvements in infant survivorship may, to some extent, reduce the number of births.

In India, relatively few studies are available on this important subject. Based on data in respect of 1,107 women covered as part of a demographic survey of Patna in 1955, the average birth-interval by present age of mother was found to be as under :

TABLE 14 – AVERAGE BIRTH-INTERVAL BY PRESENT AGE OF MOTHER (Patna 1955)

Present age (years)	Interval in months						
	Marriage and first	1st and 2nd	2nd and 3rd	3rd and 4th	4th and 5th	5th and 6th	6th and 7th
1	2	3	4	5	6	7	8
15-19	40.2	27.8*					
20-24	46.7	29.3	32.2	32.5	29.5*	29.5*	
25-29	43.9	32.8	28.6	29.3	33.5	31.2*	
30-34	44.8	34.6	34.6	31.4	34.4	33.1	36.3
35-39	47.5	37.4	35.4	31.8	34.5	36.2	31.1
40-44	51.2	34.3	35.4	36.6	36.6	36.4	32.8
45-49	55.3	49.7	36.1	35.0	33.9*	40.2	32.3
50+	65.2	37.6	37.2	38.8	37.4	36.9	34.1

* Calculations based on less than 10 observations.

Source : M.E. Khan, "Factors affecting spacing of births, *The Journal of Family Welfare*, Bombay, (December 1973), p. 55 (*26*)

In studying the effect of infant mortality and sex of previous child on the birth-interval, it was pointed out that if a child died shortly after its birth, often a new pregnancy began within a short interval. Similarly, the sex of the previous child was reported to be of significance in increasing or reducing the birth interval for the next birth. Some data yielded by the above study on birth-intervals according to the sex and life span of the previous child are given in Table 15.

Thus sex preference and life-span of the previous child were found to play a dominant role in increasing or reducing the birth interval. The interval between two consecutive live births when the previous child was male and alive was greater than when the previous child was female and alive. Similarly, the interval between two births was reduced if the child died in infancy and specially if this was a male child. Shorter intervals were attributed to the desire of the parents to have another child and the reduction in the length of post-partum amenorrhoea.

In another study carried out in Punjab, Wyon and Gordon (27) observed that the interval between pregnancies was inordinately short when the first pregnancy ended in a still birth or an abortion occurred. The interval then was 19.4 months, compared to 29.7 months from live birth to live birth. According to them, short intervals of the same order also occurred when the first births ended in neonatal deaths. When death was within the first year, the interval was 23.7 months ; when the first child lived beyond the first year, the interval was 31 months.

TABLE 15 – AVERAGE BIRTH-INTERVAL BY SEX AND LIFE SPAN OF PREVIOUS CHILD (Patna 1955)

Survival of child	Sex of previous child	Interval between births (in months)						
		1st and 2nd	2nd and 3rd	3rd and 4th	4th and 5th	5th and 6th	6th and 7th	7th and 8th
1	2	3	4	5	6	7	8	9
Alive	Male	35.2	37.7	33.2	36.5	39.6	35.0	32.9
	Female	34.8	33.3	34.7	35.1	35.2	34.5	30.4
Died within a year	Male	28.1	29.1	30.1	30.5	31.2	24.5	17.8*
	Female	26.2	24.5	23.1	44.5	40.2	42.8	
Died in second year of life	Male	28.8	29.5	29.2	30.7	29.9	25.7	
	Female	27.5	23.8	23.8	42.0	40.2	40.1	

* Based on less than 15 observations.

Source : M.E. Khan. "Factors affecting spacing of births". *The Journal of Family Welfare.* Bombay (December 1973), p. 58 (*26*).

TABLE 16 – AVERAGE INTERVAL BETWEEN CURRENT BIRTH AND LAST LIVING CHILD AND BETWEEN TWO LIVING CHILDREN (EXCLUDING CURRENT BIRTH) : SRS RURAL INDIA 1966-67

Age-group (years)	Current birth and last living child		Between last two living children excl. current birth	
	No. of current mothers	Interval (months)	No. of current mothers	Interval (months)
1	2	3	4	5
15-19	301	37.12	40	30.84
20-24	1 590	34.56	775	30.36
25-29	2 279	39.84	1 708	34.68
30-34	1 758	41.64	1 538	37.44
35-39	1 123	49.68	1 024	37.32
40-44	407	51.36	373	40.80
45-49	150	54.04	135	42.00
15-49	7 608	41.64	5 593	36.12

Based on preliminary data for eight states viz. Assam, Jammu & Kashmir Karnataka, Madhya Pradesh, Orissa Rajasthan, Uttar Pradesh and West Bengal.

In the above context, it may be relevant to note that based on some preliminary data in respect of current mothers during 1966-67 under SRS, it was found that in rural areas the average interval between current birth and last living child was about 41.6 months. In case the current birth was excluded, the average interval between last two living children was around 36.1 months.

State differentials in infant mortality and its relationship with fertility and other demographic variables

One distinct feature of the present-day Indian demographic situation is that vital rates and other demographic indicators show wide variations among States. Based on available SRS data and the 1971 census results, States have been classified according to the current levels of infant mortality along with corresponding birth and death rates, gross reproduction rates, total fertility, urbanisation and literacy. The results, separately for urban and rural areas, are presented in Tables 17 and 18. It is obvious that in the rural areas of Assam, Madhya Pradesh, Rajasthan, Gujarat and Uttar Pradesh, the infant mortality is higher than all-India. These States also rank much higher both in terms of general mortality and fertility. Of these, Madhya Pradesh, Rajasthan and Uttar Pradesh have comparatively lower proportions of literate persons as well as lower hospital bed-population ratio. These States are also otherwise considered as economically under-developed and governed by past customs and social practices. In urban areas too, Madhya Pradesh, Orissa, Uttar Pradesh and Gujarat have comparatively higher levels of infant mortality and crude birth and death rates. There is

TABLE 17 – STATE-WISE DIFFERENTIALS IN INFANT MORTALITY, CRUDE BIRTH AND DEATH RATES AND OTHER INDICATORS (urban India)

State	Infant mortality rate per 1 000 L.B's (1970-71)		Crude death rate per 1 000 pop. (1970-71)		Crude birth rate per 1 000 pop. (1970-71)		Gross reproduction rate (1969)	Total fertility rate (1969)	Percentage of urban population (1971)	Percentage of literate population (1971)
	Rate (average)	Rank	Rate (average)	Rank	Rate (average)	Rank				
1	2	3	4	5	6	7	8	9	10	11
IMR below all-India rate										
Manipur	18.6	1	5.4	1	25.6	5	n.a.	n.a.	13.2	53.2
Kerala	43.0	2	8.6	7	29.9	10	n.a.	n.a.	16.2	66.3
Jammu & Kashmir	53.8	3	5.8	2	23.6	3	1.97	4.3	18.6	38.2
Haryana	54.6	4	6.9	3	30.2	11	n.a.	n.a.	17.7	51.0
West Bengal	63.9	5	7.8	6	23.3	2	n.a.	n.a.	24.8	55.9
Karnataka (Mysore)	64.9	6	8.8	8	26.6	7	n.a.	n.a.	24.3	51.4
Tripura	68.9	7	6.9	4	23.3	1	n.a.	n.a.	10.4	64.0
Himachal Pradesh	69.2	8	7.4	5	24.3	4	n.a.	n.a.	7.0	60.5
Bihar	69.5	9	9.6	11	28.2	8	n.a.	n.a.	10.0	44.9
Andhra Pradesh	71.4	10	10.3	14	32.6	15	n.a.	n.a.	19.3	47.1
Assam (incl. Meghalaya)	77.9	11	9.9	13	31.5	14	2.15	4.1	8.9 14.5	58.7 65.2
Punjab	78.0	12	9.0	9	31.0	12	1.89	4.2	23.7	52.5
Rajasthan	80.7	13	10.6	16	33.4	13	2.57	5.6	17.6	43.5
Maharashtra	80.8	14	9.8	12	29.7	9	n.a.	n.a.	31.2	58.1
IMR above all-India rate										
Tamil Nadu	86.6	15	9.4	10	25.8	8	n.a.	n.a.	30.3	56.4
Madhya Pradesh	90.8	16	10.3	15	33.4	16	n.a.	n.a.	16.3	49.6
Orissa	91.4	17	10.7	17	33.6	17	n.a.	n.a.	8.4	49.0
Uttar Pradesh	117.0	18	13.4	18	34.7	18	2.55	5.4	14.0	44.1
Gujarat	121.6	19	13.4	19	35.4	19	n.a.	n.a.	28.1	54.9
India	83.5		10.0		29.9		n.a.	n.a.	19.9	52.5

1. SRS data for Nagaland being incomplete, have not been included.

2. SRS work in urban areas of most of the states began from 1970. As such, the vital rates are based mainly for 1970 and 1971.

3. In Manipur and Tripura, the SRS sample size in urban areas is 10 units each. The vital rates may, therefore, have limited comparative value.

4. *Source* : As for Table 18.

TABLE 18 – STATE-WISE DIFFERENTIALS IN INFANT MORTALITY, CRUDE BIRTH AND DEATH RATES AND OTHER INDICATORS (rural India)

State	Period	Infant mortality rate (per 1 000 L.B's)		Crude death rate (per 1 000 pop.)		Crude birth rate (per 1 000 pop.)		Gross reproduction rate (1969)	Total fertility rate (1969)	Percentage of rural population (1971)	Percentage of literate population (1971)	Bed-population ratio (overall) per 1 000 population (1970)
		Rate (average)	Rank	Rate (average)	Rank	Rate (average)	Rank					
1	2	3	4	5	6	7	8	9	10	11	12	13
IMR below all-India rate												
Manipur	1970-71	29.5	1	7.9	1	34.5	6	n.a.	n.a.	86.8	29.8	0.88
Kerala	1968-71	59.2	2	9.4	2	32.0	1	2.07	4.26	83.8	59.3	0.92
Haryana	1969-71	74.2	3	10.7	3	40.5	12	3.03	6.43	82.3	21.7	0.56
Jammu & Kashmir	1968-71	97.3	4	14.3	6	37.9	11	2.64	5.81	81.4	14.1	1.00
Tripura	1970-71	98,4	5	15.8	8	37.5	10	n.a.	n.a.	89.6	27.1	0.50
Karnataka (Mysore)	1968-70	100.8	6	14.3	7	34.3	5	2.27	4.66	75.7	25.1	0.85
Maharashtra	1968-71	102.3	7	14.0	5	33.9	3	2.20	4.59	68.8	30.6	0.68
Punjab	1968-71	103.4	8	11.6	4	34.2	4	2.66	5.65	76.3	27.8	0.77
Andhra Pradesh	1968-71	118.3	9	16.4	10	35.9	8	2.42	4.93	80.7	19.2	0.45
Tamil Nadu	1969-71	122.1	10	17.8	13	33.1	2	2.15	4.40	69.7	32.1	0.78
Himachal Pradesh	1970-71	126.5	11	16.2	9	35.8	7	n.a.	n.a.	93.0	29.8	1.08
Orissa	1970-71	133.8	12	16.4	11	36.6	9	n.a.	n.a.	91.6	24.1	8.38
IMR above all-India rate												
Assam (incl. Meghalaya)	1968-71	137.4	13	18.2	14	41.4	14	2.98	6.08	91.9 / 85.0	25.8 / 23.4	0.44
Madhya Pradesh	1970-71	141.4	14	17.1	12	40.4	13	n.a.	n.a.	83.7	16.8	0.38
Rajasthan	1968-71	145.5	15	19.6	16	43.5	16	3.05	6.58	82.4	13.9	0.51
Gujarat	1968-71	149.6	16	18.7	15	43.1	15	2.90	5.95	71.9	28.3	0.43
Utter Pradesh	1968-71	173.4	17	23,2	17	46.0	17	3.36	7.01	86.0	18.1	0.39
India	1968-71	135.2		17.4		38.9		2.70	5.62	80.1	23.7	0.49

1. SRS data for Bihar, Nagaland and West Bengal, being incomplete, have not been included.

2. In Manipur and Tripura, the SRS sample size in rural areas is 26 and 10 units respectively. The vital rates may, therefore, have limited comparative value.

3. *Source* : SRS, census reports and for col. 13 *Statistical profile of children and youth in India.* UNICEF, New Delhi (October 1974).

accordingly reason to believe that some positive relationship exists between higher infant mortality and higher fertility, particularly under the Indian situation, though this is not clearly borne out by States having lower levels of infant mortality. Based on data in Table 17, the zero-order correlation between the total fertility rate and the infant mortality rate for 12 Indian States around 1970 can be computed as 0.560 ; for 17 States, the correlation between IMR and the crude birth rate was 0.654. Controlling for regional percent literate, the equivalent partial correlation coefficients are 0.340 and 0.520 ; controlling for percent rural, they are 0.597 and 0.668. All correlation coefficients except one are significant at 5 %. It has, however, to be noted that such association may not necessarily be causal because of the presence of time-lag between decline in infant and childhood mortality and fertility.

Socio-cultural factors for higher family-size norms

We may recapitulate briefly the socio-cultural factors which influence the reproductive behaviour of a traditional society like India's. In Indian society, procreation has traditionally been considered not only a right but also an obligation. The status of women in India has depended heavily on their becoming mothers. The new daughter-in-law in the Indian family is accorded her rightful status only after she gives birth to a child – more often than not, a male child . . . Bringing forth a son is necessary because he can ceremoniously kindle the funeral pyre, and thus effect the salvation of his father's soul . . . In turn, the son can be expected to take care of his parents in their old age and thus repay the debt regarding the granting of life. As a matter of fact, marriage and procreation are held in such an exaggerated sanctity, particularly in the rural agrarian society, that not much thought is given to too many children being born. In such a situation, many demographers still feel doubtful whether it will be possible to reduce the non-economic as well as the economic values of children in the short run (Rele & Bhende) (22). Among the several reasons identified in Mysore Population Study and in other studies in India for wanting children are : to make home happier, to ensure family survival, to be taken care of in old age, to increase family income, to avoid community criticism, to follow community pattern or examples of friends, relatives and to get fair share of family property for children (28).

On the brighter side, Indian society like many other societies, imposes restrictions upon sexual relations during the period of lactation which helps to assure sufficient nourishment for new-born children by preventing another pregnancy following too soon after birth. The segregation of women for periods extending generally from three to four weeks after delivery is a widely accepted practice in India. During this time, the woman is considered polluted and should not even be touched. A related practice which is common in this country is that of a woman going to her parents' home for delivery and remaining there for a considerable period of time afterwards, before she returns to her husband (29). Any infant death would, however, seem to remove the moral restraints in having another conception soon after the birth. It may thus reduce the spacing between births and indirectly affect the levels of fertility of such women.

PRESENT DAY DEMOGRAPHIC SITUATION AND IMPLICATIONS FOR FUTURE

Minkler (30) had summarised the Indian demographic situation as under :

". . . the desire for children is heavily conditioned by sociological factors. Thus, the care that surviving children are expected to provide in their parents' old age and the wish for one or more surviving sons to carry on the family name or to perform certain religious functions will naturally encourage higher fertility where the survival of children born is uncertain. Historically, birth rates have fallen only slowly until infant mortality falls below about 40 per 1,000. Only then do sharp declines in birth rates become evident. Heer and Smith have studied the relationships between family size and joint survival of parents and sons in India. They noted that as death rates began to fall, the desire for surviving sons leads to an increased growth in population, especially when life expectancy is short. Then, when death rates decline faster and especially when life expectancy is 50 years or more, the desired survivorship pattern leads to a decreased fertility rate.

According to their data, when life expectancy at birth was only 20 years, as it was in India many years ago, death rates and particularly infant mortality were so high that a family would have to have 7 to 8 male children to ensure that one son would survive to the father's age 65. By 1960, Indian life expectancy was about 40 years and has now increased to about 50 years, and the number of sons needed per family to achieve the desired survivorship is greatly reduced.

It has been pointed out that with present Indian mortality and with likely prospects for still further improvement, a father with only one son who has already survived to age two has a likelihood of at least 80 per cent that son will outlive him. There is also evidence that Indian birth rates stay as high as they are because people do not realise how much infant mortality has already improved . . . As the duty to provide

against such contingencies shifts away from family of the affected individual, another powerful influence on family size is altered. With fewer children required to achieve births necessary to have a desired number of children, the stage is set for the sharp decline in fertility that are the avowed goals of India's family planning programme".

While the above analysis still holds good for India, some of the recent thinking about Indian fertility levels may be of interest. According to Raina (31), the fertility of Indian women has been high, although not to the same extent as compared with fertility levels in some pre-industrial societies of the West and the current levels of fertility in the developing countries of the East. Such a relatively low level of fertility could be the result of cultural practices in the past which involve voluntary abstinence on religious and health grounds and long periods of lactation-amenorrhoea following child-birth. It is also increasingly felt that family planning involves a change in the norms, attitudes and values of the people, so that they prefer small families in place of traditional large families. Unless there is a change in the main aspects of traditional way of life, it would be difficult for people to change their attitudes and start favouring small families. Family planning, therefore, must precipitate social change (Agarwala) (32). According to Mitra (33) also, in the matter of creating the conditions themselves for sustaining the small family norm, a fuller transformation still awaits the developing countries. Without this transformation, it is possible that the developing countries will still hold out the promise but not the fulfilment of the small family norm. This transformation seems to lie through the adoption of universal literacy, the resolute removal of acute inequalities of income that constricts the saving and consumption of large masses of population, the replacement of subsistence by economic choice, and particularly by affording the child-bearing half of the population, that is women, the means of education, employment and income.

Balkrishnan and Camp (34) have argued that family planning will have little success in India unless a social security programme is introduced. They advocate a system in which elderly couples with two or more surviving sons would receive no benefits and couples with no sons would receive twice the amount received by those with one son. According to Saksena (35) it does not seem very plausible that the basis for higher fertility would be weakened by the increased probabilities of child-survival. Though a great element of security for the survival of the children may encourage the practice of planned parenthood on an individual basis, in his opinion the reverse of this does not seem to be strictly true. Indian fertility is not high because of the apprehensions or risks involved in the survival of a child, but because people are not strongly motivated to adopt small family norm. On the other hand, Kamat (36) is more optimistic. According to him, the rapidly falling death rate in India is bound to induce a change sooner than later, towards a smaller family size, though there would be a time-lag due to the difficulty of overcoming the traditional thinking on this question, i.e., motivation of having a larger number of children as investment in manpower and security in old age. Mitra (33) seemed to be more optimistic when he observes that thanks to assiduous public health measures along with a better distribution and availability of food, mortality has spectacularly declined, particularly at the early ages, convincing every parent that it is no longer necessary to raise a number of children to guarantee the survival of only a few. According to him, even infant mortality and mortality at very young ages, although still comparatively high, have been reduced by more than half during the last 20 years, so much so that a parent feels reasonably assured that once a child has reached the age of six it can survive to the full

TABLE 19 – EXPECTATION OF LIFE AT BIRTH BY SEX IN INDIA

Period 1	Persons 2	Males 3	Females 4
1901-11	22.9	22.6	23.3
1911-21	20.1	19.4	20.9
1921-31	26.8	26.9	26.6
1931-41	31.8	32.1	31.4
1941-51	32.1	32.5	31.7
1951-61	41.3	41.9	40.6
1961-71	46.4	47.1	45.6
Projected			
1973	n.a.	48.3	48.9
1978	n.a.	50.7	51.7
1981	n.a.	52.1	53.3

Figures for 1961-71 are based on one per cent sample and are provisional.

Source : 1. *The Population of India* (1974) p. 36
2. U.P. Sinha *Revised mortality levels for India 1951-81*, unpublished (1974) (*37*).

span of life. This is well reflected in the expectation of life at birth which has been more than doubled since the beginning of the current century (Chart II). The expectation of life at birth is expected to go still higher. These figures thus seem to suggest that it is now unnecessary to have children by more than a margin, say, 20 per cent of what labour a parent actually requires for the economic activity of his family.

Based on the available data and the deep-rooted socio-cultural environments of our largely rural population, we can reasonably conclude that under the Indian situation, a further decline in infant and childhood mortality will no doubt hasten the process of decline in fertility levels, but a spectacular reduction in Indian fertility cannot be expected on this account in the near future. In brief, the Indian situation can perhaps be summed up along the lines outlined by Carlsson (38).

"It is possible that parents plan their family on the basis of expectations which were well founded at some earlier period but are no longer realistic an instance of lagged perception. Or there could exist a predictable 'threshold' so that a change in mortality and increase in survival chances is not noticed and taken into account unless it exceeds the threshold value . . ."

He had therefore advocated a study of the beliefs and opinion of parents regarding infant and child mortality as part of surveys and field studies of birth control and related topics. In his opinion, the desired family size, infant and child mortality and fertility should be seen as three inter-related variables. In a recent paper, Westoff observed that one of the prevailing theories in the field is that birth rate decline when parents in the developing world realise that they no longer have to reproduce at such high levels in order to ensure surviving children who provide status and support in old age. Some limited support for this proposition exists at both the micro and macro levels. The most persuasive evidence shows higher fertility connected with the direct experience or fear of child mortality rather than in the correlation between declining infant mortality and crude birth rate which are interpretable on various grounds. The evidence is not overwhelming but the potential significance of the relationship is certainly important enough to warrant more definitive research on the question (39).

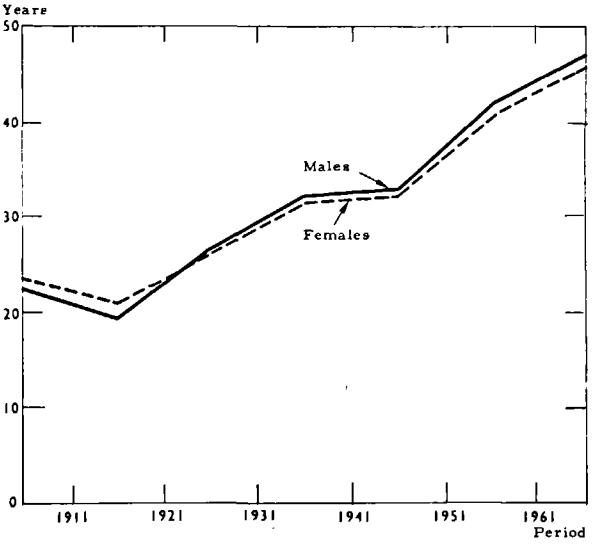

Chart II. – Expectation of life at birth in India (1901-1971)

Acknowledgements

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RELATIONS ENTRE FÉCONDITÉ ET MORTALITÉ EN AFRIQUE TROPICALE *

P. CANTRELLE, B. FERRY
Office de la Recherche Scientifique et Technique Outre-Mer (O.R.S.T.O.M.) Paris
J. MONDOT
O.C.D.E. Centre de développement, Paris

RÉSUMÉ

Les relations entre fécondité et mortalité de l'enfance sont le plus souvent posées en termes de corrélations entre les niveaux. Ce type de corrélation globale aboutit généralement à des résultats peu opérationnels et à une analyse trop sommaire des liaisons sans en faire apparaître les mécanismes. La corrélation calculée ici à partir d'enquêtes rétrospectives réalisées dans les pays d'Afrique intertropicale est nulle.

Par contre, l'analyse des variables intermédiaires devrait conduire à une meilleure connaissance des facteurs influençant la fécondité, la mortalité, et leur interaction. Pour la mortalité, les variables sont les causes de décès et pour la fécondité, il s'agit soit de variables de comportement, soit de variables biologiques. Sans prétendre épuiser le jeu des variables ni celui de leurs interrelations, l'étude aborde les variables biologiques en raison de leur poids actuel en Afrique et parmi celles-ci, l'allaitement et l'aménorrhée du post-partum.

Compte tenu de la liaison existant entre la durée de l'allaitement maternel et l'espacement des naissances, il était intéressant de rechercher s'il y avait évolution des durées d'allaitement en Afrique. Peu d'observations systématiques fournissent des données. Les indications, bien que de valeur inégale, permettent cependant de constater dans l'ensemble de l'Afrique une longue durée moyenne d'allaitement, se situant aux extrêmes entre 12 et 36 mois, mais généralement autour de 18-24 mois. Cependant, cette durée est moins longue, se situant autour de 12 mois dans certains pays ou en milieu très urbanisé des grandes villes.

En ce qui concerne la durée d'allaitement et les intervalles entre naissances successives, les données disponibles pour l'Afrique montrent que plus l'âge au sevrage est tardif, plus l'intervalle entre naissances est long. Par conséquent, la fécondité est plus faible que s'il n'y avait pas allaitement et évidemment en l'absence de contraception. L'étude rurale sur le Sine au Sénégal montre aussi que le décès d'un enfant en bas âge, équivalent d'un sevrage, a une incidence sur la fécondité. Des faits analogues sont mis en évidence dans diverses études de démographie historique.

De même pour les femmes allaitantes, la durée d'aménorrhée du post-partum est considérablement allongée et en général, plus l'allaitement est prolongé, plus longue est la durée d'aménorrhée. Pour préciser la corrélation, il faudrait disposer d'un nombre plus grand de données individuelles. Par contre, pour les femmes qui n'allaitent pas, la durée moyenne d'aménorrhée, de l'ordre de 60 jours, est pratiquement identique dans les populations considérées qui appartiennent à des milieux très divers.

Les longues durées d'aménorrhée du post-partum trouvées en Afrique chez les femmes allaitantes, sont-elles imputables à la malnutrition ? Si la malnutrition

(*) La troisième partie de la présente communication emprunte de larges extraits au document préparé par J. Mondot-Bernard (Mme) qui sera publié par le Centre de développement de l'O.C.D.E.

avait un effet sur la durée d'aménorrhée du post-partum, il ne se manifesterait qu'en cas d'allaitement. L'absence d'indications sur le niveau nutritionnel des femmes allaitantes des études citées n'autorise pas à conclure. Des observations comparables portant à la fois sur la durée d'aménorrhée, la durée d'allaitement et le niveau nutritionnel des femmes seraient nécessaires pour se prononcer.

SUMMARY

The relationships between fertility and child mortality are most often given in terms of correlations between aggregate data. This type of global correlation generally leads to results which are of little operational use and to a too summary analysis of the relationships, without showing the mechanisms. The correlation calculated here from retrospective surveys carried out in the countries of intertropical Africa is worthless.

On the other hand, the analysis of the intermediary variables should lead to a wider knowledge of the factors influencing fertility, mortality and their interaction. For mortality, the variables are the causes of death and for fertility, it is a matter of either behavioural variables or biological variables. Without pretending to exhaust the set of variables nor that of their interrelations, the study tackles the biological variables on account of their present weight in Africa, and amongst these, breast-feeding and post-partum amenorrhoea.

Taking into account the relationship existing between the duration of breast-feeding and the spacing of births, it was interesting to find out if there was a development of the duration of breast-feeding in Africa. Few systematic observations yield any data. Although of inequal value, the indications allow, however, to ascertain in Africa as a whole a long average breast-feeding period, falling, at the limits, between 12 and 36 months, but generally, about 18-24 months. However, this period is shorter, being about 12 months, in certain countries or in highly-urbanised areas of large towns.

Concerning the length of breast-feeding and the successive birth intervals, the data available for Africa show that the older the age at weaning, the longer the birth interval. Consequently, the fertility is lower than if there had been no breast-feeding and obviously in the absence of contraception. The rural study on the Sine of Senegal shows also that the death of a child at young age, equivalent to that of weaning, has an effect on the fertility. Parallel events are brought to light in various historical demographic studies.

As in the case of nursing mothers, the length of post-partum amenorrhoea is considerably longer and, in general, the longer the nursing period, the longer the length of amenorrhoea. To specify the correlation, a larger amount of individual data would be required. On the other hand, for the women who do not breast-feed, the average length of amenorrhoea, amounting to 60 days, is practically identical in all the populations considered, belonging to very varied environments.

Can the long durations of post-partum amenorrhoea found in Africa amongst nursing mothers be attributed to malnutrition ? If malnutrition had an effect on the post-partum amenorrhoea, it would only be revealed in case of breast-feeding. The absence of indications on the nutritional level of nursing mothers in the studies quoted does not allow any conclusion. Comparable observations dealing at the same time with the duration of amenorrhoea, duration of breast-feeding and the nutritional level of the women would be necessary to allow judgement.

RESUMEN

Muy frecuentemente, las relaciones entre fecundidad y mortalidad de la niñez se plantean en forma de correlaciones entre los niveles. Este tipo de correlación global conduce generalmente a resultados poco operacionales y a un análisis demasiado resumido de las relaciones, sin poner en evidencia los

mecanismos. La correlación calculada aquí, sobre la base de encuestas realizadas en países de Africa intertropical, es nula.

Por el contrario, el análisis de las variables intermedias, debería conducir a un mejor conocimiento de los factores que influencian la fecundidad, la mortalidad y sus inter-relaciones. En el caso de la mortalidad, las variables estudiadas son las causas de defunción y en el caso de la fecundidad, se trata tanto de variables relativas a la conducta como de variables biológicas. Sin pretender agotar ni el conjunto de variables ni sus inter-relaciones, el estudio aborda las variables biológicas debido a su influencia actual en Africa y entre ellas, la lactancia y la amenorrea post-parto.

Tomando en consideración la relación existente entre la duración de la lactancia materna y el espaciamiento entre los nacimientos, parecía interesante estudiar si existía o no alguna modificación de la duración de la lactancia en Africa. Los datos básicos proporcionaban muy poca información sistemática. Sin embargo, algunas indicaciones permitían constatar que existía una larga duración media de la lactancia en el conjunto de Africa, cuyos valores extremos se situaban entre los 12 y los 36 meses, pero con una frecuencia mayor entre los 18 y los 24 meses. Sin embargo en algunos países y en los medios muy urbanizados de las grandes ciudades, esta duración era menos larga, ubicándose generalmente alrededor de los 12 meses.

En relación a la duración de la lactancia y de los intervalos sucesivos entre nacimientos, la información disponible para Africa muestra que a medida que aumenta la edad del destete, es mayor la duración del intervalo entre nacimientos. Por consecuencia, la fecundidad es más baja que si no hubiera lactancia y, por supuesto, en ausencia de contracepción. El estudio rural sobre el Sine en Senegal muestra que la muerte de un niño de corta edad, equivalente a un destete, tiene también un efecto sobre la fecundidad. Relaciones análogas se ponen en evidencia en diversos estudios de demografía histórica.

En el caso de las mujeres que están amamantando a sus hijos, se verifica un aumento de la duración de la amenorrea post-parto y en general se encuentra que a mayor duración de la lactancia corresponde una mayor duración de la amenorrea. Sin embargo habría que contar con un número más grande de observaciones individuales para precisar esta correlación. Al revés, en el caso de las mujeres que no amamantan a sus hijos, la duración media de la amenorrea es del orden de 60 días y es prácticamente similar en todas las poblaciones consideradas a pesar de pertenecer a medios muy diferentes.

¿ Pueden adjudicarse a la desnutrición las largas duraciones de la amenorrea post-parto que se encuentra en Africa entre las mujeres que amamantan a sus hijos ? Si la desnutrición tuviera algún efecto sobre la duración de la amenorrea post-parto, este no se manifestaría sino que en el caso del amamantamiento. La falta de datos sobre el nivel de nutrición de las mujeres que amamantan a sus hijos en los estudios citados, no permite establecer una correlación. Es necesario disponer de informaciones comparables sobre la duración de la amenorrea, la duración de la lactancia y el nivel nutricional de las mujeres para pronunciarse al respecto.

INTRODUCTION

Les relations entre fécondité et mortalité de l'enfance sont, le plus souvent, posées en termes de corrélations entre les niveaux. Ce type de corrélation globale, qui sera envisagé ici dans un premier temps, aboutit généralement à des résultats peu opérationnels et à une analyse trop sommaire des liaisons sans en faire apparaître les mécanismes. Le passage à une analyse des variables intermédiaires devrait éclairer le débat (7).

En Afrique tropicale diverses enquêtes menées permettent de considérer la valeur de ces différentes approches. Si l'on ne peut évaluer actuellement l'incidence d'une modification de la mortalité sur la fécondité, il est cependant possible d'apprécier certaines relations directes et indirectes qui les lient.

I – ANALYSE DES CORRELATIONS DES INDICATEURS DE MORTALITE-FECONDITE

Analyse des corrélations globales

Les enquêtes démographiques rétrospectives à passage unique, la plupart du temps par sondage, réalisées dans différents pays d'Afrique depuis les années 1950, fournissent les principaux indicateurs utiles pour établir des corrélations globales entre les niveaux de mortalité et de fécondité.

Pour douze pays ou régions des taux ont été ajustés selon la même méthode et fournissent par conséquent un ensemble homogène (3). Ces indicateurs sont la descendance par fécondité cumulée, le quotient de mortalité infantile ($_1q_0$), celui de la deuxième année ($_1q_1$) et des deux premières années ($_2q_0$).

Un calcul de corrélation a été effectué en prenant d'abord les douze pays en entier (tableau 1) puis des résultats plus détaillés par strates, au total 47 strates (tableau 2).

Pour les 12 pays du tableau 1 les coefficients de corrélation sont les suivants :

– fécondité et mortalité $_1q_0 = -0.38$

– fécondité et mortalité $_1q_1 = -0.37$

(seuil de signification à 0,05 à 10 degrés de liberté = 0.58).

On constate que ces deux coefficients traduisent une liaison négative mais non significative (*).

Au niveau des 47 strates de ces pays (tableau 2) les coefficients de corrélation s'établissent comme suit :

– fécondité et mortalité $_1q_0 = -0{,}058$

– fécondité et mortalité $_2q_0 = -0{,}061$

(seuil de signification à 0,05 à 45 degrés de liberté = 0,273).

La corrélation est pratiquement nulle, qu'il s'agisse de la mortalité infantile ou de celle de l'ensemble des deux premières années.

TABLEAU 1 – FECONDITE ET QUOTIENTS DE MORTALITE DANS 12 PAYS AFRICAINS (3)

Pays	Fécondité	$_1q_0$	$_1q_1$
Dahomey	6.4	.221	.077
Guinée	5.8	.246	.087
Haute-Volta	6.5	.270	.096
Niger	7.7	.211	.073
Angola	5.8	.273	.098
Zaïre	5.9	.163	.084
Cameroun	4.9	.232	.082
Kenya	6.8	.132	.043
Mozambique	5.4	.212	.074
Rwanda	7.0	.156	.057
Tanzanie	6.4	.193	.066
Ouganda	6.7	.172	.058

Certes, la mortalité infantile est souvent sous-estimée en raison des difficultés d'enregistrement. En fait elle risque d'être d'autant plus sous-estimée qu'elle est plus élevée et on peut logiquement penser que si elle était mieux estimée, la corrélation serait plus fortement négative.

On aurait pu s'attendre à une corrélation positive et significative : un niveau élevé de fécondité correspondrait à un niveau élevé de mortalité de l'enfance. Pour l'ensemble géographique considéré, l'Afrique tropicale, cette liaison n'existe pas à partir des indices utilisés.

D'autres observations ont été faites en utilisant des méthodes plus précises. C'est le cas au Sénégal où l'on peut comparer des populations à niveaux différents de mortalité infantile et juvénile (tableau 3).

On peut constater que dans un même pays de milieu culturel homogène, à fécondité égale la mortalité infantile varie du simple au quadruple. Autrement dit un niveau bas de la mortalité infantile ne semble pas affecter pour la période présente le niveau de fécondité.

On peut trouver d'autres exemples en Afrique qui montrent que d'autres situations relatives de mortalité et de fécondité apparaissent. Par exemple au Gabon (5) quotient de mortalité infantile ($_1q_0$) : 229 pour mille pour une fécondité cumulée de 4,2 enfants. Chez les Foulbé (8) respectivement 85 et 3,5.

(*) Signalons une corrélation très élevée (0,996) entre les deux indicateurs de mortalité $_1q_0$ et $_1q_1$.

TABLEAU 2 – FECONDITE ET QUOTIENTS DE MORTALITE DE 47 STRATES EN AFRIQUE (3)

Pays	Strate	Fécondité	$_1q_0$	$_2q_0$
Dahomey	Nord	6.1	.194	.248
	Sud	6.6	.232	.295
Guinée	Forêt	5.7	.281	.353
	Fouta Djallon	5.9	.228	.289
	Maritime	5.6	.238	.302
	Haute Guinée	6.1	.241	.306
Côte d'Ivoire	1er secteur	7.3	.195	.249
Mali	Mopti	6.9	.344	.426
Niger		7.7	.211	.269
Guinée Bissau		4.8	.211	.269
Sénégal	Vallée	6.3	.223	.283
Haute Volta	Mossi	6.7	.296	.371
	Peul	5.8	.195	.250
	Ouest	6.1	.241	.305
Angola	Benguela	6.8	.275	.346
	Bie	5.0	.228	.290
	Huila	5.4	.166	.213
	Luanda	6.4	.329	.409
	Malange	5.6	.276	.348
RCA	Central Oubangui	4.4	212	.270
	Banda	4.1	.222	.282
	Mandjia	5.3	.210	.267
	Rivières	4.2	.183	.234
Zaïre	Equateur	5.0	.155	.199
	Katanga	8.2	.124	.159
	Kasaï	5.9	.201	.286
	Kivu	7.1	.177	.226
	Kinshasa	6.7	.156	.200
	P. Orientale	4.0	.131	.167
Cameroun Nord	Montagnes	5.8	.259	.327
	Musulmans	3.5	.193	.246
	Plaine	5.3	.246	.312
Burundi		6.4	.156	.204
Kenya	Central	6.6	.098	.122
	Côte	5.4	.151	.193
	Est	6.8	.111	.140
	Nyanza	7.9	.193	.246
	Rift Valley	6.5	.089	.111
	Ouest	8.1	.170	.218
Mozambique	Central	6.7	.254	.321
	Nord	5.0	.167	.214
	Sud	4.6	.201	.257
Rwanda		7.0	.156	.204
Tanzanie		6.4	.193	.246
Ouganda	Buganda	5.4	.160	.205
	Est	6.1	.189	.242
	Nord	8.4	.174	.223
	Ouest	7.7	.161	.206

TABLEAU 3 – NIVEAUX DE FECONDITE ET DE MORTALITE AU SENEGAL

		Taux de fécondité	Fécondité actuelle cumulée	Quotient de mortalité	
				$_1q_0$	$_1q_1$
Rural	Sine 1963-65 (2)	217	6,8	238	182
	1963-70 (10)	194	6,2	(238)	
	Saloum 1963-65 (2)	219	6,6	(130)[a]	125
Urbain	Dakar 1972 (4)	205	6,6	60	

(a) Vraisemblablement sous-estimée

Schématiquement quatre cas de figures apparaissent avec les exemples cités concernant le Sénégal, le Gabon et les Foulbé du Cameroun (tableau 4).

TABLEAU 4

		Mortalité	Fécondité
Gabon	Ensemble	Forte	Faible
Cameroun	Foulbé	Faible	Faible
Sénégal	Rural	Forte	Forte
	Urbain	Faible	Forte

Ce tableau explique assez bien les corrélations nulles mentionnées plus haut. Il se confirme donc que ce type d'analyse n'éclaire pas le problème des relations entre fécondité et mortalité infantile.

Il serait possible d'appliquer les mêmes principes de corrélation à des indicateurs différentiels liés à des sous-populations : en effet les enquêtes peuvent fournir les indicateurs selon certaines variables indépendantes, telles que la catégorie socio-professionnelle, le niveau d'instruction, la religion, etc.

Ce type de corrélation reste descriptif et ne permet pas de considérer l'effet de la mortalité sur la fécondité. Il ne met en relation de façon non-opérationnelle que des facteurs qui ne sont pas directement liés aux variables dépendantes. Cette approche utilisant finalement le même principe de corrélation amène à des conclusions du même type que les corrélations sur les pays.

Analyse des corrélations sur la base des données individuelles

En plus des indicateurs globaux par pays ou strates, les enquêtes fournissent pour chaque femme le nombre total d'enfants nés vivants et décédés. Il est alors préférable de corréler à partir de ces données individuelles. Mais la plupart des enquêtes ne mentionnent pour chaque femme qu'un nombre total d'enfants décédés sans préciser l'âge au décès, ce qui rend alors impossible la corrélation recherchée.

Quelques rares enquêtes antérieures ont donné l'âge au décès des enfants, mais une telle analyse n'a pas été effectuée et si on voulait la faire, se poserait le problème d'en retrouver les archives.

Cette lacune pourrait être comblée à partir d'enquêtes plus récentes où l'on a tenté de reconstituer la biographie génésique de la femme et le devenir de ses enfants. C'est le cas notamment d'enquêtes réalisées au Sénégal : enquête démographique nationale 1970-71 (9), enquête sur la fécondité à Dakar (4), Fakao (6).

En ce qui concerne les enquêtes CAP, elles ne procurent pas en général ce type de données.

Le projet de l'enquête mondiale sur la fécondité (WFS) qui sera réalisée dans quelques pays d'Afrique devrait être l'occasion d'une telle étude.

L'analyse par la corrélation entre fécondité et mortalité de l'enfance même si elle s'avérait plus adéquate au niveau individuel resterait cependant sommaire et n'expliquerait pas l'effet de la mortalité sur la fécondité ; a fortiori, elle ne permettrait pas d'estimer le délai et les modalités pour qu'un tel changement apparaisse. Dans ce but l'approche la plus fructueuse serait sans doute d'examiner l'incidence de variables intermédiaires par lesquelles joue l'interaction entre mortalité de l'enfance et fécondité.

II – MECANISMES D'INTERACTION MORTALITE-FECONDITE : LES VARIABLES INTERMEDIAIRES

Les différences constatées concernant le Sénégal (tableau 3) pour la mortalité infantile à un niveau semblable de fécondité dans des milieux différents urbain et rural, et les conclusions du tableau 4 amènent à envisager quels pourraient être les mécanismes déterminant ces niveaux et leurs inter-relations.

Deux types de relations peuvent en effet exister entre mortalité de l'enfance et fécondité :

– soit une incidence directe de la mortalité sur la fécondité (*) par des variables intermédiaires ;

– soit une relation indirecte : un facteur commun influençant séparément chacune des deux variables dépendantes, dans le même sens ou en sens contraire.

Les principales variables intermédiaires en jeu sont pour la mortalité : les causes de décès, et pour la fécondité : soit des variables de comportement, soit des variables biologiques (**).

Incidence directe

L'incidence directe de la mortalité sur la fécondité peut se manifester de deux façons : d'une part, le décès d'un enfant peut déterminer un comportement de remplacement soit individuel, soit collectif, devant l'incidence de la mortalité élevée de l'enfance dans une population.

D'autre part, le décès d'un enfant détermine directement la durée d'allaitement. S'il s'agit d'un mort-né ou d'un enfant né vivant et décédé après quelques jours, l'allaitement n'a pratiquement pas eu lieu. Lorsque l'allaitement est en cours, le décès de l'enfant est l'équivalent d'un sevrage. Certes, dans quelques cas, des femmes servent alors de nourrice à des enfants dont la mère manque de lait ou vient de décéder ; mais ces cas sont sans doute peu nombreux et n'auraient par conséquent pas de poids sur la fécondité.

La liaison entre durée d'allaitement et fécondité, précisée plus loin, montre qu'une mesure de ce phénomène peut être estimée, dans l'hypothèse où il n'y a ni abstinence ni contraception.

Ces deux variables intermédiaires, comportement et absence ou arrêt d'allaitement par décès de l'enfant, auraient une incidence dans le même sens : une mortalité infantile élevée entraînerait un raccourcissement de l'intervalle de naissance et par conséquent une fécondité élevée. Les exemples mentionnés précédemment de fécondité qui reste élevée alors que la mortalité infantile a diminué (Sénégal urbain) et de fécondité relativement basse alors que la mortalité infantile reste élevée (Gabon), amèneraient à conclure que l'effet de ce mécanisme serait dominé par d'autres plus forts intervenant en sens contraire.

Effets de variables indépendantes

A l'ensemble des variables indépendantes de nature socio-économique sont liées la mortalité et la fécondité différentielles. Malgré le niveau relativement élevé de la mortalité de l'enfance et de la fécondité en Afrique Tropicale, l'amplitude des variations est importante selon des caractéristiques de milieu comme la catégorie socio-économique du ménage, la région géographique, les milieux urbain et rural, etc. Ce dernier critère seulement sera envisagé ici.

Le passage de la campagne à la ville, qu'on le considère de façon synchronique ou diachronique, entraîne le plus souvent une diminution de la mortalité de l'enfance, comme le montrent la plupart des enquêtes démographiques réalisées en Afrique. Ceci s'explique par différents facteurs, plus ou moins indépendants, tels que les éléments du niveau de vie, notamment les disponibilités alimentaires, l'action sanitaire préventive et curative.

D'autre part, le passage de la ville à la campagne s'accompagne de différences portant sur des variables intermédiaires de la fécondité comme l'union, le comportement d'abstinence et d'allaitement.

L'âge à la première union peut se modifier et aussi la fréquence du type d'union, monogame ou polygame.

Les coutumes d'abstinence de rapports après l'accouchement dans les populations où elles existent peuvent s'estomper en milieu citadin. La durée d'allaitement tendrait également à y diminuer.

(*) La relation inverse de la fécondité sur la mortalité, ne faisant pas partie du cadre du séminaire Cicred,ne sera pas envisagée ici.

(**) La typologie des différentes variables étant précisée dans un autre rapport du séminaire, ne sera pas présentée ici ; on se limitera à quelques variables sans prétendre épuiser le jeu de leurs inter-relations.

Si un retard moyen de l'âge à la première union a un effet de baisse de la fécondité générale, la diminution du délai de reprise des rapports et de la durée d'allaitement vont au contraire dans le sens d'une élévation.

Le maintien d'une fécondité aussi élevée en milieu urbain qu'en milieu rural, constaté dans le cas du Sénégal, tandis que la mortalité de l'enfance a considérablement baissé, s'expliquerait donc par le jeu des variables intermédiaires dont on vient d'esquisser le mécanisme : la variable ville-campagne intervient séparément sur la fécondité et la mortalité (mis à part l'effet induit de l'incidence directe mortalité sur fécondité) ; au total les effets contraires sur la fécondité s'annuleraient.

Facteurs pathologiques : infections, nutrition

Un autre exemple de facteurs déterminant de façon séparée ou associée la mortalité de l'enfance et la fécondité sont les facteurs pathologiques dont l'incidence semble particulièrement importante en Afrique tropicale. Ils sont distingués en deux groupes : les infections et la malnutrition.

Par rapport à leur incidence respective sur la mortalité de l'enfance et la fécondité, les *infections* se répartissent schématiquement en trois catégories :

– incidence seulement sur la mortalité, par exemple le tétanos ombilical du nouveau-né et la rougeole à partir de six mois.

– seulement sur la fécondité, par exemple la gonococcie.

– à la fois sur la mortalité et la fécondité, par exemple, le paludisme particulièrement grave vers l'âge d'un an, mais qui entraînerait aussi des avortements.

Il arrive que les interventions des services sanitaires soient sélectives ; les services de protection maternelle et infantile peuvent entreprendre une prévention systématique contre le tétanos néo-natal ; ou bien des services de lutte contre les endémies entreprendre des campagnes périodiques dans les secteurs où l'incidence de certaines affections est importante (gonococcie, syphilis endémique . . .).

Dans les populations où la proportion de femmes stériles est élevée (par exemple au Gabon plus de 25 % de stérilité primaire, à quoi s'ajoute la stérilité secondaire), un programme de lutte contre la stérilité ne sera pas forcément accompagné d'une baisse de la mortalité de l'enfance.

Malgré les imprécisions des statistiques épidémiologiques, on pourrait cependant parvenir à estimer le poids de ces différentes affections selon les populations. Dans l'ensemble la lutte contre les maladies infectieuses sans modification des autres variables, aurait pour résultat d'augmenter la fécondité.

L'incidence des facteurs nutritionnels sur la fécondité reste en partie dans le domaine des hypothèses, car les phénomènes ont été mis en évidence dans des conditions exceptionnelles telles que des famines, et il resterait à les étudier dans des conditions plus courantes.

La relation entre la malnutrition et la mortalité de l'enfant est bien connue ; mais la synergie avec nombre de maladies infectieuses rend difficile la mesure de ce facteur.

Sur la fécondité les carences alimentaires interviendraient par plusieurs voies :

– en augmentant l'incidence ou la gravité de certaines maladies infectieuses ;

– en favorisant les avortements spontanés ;

– en allongeant la période d'aménorrhée post-partum ;

– en faisant cesser plus tôt l'allaitement ;

– enfin, sur le conjoint par modification de la libido et de la fréquence des rapports.

Dans l'ensemble l'amélioration des disponibilités alimentaires et de leur utilisation irait dans le sens d'une diminution de la mortalité de l'enfant et d'une augmentation de la fécondité.

Un inventaire systématique des connaissances quantitatives sur les variables intermédiaires serait donc nécessaire. Une illustration est donnée dans les paragraphes suivants pour deux d'entre elles : la durée d'allaitement et de l'aménorrhée post-partum.

III – ETUDE DE CERTAINES VARIABLES INTERMEDIAIRES ALLAITEMENT, AMENORRHEE POST-PARTUM

Allaitement maternel en Afrique

L'allaitement revêt une importance toute particulière puisqu'il a un rôle tant sur la fécondité que surtout sur la santé de l'enfance et par conséquent sur la mortalité. Bien qu'il s'agisse d'un phénomène facile à mesurer intéressant tout d'abord les pédiatres, peu de données ont été collectées par ces derniers. La recherche

TABLEAU 5 – DUREE D'ALLAITEMENT EN AFRIQUE DE L'OUEST

Pays	Nombre enfants	Age au sevrage en mois	Auteurs
Gambie			
Keneba village isolé	44	18 à 24 et plus	THOMPSON 1962
Milieu rural	69		CRAPUCHET 1967
Guinée			
Rural		36 et plus	PAULME 1954
Côte d'Ivoire			
Abidjan	97	13,5	CHAPUIS et ASSI ADOU ... 1966
Milieu rural		36 – 48	1966
Cocody ville		12	AYE et ASSI ADOU 1966
Abidjan – femmes illettrées	921	24	LEROUX 1972
Katiola – poticres "Mangora"	280	12 mode 13 moyenne	BELS A. 1972
Nigeria			
Lagos		12	
Rural		18 – 22	BASSIR 1957
Ibadan	380	14 et plus	MATTHEWS 1957
Inesi rural	241	23,2	MARTIN 1967
Mali Dogon		24 – 36	ERNY 1967
Sénégal		16 – 24	RAQUET 1956
Khombole rural Wolof Serer	69	19 – 36	CRAPUCHET 1967
Fouta Toro Toucouleur		12 – 24	WANE 1969
Dakar Wolof – filles		24	
garçons		18	DIOP 1957
Guinéen peul		18	
Sine rural	8456	24 mode 24,3 moyenne	CANTRELLE 1971
Dakar ensemble	643	18,7	FERRY 1972
Haute Volta			
Pays Lobi		24 – 30	MAZER 1961
Burundi			
Banlieue Bujumbura		18 – 30	MAGOS 1970
Cameroun			
Les Fali du Tingalin		24	MALZY 1956
Pahouins		18 – 24	OTO 1953
Plaine Guiziga		24 – 36	
Montagne Mofou		36	PODLEWSKI 1966
Hina		24 – 36	
Congo			
Dolisie		18 – 24	CROCE SPINELLI 1967

des données a été faite au travers de divers documents économiques, enquêtes alimentaires, études démographiques.

Il est très difficile de se faire une idée précise même sur sa durée selon les pays, les ethnies et encore moins au cours des années. Sur plus de cinquante documents retrouvés couvrant 17 pays répartis en Afrique du Nord, en Afrique de l'Ouest, en Afrique Centrale et en Afrique de l'Est, s'échelonnant des années 1922 à 1974, dix apportent des indications précises sur les temps d'allaitement en fonction de l'âge de l'enfant. Parmi ces derniers cinq font l'objet d'enquêtes portant sur des échantillons de plus de 400 enfants, ce sont des documents sur l'allaitement en : Algérie du Nord, D. Tabutin, 1973 ; une zone rurale du Sénégal, P. Cantrelle, 1971 ; Côte d'Ivoire, les potières Mangoro de Katiola, A. Bels, 1972 ; Zaïre, l'Alimentation chez les enfants

TABLEAU 5 (suite)

Pays	Nombre enfants	Age au sevrage en mois	Auteurs
Rwanda			
Usumbura-Bahutu		12 et plus	VINCENT..... 1954
Babembe		18	
Astrida	100	moins de 24	DUREN..... 1960
Zaïre			
Bambara rural		24 – 36	MERTENS 1948
Kasaï		18 – 24	BROCK AUTRET 1952
Kwango Basuku	57		HOLEMANS et al. 1954
Coquilhatville	500	15 – 19	DEVREESE 1960
Léopoldville	100	12 – 24	LAMBILLON 1960
forêt lac - Tumba	164	18 – 24	VIS et HENHART 1974
Zone savane		24	" "
Tribu des hauts plateaux	400	18 – 36	" "
Ethiopie			
Femmes militaires	2 000	12 et plus	HUBER et ULM 1962
Trois communautés		plus de 12	
		moins de 12 précoce	KNUTSSON 1969
Kenya Masai		36	BROCK et AUTRET 1952
Ouganda			
Baganda de Kampala	245	12 – 16	WELBOURNE 1963
Baganda		12	GERBER, DEAN 1964
Somalie			
Ex anglaise		18	HOUSSELEN L..... 1950
Ex italienne (Peuples bergers)		24	LIPPARONI 1952
Tanzanie			
Wahehe		24	MOLLER..... 1961
Wagogo		36 – 48	
Wanyakynsa		24 +	
Wachaga		24	
Bahaya		30 – 36	
Moshi		12 – 24	SAWAKI K. et al. 1974
Madagascar		7 – 12 mode 15 moyenne	FRANCOIS P. 1962
Algérie du Nord			
Ville	3 187	11,3	TABUTIN D..... 1973
Campagne	6 970	14.4	
Soudan			
Sud		24 – 36	HOUSDEN L. 1950
Nord		moins de 24	

Havu de l'Ile Idjwi, H. Vis et P. Henhart, 1974 ; Madagascar, Allaitement et alimentation de sevrage des enfants, INSRE, CINAM, INSEE, 1962.

Sera considéré le temps durant lequel l'enfant prend le sein, c'est-à-dire de sa naissance au jour du sevrage. Le sevrage indiquera le jour où l'enfant ne tète plus, c'est-à-dire le jour à partir duquel le lait maternel ne fera plus partie de l'alimentation de l'enfant. Cette durée d'allaitement ainsi définie indiquera aussi bien l'allaitement au sein exclusif ou déjà un allaitement mixte, c'est-à-dire un mode d'alimentation comprenant l'allaitement au sein, auquel s'ajoutent des laits animaux et/ou d'autres aliments (bouillies, etc.).

Les indications précisées dans les tableaux, bien que de valeur inégale, permettent cependant de constater dans l'ensemble de l'Afrique une longue durée moyenne d'allaitement se situant aux extrêmes entre 12 et 36 mois, mais généralement autour de 18-24 mois. Cependant cette durée est moins longue, se situant autour de 12 mois, dans certains pays comme l'Algérie, l'Ethiopie, l'Ouganda, Madagascar, ou en milieu très urbanisé des grandes villes.

Deux cas, Algérie et Sénégal, montrent plus précisément les variations dans un même pays.

L'allaitement en Algérie

L'analyse de D. Tabutin (68) met en lumière les conclusions suivantes :

– la durée moyenne d'allaitement est plus faible en ville qu'en milieu rural (11,3 et 14,4 mois). Cette différence est sous-estimée par le biais d'une mortalité infantile plus élevée en milieu rural (14 % contre 10,9 % en 1968-69).

– un plus grand nombre de femmes des villes n'allaitent pas ou allaitent leur enfant moins d'un mois (14,4 % en ville).

– la durée moyenne d'allaitement augmente régulièrement avec l'âge des femmes en milieu urbain comme en milieu rural. En admettant que le comportement des femmes en matière d'allaitement se modifie peu avec l'âge il est conclu que la diminution de la durée d'allaitement est sensible chez les jeunes générations. Cette diminution est plus lente en milieu rural, vraisemblablement sous l'effet des facteurs suivants : plus grand attachement du milieu rural aux coutumes de la famille, moins bonne distribution d'aliments industriels de sevrage.

– la durée d'allaitement augmente avec le rang de naissance ce qui est normal, ce dernier étant lié à l'âge de la mère. Elle décroît aux rangs de naissance élevés (7 et plus) ; cette durée est sous-estimée, la mortalité augmentant en Algérie avec le nombre d'enfants, d'une part ; d'autre part à âge égal plus une femme a d'enfants, plus l'intervalle entre les deux dernières naissances est petit donc plus grande est la probabilité d'une interruption d'allaitement par une nouvelle conception. Enfin la capacité d'allaitement d'une femme diminue avec l'âge.

Quel que soit son âge une femme alphabétisée allaite beaucoup moins qu'une femme illettrée : 7,5 mois contre 13,4 mois en moyenne pour l'ensemble.

A instruction égale, les durées moyennes d'allaitement sont plus élevées à la campagne.

L'allaitement au Sénégal

Le temps moyen d'allaitement de la zone rurale du Sine (7) est de 24,3 mois (24,5 garçons, 24,1 filles). Aucune différence significative selon le rang de la naissance n'a pu être mise en évidence, ce qui indiquerait que les jeunes générations conservent les coutumes ancestrales.

Selon les observations faites à Dakar (20), la durée moyenne d'allaitement est de 18 mois. Nettement plus courte que dans la zone rurale du Sine, une durée moyenne d'allaitement de 18 mois à Dakar ne peut pas être interprétée comme une désaffection pour l'allaitement maternel des mères des villes, mais cependant comme un changement progressif de comportement en milieu urbain.

Allaitement et fécondité

La durée moyenne de l'allaitement a été mise en relation avec deux types d'indicateurs, la fécondité et les intervalles entre naissances.

Durée d'allaitement et taux de fécondité

Au cours d'une enquête par sondage sur la consommation des ménages réalisée en 1962 à Madagascar, la durée d'allaitement a été estimée dans quinze groupes ethniques. Ces résultats ont été rapprochés de ceux d'une enquête démographique par sondage réalisée en 1966 (tableau 6).

TABLEAU 6 – DUREE D'ALLAITEMENT (21) ET FECONDITE (25) A MADAGASCAR

Région	Ethnie	Age moyen du sevrage en mois	Taux de fécondité pour mille	Fécondité cumulée	Descendance finale
Plateaux	Mérina	16			
	Sihanaka	11	220	7.7	5.4
	Betsileo	15	150	5.4	4.6
Nord	Tsimihéty	16	220	7.2	4.4
Est	Berzanozano	17			
	Betsimisaraka	12	210	6.5	4.7
	Tanala	13			
Sud Est	Antaimoro	14			
	Antefasy	13	200	6.4	4.3
	Antaisaka	13			
Sud	Bara	15			
	Antadroy	11	160	5.2	3.4
	Mahafaly	14			
Ouest	Sakalava	14	210	6.7	3.4
	Makoa	13			

La relation entre l'âge moyen au sevrage et le taux de fécondité n'apparaît pas dans ce cas. Plus précise devrait être la relation avec la fécondité traduite par l'intervalle entre naissances.

Durée d'allaitement et intervalles entre naissances

Les données sur l'Afrique sont peu nombreuses (tableau 7) ; difficilement comparables, elles méritent cependant qu'on s'y arrête : elles concernent l'Algérie, le Sénégal, le Nigeria, le Zaïre et le Rwanda. Les données offrant une grande différence entre les durées d'allaitement montrent que : plus

TABLEAU 7 – DUREE D'ALLATIEMENT ET INTERVALLES ENTRE NAISSANCES DANS QUATRE PAYS AFRICAINS

Pays	Durée d'allaitement en mois	Intervalle entre naissances en mois	Effectif des observations
Algérie (60) 1970	11.9	25.4	urbain 8 500 femmes environ
	12.9	27.0	rural
Nigeria (42) 1955	23.2	35.5 (a)	248 naissances
Sénégal (7) 1963 – 67	0 – 11	25.1	région du Sine 8 456 naissances
	12 – 14	25.4	
	21 – 23	32.5	
	33 – 35	40.9	
Zaïre (61)			
1958		26.5	Léopoldville 280 ménages
1960	27	34.7 (a)	Bandibu (*)
1960	27	27.9	Bashi (**)

(a) Les rapports sexuels sont interdits pour la femme durant la période de l'allaitement, car les mères savent qu'il n'y a pas de "substitut" au lait maternel et que si l'enfant ne peut bénéficier d'un allaitement prolongé au sein, sa vie est en danger.

Sources : (60) p. 111 et p. 143

(61) A. Romaniuk – *La fécondité des populations congolaises*, p. 285.

(*) Renseignements basés sur une enquête effectuée en 1960 par le Bureau Démographique Kinshasa

(**) Renseignements d'une enquête effectuée en 1960 par R. Deman.

l'âge au sevrage est tardif, plus l'intervalle de naissance est long. Par conséquent la fécondité est plus faible que s'il n'y avait pas allaitement, et évidemment en l'absence de contraception.

L'étude sur le Sine au Sénégal a permis de calculer qu'en l'absence de mortalité, l'intervalle entre naissances vivantes est allongé de neuf mois quand l'âge au sevrage augmente d'un an (pour les sevrages de 12 à 36 mois).

Cette étude a montré aussi que le décès d'enfant en bas âge, équivalent d'un sevrage, a une incidence sur la fécondité. Des faits analogues sont mis en évidence dans plusieurs études de démographie historique (tableau 8). Tous les résultats concordent et montrent que le décès d'un enfant en bas âge est la cause du raccourcissement de l'intervalle entre la naissance de cet enfant et la suivante (tableau 9). Dans son étude sur la population de Crulai (24) (*), Louis Henry démontre, après avoir envisagé toutes les possibilités, que cette liaison provient de la différence dans la durée de l'allaitement

TABLEAU 8 – INTERVALLES ENTRE NAISSANCES DANS L'EUROPE ANCIENNE

Pays	Intervalle normal (*)	Intervalle après décès (*)	N
Anciennes familles Genevoises			
Générations avant 1600	30.8 mois	25.9 mois	26 familles
Génération 1600-1649 (27)	27.3	19.8	43 familles
Crulai (24)	29.6	20.7	89 familles
Le Neanil (22)	27.7	22.7	97 familles

(*) Intervalle normal : l'enfant né de l'accouchement précédent a vécu au moins 1 an ;
Intervalle après décès : l'enfant né de l'accouchement précédent est mort avant la fin de sa première année.

TABLEAU 9 – INTERVALLES ENTRE NAISSANCES SELON LA DUREE DE VIE DE L'ENFANT PRECEDENT
i = Intervalle entre naissances en mois – *N* = Nombre de cas

		Durée de vie de l'enfant précédent		
		0.5 mois	6 – 11 mois	12 mois et plus
Le Mesnil (22)	*i*	20.6	26.4	27.2
	N	176	229	710
Canada, 18ème s. (26)	*i*	18.8	23.5	25
	N	482	65	545
Tunis, 19ème s. (23) (a)	*i*	18.4	23.2	27.5
	N	125	42	670
Mömmlingen, fin 19ème s. (34)				
	i	17.3	20.1	27.5
	N	72.	62	1 086
Sénégal 1963-67 (7)	*i*	20.3	23.8	32.1
	N	140	128	340
Sénégal 1972 (20)	*i*	27.1	28.0	29.0
	N	226	155	174
Nigeria, village Inesi (42		17.0 (b)		35.5
		34		248

(a) Référence (23) p. 81
(b) Ensemble des enfants morts-nés et décédés à moins d'un an.

(*) (24) p. 151-152-153-154.

au sein, la mort de l'enfant interrompant l'allaitement. Il s'agit d'une liaison statistique, toute femme qui allaite n'étant pas de ce fait temporairement stérile.

Allaitement et aménorrhée post-partum

La durée d'aménorrhée post-partum des femmes qui allaitent a été comparée avec celle des femmes qui n'allaitent pas parce qu'elles ont accouché d'un mort-né ou que l'enfant est décédé avant cinq jours.

Les quelques études disponibles (tableau 10) montrent pour les femmes qui n'allaitent pas une durée moyenne de l'ordre de soixante jours, pratiquement identique dans les populations considérées, bien qu'elles appartiennent à des milieux très divers.

Pour les femmes allaitantes (tableau 11) la durée d'aménorrhée post-partum est considérablement allongée, et en général plus l'allaitement est prolongé, plus longue est la durée d'aménorrhée. Mais les données publiées ne sont pas toujours précises; de plus il s'agit de moyennes et il conviendrait d'établir la corrélation à partir de données individuelles. Ainsi pour Dakar au Sénégal, le tableau 12 indique la durée moyenne d'aménorrhée selon la durée d'allaitement.

La nature de l'allaitement exclusif ou mixte interviendrait. Les observations faites tant aux Etats-Unis qu'en Angleterre et à Taïwan montrent qu'avec l'allaitement mixte, la durée d'aménorrhée est moins longue qu'en allaitement exclusif. Les données sur l'Afrique semblent confirmer ce résultat.

En tout état de cause on retiendra que l'allaitement allonge l'intervalle entre naissances et par conséquent, par l'intermédiaire de phénomènes physiologiques traduits par l'aménorrhée post-partum, diminue la fécondité.

TABLEAU 10 – DURÉE D'AMENORRHEE POST-PARTUM CHEZ LES FEMMES NON ALLAITANTES

Pays	Nombre cas	Durée aménorrhée post-partum en jours (moyenne)	Sources
Etats-Unis			
1934 Baltimore+	2 285 *n*		PECKHAM (55)
1940 Cincinnati+	3 946 *n*	60	STIX (a) (70)
1940 Spartanburg+	2 131 *n*		
1966 Boston++	1 712 *f*	55	SALBER (63)
Angleterre			
1968 Birmingham	93 *f*	59	CRONIN (12)
France			
1969 Cambrai	276 *f*	58	Juliette PASCAL (53)
1957 Bombay		60	P.J. BASCI (2)
1965 Chili	30 *f*	60	PEREZ A. et al. (56)
1966 Taïwan	297 *f*	48	JAIN (31)
1969 Bangladesh	27 *f*	63	CHEN et al. (37)
1960 Léopoldville		49	J. LAMBILLON (36)
1965 Rwanda	50 *f*	60	BONTE and Van BALEN (5)
1972 Dakar, Sénégal	35 *f*	43	FERRY (20)

(+) *n* = nombre de naissances – ce chiffre représente la totalité des naissances de l'étude (enfants nourris au sein ou non).

(++) *f* = femme

(a) Stix R.K. "Factors underlying individual and group differences in uncontrolled fertility" *Milbank Memorial Quarterly Fund* 18 : 239-256 July 1940. D'après (70) Tietze, C.

(5) M. Bonte and H. Van Balen. "Prolonged lactation and family spacing in Rwanda" *J. Biosoc Sci* (1969) 1,97-100 Recalculé sur la base de 74 % de conception dans les 9 mois après la naissance selon la méthode Potter. (Cycle sans ovulation : 2, temps moyen pour concevoir, l'ovulation étant revenue : 9 – 7 = 2 mois. Temps surestimé car il n'est pas tenu compte de perte foetale).

TABLEAU 11 – DUREE D'AMENORRHEE POST-PARTUM ET DUREE D'ALLAITEMENT

Pays	Nombre de cas	Femmes allaitantes		
		Temps (jours) aménorrhée	Temps (jours) allaitement	
1954 Ramanagarum villagers, Mysore		300 – 330		
1959 rural district Bombay, Hyderabad		390 – 450		d'après TIETZE (70)
1957 Bombay	434	360	480	P.J. BASCI (2)
1966 Taïwan	1 208	270	390 (a)	JAIN (31)
	1 636	336	468	
	2 664	342	561	
	427	294	537 (b)	
1965 Chili	158	110	120	PEREZ A. (56)
1969 Bangladesh	83	510	300 (c)	CHEN L. et al. (37)
1952 Somalie	2 957	570 (d)	660	LIPPARONI E. (38)
1955 Nigeria	380	480	600	MATTHEWS (43)
1960 Zaïre Coquilhatville	500	278	519	DEVREESE A. (15)
1960 Rwanda Astrida	100	343	360 – 540	DUREN P. (17)
1965 Rwanda	209	471 (e)	540 ou plus	BONTE M. VAN BALEN H. (5)
1962 Ethiopie	2 000	405	365 ou plus	HUBER A. et ULM R. (30)
1972 Dakar	650	310	562	FERRY B. (20)
1934 Baltimore	2 285	162	255	PECKHAM Ch. (55)

(a) Lactation insuffisante.

(b) Enfants non encore sevrés.

(c) Temps moyen d'allaitement complet calculé pour l'échantillon de 83 femmes d'après la table 7 page 289.

(d) Temps moyen d'aménorrhée sous-estimé du fait que pour les femmes (62,5 %) dont le retour des règles a eu lieu après deux ans après la naissance, le moment exact du retour des règles n'est pas connu.

(e) Calculé d'après les données de la table 2 "reappearance of menstruation in relation to conception after delivery".

TABLEAU 12 – DUREE D'AMENORRHEE SELON LA DUREE D'ALLAITEMENT, DAKAR 1972 (20)

Durée d'allaitement en mois	Durée moyenne d'aménorrhée en mois	Nombre de cas
Sans allaitement	1.45	35
1 – 8	4.5	13
9 – 14	5.8	57
15 – 20	10.7	386
21 – 26	13.4	137

Quelques auteurs ont cherché si cette stérilité temporaire de femmes allaitantes variait selon certaines caractéristiques ; Potter aux Etats-Unis n'a trouvé en plus de l'allaitement que la liaison avec l'âge de la mère. A Taïwan, Jain n'a pas trouvé de variations selon le niveau d'instruction, ni le lieu de résidence. Mais en Inde, Malkani et Mirchandani (*) ont observé que la durée d'aménorrhée post-partum était plus longue lorsque le revenu par tête était plus bas, et ont attribué ce résultat au meilleur niveau nutritionnel des personnes aux revenus plus élevés...

Les longues durées d'aménorrhée post-partum trouvées en Afrique chez les femmes allaitantes sont-elles imputables à la malnutrition ? On a vu plus haut qu'il n'y a pas de différence entre les différents échantillons étudiés de femmes non allaitantes d'Europe, d'Asie et d'Afrique. Si la malnutrition des femmes avait un effet sur la durée d'aménorrhée, il ne se manifesterait qu'en cas d'allaitement. Mais on ne dispose pas d'indications sur le niveau nutritionnel des femmes allaitantes des études citées et des observations comparables portant à la fois sur la durée d'aménorrhée, la durée d'allaitement et le niveau nutritionnel des femmes seraient nécessaires pour se prononcer.

(*) Malkani P.K. et Mirchandani J. "Menstruation during lactation", *J. Obstet. Gynec.*, India, 1960, 11, 11-22, d'après Salber (63).

CONCLUSION

Il ne semble pas possible actuellement d'évaluer la relation mortalité-fécondité en Afrique. Les différentes recherches menées jusqu'à présent selon une approche macro-démographique conduisent à considérer une relation directe de cause à effet qui ne s'avère pas concluante.

La nécessité de passer par des variables intermédiaires est essentielle pour poser en termes adéquats cette problématique. Malheureusement les recherches entreprises jusqu'à présent dans ce sens n'aboutissent pas encore à une vue synthétique ; seules quelques-unes des variables intermédiaires impliquées dans cette relation ont pu être appréhendées.

Il serait nécessaire d'entreprendre de nouvelles recherches spécifiques qui permettraient de compléter les connaissances concernant ces variables et d'en évaluer leur poids relatif dans la relation considérée. Notons que différents organismes abordent ce sujet dans cette optique par des enquêtes ponctuelles. De plus l'Enquête Mondiale de Fécondité (W.F.S.) propose à certains Etats d'inclure dans les enquêtes nationales des groupes de questions concernant ces variables.

L'élaboration d'une typologie théorique serait nécessaire pour mettre en évidence et systématiser les implications des différentes variables intermédiaires. Pour en mesurer les interractions réciproques un modèle, calqué sur cette typologie et alimenté par des données empiriques, pourrait être élaboré.

Cette démarche devrait permettre d'appréhender de façon plus pertinente les perspectives d'évolution de la fécondité lorsque la mortalité de l'enfance se modifie.

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THE SEPARATE EFFECTS OF INDIVIDUAL CHILD LOSS PERCEPTION OF CHILD SURVIVAL AND COMMUNITY MORTALITY LEVEL UPON FERTILITY AND FAMILY-PLANNING IN RURAL TAIWAN WITH COMPARISON DATA FROM URBAN MOROCCO*

David M. HEER
University of Southern California
and
Hsin-Ying WU
National Taiwan University

SUMMARY

This paper concerns a comparison of the results of a survey conducted in Taiwan by the authors with some results of a KAP survey conducted in urban Morocco by the government of Morocco. The Taiwan survey is the first survey with the explicit aim of investigating the effect of infant and child mortality differences upon fertility and family planning. A principal aim of the Taiwan survey was to investigate the separate effects of individual child loss, perception of child survival and community mortality level. To this end, interviews were conducted in two separate townships in northern Taiwan, differing very greatly in their level of infant and child mortality.

In the high mortality township (Kungliao) the death rate for children under 5 years was at least twice as high as that in the low-mortality township (Hsinchuang); however, the two townships also differed greatly in every other aspect of modernisation.

Differences in the community level of infant and child mortality can plausibly affect the behaviour and attitudes both of those married couples who lose a child and those married couples who do not since, when the level of mortality is high, all couples may fear the loss of a child and may decide to have additional children as insurance against the possibility that one or more of them may die in the future.

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Questions measuring the perception of the proportion of children who survive to age 15 were also included in the survey. If this perception of child survival were accurately measured for individuals, residual differences in individual fertility according to township should no longer measure the effects of community differences in mortality. However, in our survey, the perception of child survival could not be measured reliably.

Altogether, 8,178 individuals were interviewed in the Taiwan survey including 6,814 ever-married females and 1,364 currently-married men. The number of respondents in the high-mortality township (Kungliao) was 3,178 and in the low-mortality township (Hsinchuang), 5,000. A reinterview to determine reliability of response to the chief questionnaire items took place about one year after the original interview.

The data were analyzed by means of Multiple Classification Analysis. The first dependent variable to be analyzed was the number of subsequent births among currently-married women of third parity or higher. The chief independent variables were the number of survivors of the first three live births, the number and sex of survivors of the first three live births, the perception of child survival, and township. Control variables included the elapsed reproductive interval since the third birth in single years, the mean length of lactation of all births beginning with the third, and many other variables commonly associated with fertility, such as wife's age and education, husband's income, etc.

Holding constant the effect of all other variables, women with one child death among their first three births had about .285 more subsequent births up to the time of interview (with a median interval between third birth and interview of 11.9 years) than did women who had not lost a child among their first three births. Holding constant the effect of other variables, women in the high mortality township (Kungliao) had about .35 more subsequent births than women in the low-mortality township (Hsinchuang) and women perceiving that less than 85 % of children survived to age 15 had about. 24 more subsequent births than the average for all women.

Another Multiple Classification Analysis was conducted with ever use of contraception as the dependent variable. When one, two or three sons had been born, respondents who did not have a son die were more likely to have practised contraception after adjustment for other variables. However, the differences were significant only for the case where two sons were born. After control for other variables, ever use of contraception was significantly greater in the low-mortality township (Hsinchuang) than in the high-mortality township (Kungliao). A third Multiple Classification Analysis was conducted with the dependent variable being the additional number of children desired. After control for other variables, at each number of sons born the additional number of children desired was lower if all of the sons survived than if some had died.

After control for other variables, women in the high mortality township wanted .21 more additional children than women in the low-mortality township.

The data from urban Morocco were also analyzed by Multiple Classification Analysis with the dependent variable being the number of subsequent births among currently-married women of third parity or higher. The chief dependent variable was either the number and sex of survivors to age 10 or to interview of the first three live births or simply the number of survivors to age 10 or to interview of the first three live births.

Control variables included wife's age, wife's age at marriage, marital duration before age 45, number of times married and many other variables commonly associated with fertility differences. Unfortunately, this set of control variables did not allow us to separate out the voluntary effect of child loss from the psychological. Moreover, it was also not possible to separate out the effect of community mortality level. After adjustment for the control variables that were entered into the equation, women who lost

one child from their first three live births had .60 more subsequent children than women who lost none of their first three live births.

RÉSUMÉ

Dans cette communication, il s'agit d'une comparaison entre les résultats d'une enquête faite par les auteurs à Formose et ceux d'une enquête d'opinion dans les zones urbaines du Maroc faite par le Gouvernement marocain. L'enquête de Formose est la première qui ait été faite avec le propos délibéré de rechercher l'effet des différences dans la mortalité infantile et celle des enfants sur la fécondité et le planning familial. Le but principal de l'enquête de Formose était de rechercher les effets séparés de la perte d'un enfant au niveau individuel, de la conscience que l'on a de la survie des enfants et du niveau de la mortalité dans les communautés étudiées. A cette fin, des entrevues ont été faites dans deux communes du Nord de Formose où la mortalité infantile et celle des enfants sont très différentes.

Dans la commune où la mortalité est forte (Kungliao), le taux de mortalité des enfants de 0 à 4 ans était au moins deux fois plus élevé que dans la commune où la mortalité est faible (Hsinchuang); cependant, ces deux communes différaient également beaucoup l'une de l'autre par tous les autres aspects de la modernisation.

Il est concevable que les différences, au niveau des communes, de la mortalité infantile et de la mortalité des enfants affectent le comportement et les attitudes des couples mariés qui perdent un enfant et de ceux qui n'en perdent pas. En effet, lorsque la mortalité est forte, tous les couples peuvent craindre de perdre un enfant et peuvent décider d'en avoir d'autres pour s'assurer contre la possibilité d'en perdre un ou davantage dans l'avenir.

Des questions destinées à mesurer la conscience que l'on a de la proportion des enfants qui survivent à 15 ans figuraient également dans l'enquête. Si les mesures qu'on en tire étaient exactes pour chaque couple, les différences résiduelles de la fécondité individuelle selon la commune ne mesureraient plus les effets des différences de mortalité entre les communes. Cependant, dans notre enquête, la conscience que l'on a de la survie des enfants n'a pu être mesurée exactement.

Au total, 8 178 personnes ont été interviewées dans l'enquête de Formose parmi lesquelles 6 814 femmes mariées ou l'ayant été et 1364 hommes actuellement mariés. Le nombre des enquêtés était de 3 178 dans la commune où la mortalité est forte (Kungliao) et de 5 000 dans la commune où la mortalité est faible (Hsinchuang). Une seconde entrevue pour déterminer la fiabilité des réponses au questionnaire principal a eu lieu environ un an après la première entrevue.

Les données ont été étudiées au moyen de l'analyse par classification multiple. La principale variable dépendante à analyser était le nombre de naissances ultérieures parmi les femmes actuellement mariées ayant eu trois enfants ou plus. Les principales variables indépendantes étaient le nombre de survivants parmi les trois premières naissances vivantes, le nombre et le sexe des survivants parmi les trois premières naissances vivantes, la conscience que l'on a de la survie des enfants et, enfin, la commune de l'enquêté. Parmi les variables de contrôle figuraient l'intervalle de temps passé par les couples reproducteurs depuis la troisième naissance en années révolues, la durée moyenne de lactation pour toutes les naissances à partir de la troisième et bien d'autres variables dont on admet en général que dépend la fécondité telles que l'âge de la mère, son instruction, le revenu du mari, etc.

Si on maintient constant l'effet de toutes les autres variables, les femmes ayant perdu un enfant parmi leurs trois premiers nés avaient eu jusqu'au moment de l'entrevue environ 0,285 naissances de plus (avec un intervalle médian de 11,9 ans entre la troisième naissance et l'époque de l'entrevue) que celles qui n'avaient perdu aucun de leurs trois premiers nés. Si on maintient constant l'effet des autres variables, les femmes vivant dans

la commune où la mortalité est forte (Kungliao) avaient eu environ 0,35 naissances ultérieures de plus que celles vivant dans la commune où la mortalité est faible (Hsinchuang). En outre, les femmes qui estimaient que moins de 85 % des enfants atteignaient l'âge de 15 ans avaient eu environ 0,24 naissances ultérieures de plus que la moyenne de l'ensemble des femmes.

Une autre analyse par classification multiple a été faite dans laquelle la variable dépendante était la réponse à la question "a déjà utilisé la contraception". Quand il y avait eu un, deux ou trois fils, les enquêtées qui n'en avaient perdu aucun avaient en général eu plus recours à la contraception, toutes les autres variables ayant été contrôlées dans l'analyse. Cependant, la différence n'était significative que dans le cas où il y avait eu deux naissances masculines dans la famille. Après contrôle des autres variables, la réponse à la question sur l'utilisation de la contraception jouait un rôle significativement plus important dans la commune de faible mortalité (Hsinchuang) que dans celle de forte mortalité (Kungliao). Une troisième analyse par classification multiple a été faite en utilisant comme variable indépendante le nombre supplémentaire d'enfants désirés. Après contrôle des autres variables, pour chaque nombre de naissances masculines, le nombre supplémentaire d'enfants désirés était plus bas si tous les fils avaient survécu que si quelques-uns d'entre eux étaient morts.

Après contrôle des autres variables, les femmes vivant dans la commune de forte mortalité voulaient 0,21 enfant de plus que celles vivant dans la commune de faible mortalité.

Les données relatives au Maroc urbain ont également été analysées au moyen de l'analyse par classification multiple, la variable dépendante étant le nombre de naissances ultérieures parmi les femmes actuellement mariées et ayant eu trois enfants ou plus. La variable dépendante principale était soit le nombre et le sexe des enfants survivants à 10 ans ou lors de l'entrevue parmi les trois premiers nés, soit, tout simplement, le nombre des survivants à l'âge de 10 ans ou lors de l'entrevue parmi les trois premiers nés vivants.

Parmi les variables de contrôle figuraient l'âge de l'épouse, son âge au mariage, sa durée d'union avant 45 ans, le nombre de fois qu'elle avait été mariée et de nombreuses autres variables dont, estime-t-on généralement, dépendent les différences de fécondité. Malheureusement cette série de variables de contrôle ne nous a pas permis de distinguer l'effet volontaire de la perte d'un enfant de l'effet physiologique. De plus, il n'a pas été possible de distinguer l'effet du niveau de la mortalité dans l'ensemble de la commune. Après ajustement des variables de contrôle utilisées pour l'équation, les femmes qui avaient perdu un enfant parmi leurs trois premiers nés avaient eu 0,60 naissances ultérieures de plus que celles qui n'avaient perdu aucun de leurs trois premiers nés vivants.

RESUMEN

Este documento se refiere a una comparación de los resultados de una encuesta realizada en Taiwan, por los autores, con algunos resultados de una encuesta KAP realizada por el gobierno de Marruecos en zonas urbanas de ese país. La encuesta de Taiwan es la primera encuesta realizada con el objetivo explícito de investigar el efecto de mortalidad diferencial infantil y de la niñez sobre la fecundidad y la planificación familiar. El espíritu principal de la encuesta de Taiwan era investigar los efectos separados de la pérdida individual de los niños, la percepción de la sobrevivencia de los niños y el nivel de la mortalidad en la comunidad. Para este propósito, se hicieron entrevistas en dos ciudades de Taiwan septentrional, que presentaban grandes diferencias en los niveles de mortalidad infantil y de la niñez.

Kungliao era la ciudad que presentaba la mortalidad más alta, por ejemplo la mortalidad de los niños de 5 años era por los menos dos veces más elevada que en la ciudad que tenía la mortalidad más baja

(Hsinchuang); sin embargo, las dos ciudades diferían también en diversos otros aspectos relativos al grado de modernización.

Las diferencias en los niveles de la mortalidad infantil y de la niñez que se observan en la comunidad pueden afectar plausiblemente tanto la conducta como las actitudes de aquellos matrimonios que han perdido un hijo como a aquellos que no han perdido ninguno, ya que, cuando el nivel de la mortalidad es alto, todas las parejas pueden tener miedo de perder un hijo y consecuentemente pueden decidir tener niños adicionales como una medida de seguridad contra la posibilidad de que uno o más de ellos pueden morir en el futuro.

En la encuesta se incluyeron también, preguntas destinadas a medir la percepción acerca de la proporción de niños que sobreviven hasta los 15 años. Si esta percepción acerca de la sobrevivencia de los niños fuera medida satisfactoriamente en los casos individuales, las diferencias individuales en la fecundidad que se observan según las ciudades, podría sin mas dilación, medir los efectos de las diferencias de la comunidad en la mortalidad. Sin embargo, en nuestra encuesta, la percepción de la sobrevivencia de los niños no pudo ser medida satisfactoriamente.

En la encuesta de Taiwan fueron interrogados 8 178 individuos en total, incluyendo 6 814 mujeres que habían estado alguna vez casadas y 1 364 hombres actualmente casados. El número de personas que respondieron el cuestionario alcanzó a 3 178 en la ciudad de más alta mortalidad (Kungliao) y a 5 000 en la de más baja mortalidad (Hsinchuang). Un año después de la entrevista original, se realizó una segunda entrevista para determinar la confiabilidad de las respuestas a los aspectos principales del cuestionario.

Los datos fueron analizados por medio de un Análisis de Clasificación Múltiple. La primera variable dependiente en ser analizada fue el número de nacimientos subsiguientes entre las mujeres actualmente casadas con una tercera paridad o una paridad mayor.

Las principales variables independientes fueron: el número de sobrevivientes de los tres primeros nacidos vivos, el número y sexo de los sobrevivientes de los tres primeros nacidos vivos, la percepción de la sobrevivencia del niño, y las variables de control de cada ciudad incluido el intervalo reproductivo transcurrido desde el tercer nacimiento en años simples, la duración media de la lactancia de todos los nacimientos a partir del tercero, y muchas otras variables asociados frecuentemente con la fecundidad, tales como la edad y educación de la madre, ingresos del padre, etc.

Si se mantiene constante el efecto de todas las demás variables, las mujeres que han experimentado la pérdida de un solo hijo entre sus tres primeros nacidos vivos tienen alrededor de 0,285 nacimientos subsiguientes más que las mujeres que no han perdido ningún niño entre sus tres primeros nacidos vivos. Esta relación se encontró hasta la fecha de la entrevisha, con un intervalo medio de 11,9 años entre la fecha del tercer nacimiento y la fecha de la entrevista. Manteniendo constante, nuevamente, el efecto de todas las demás variables, las mujeres pertenecientes a la ciudad de mayor mortalidad (Kungliao) tenían aproximadamente 0,35 más nacimientos subsiguientes que las mujeres de la ciudad de mortalidad más baja (Hsinchuang) y las mujeres que tenían la percepción de que menos del 85 % de los niños sobrevivía hasta los 15 años de edad tenían aproximadamente 0,24 más nacimientos subsiguientes que el promedio de todas las mujeres.

Otro análisis de Clasificación Múltiple fue realizado tomando como variable dependiente el hecho de haber usado alguna vez anticonceptivos. Si se hace un ajuste de la demás variables, las mujeres que habían tenido unò, dos o tres hijos nacidos vivos, y no habían experimentado la pérdida de ninguno de ellos, tenían una mayor probabilidad de haber usado la contracepción. Sin embargo las diferencias eran significativas sólo para el caso en que hubieran nacido dos hijos. Controlando las demás variables, el haber usado alguna vez la contracepción era significativamente mayor, en la ciudad de más baja mortalidad (Hsingchuang), que en la ciudad de más alta mortalidad (Kungliao). Un tercer análisis de Clasificación Múltiple fue realizado tomando como variable dependiente el número adicional de niños

deseados. Después de controlar las demás variables, y haciendo el análisis según el número de hijos nacidos vivos, se encontró en todos los casos que el número adicional de hijos deseados era más bajo cuando todos los hijos habían sobrevivido que cuando alguno de ellos había muerto.

Controlando las demás variables, las mujeres de la ciudad de mayor mortalidad deseaban 0,21 mas hijos adicionales que las mujeres de la ciudad de la mortalidad más baja.

Los datos de la encuestra de la zona urbana de Marruecos fueron también analizados mediante el Análisis de Clasificación Múltiple. Se tomó como variable dependiente el número subsiguiente de nacimientos entre las mujeres actualmente casadas con una tercera paridad o una paridad mayor. La principal variable independiente fue tanto el número y sexo de los sobrevivientes hasta los 10 años (o hasta la fecha de la entrevista) de los primeros tres nacidos vivos o simplemente el número de sobrevivientes hasta los 10 años de edad (o hasta la fecha de la entrevista) de los tres primeros nacidos vivos.

Las variables de control incluían la edad de la madre, la edad al casarse de la madre, la duración del matrimonio hasta antes de los 45 años de edad, el números de veces que contrajo matrimonio y muchas otras variables permanentemente asociadas con las diferencias de la fecundidad. Desgraciadamente, este conjunto de variables de control, no nos permitió distinguir el efecto voluntario del efecto fisiológico cuando se producen fallecimientos de los hijos. Más aún, no fue posible distinguir el efecto del nivel de mortalidad de la comunidad. Después de efectuar un control de las variables incluídas en la ecuación correspondiente, las mujeres que habían perdido un niño entre sus tres primeros nacidos vivos, tenían 0,60 niños subsiguientes más que las mujeres que no habían perdido ninguno de sus tres primeros hijos nacidos vivos.

Part 1 : Hypotheses and Questions Posed

For several years a major debate has raged concerning the factors determining the success of family planning programs in less developed nations. One school of thought believes that success is largely dependent on the availability of appropriate contraceptives. A second school of thought is of the opinion that while the availability of appropriate contraceptives will prove highly valuable, this factor by itself will not be sufficient to reduce birth rates to desired levels. The latter group contends that persons in the less developed nations are still rationally motivated to have large families and will continue to have them until institutional changes occur which will change that motivation. Evidence for this viewpoint comes from recent findings concerning desired family size in many of the less developed nations. For example, in Taiwan, a nation generally considered to have a highly successful family-planning program, the average number of children desired is still about four (Finnigan and Sun, 1972).

Several social changes have been proposed as contributing to reduced motivation for high fertility. The Taiwan study focused on two such changes : (1) a reduction in the level of infant and child mortality, and (2) a reduction in the high preference for sons. In the present paper concern will be confined to the first of these. More complete reports on the Taiwan study are contained in Heer and Wu (1975) and Heer (1972).

The possible effect of infant and child mortality on fertility and family-planning behavior and attitudes can be subdivided into two components : (1) the effect of the community level of infant and child mortality, and (2) the effect of the individual experience of child loss. Differences in the community level of infant and child mortality can plausibly affect the behavior and attitudes both of those married couples who lose a child and those married couples who do not. When the level of infant and child mortality is high, all couples who never suffer the loss of a child may, nevertheless, fear such loss and may decide to have additional children as insurance against the possibility that one or more of them may die in the future. The individual experience of child loss may also have important consequences for fertility behavior and attitudes. Comparing couples who have lost a child with couples who have not, the couples suffering child loss may logically : (1) exactly compensate for the loss of their children, i.e. end up with the same number of living children as those who have never lost a child, (2) undercompensate for their loss, i.e. end up with fewer living children than those couples who have not lost a child, or (3) overcompensate, i.e. end up with more living children than those couples never experiencing the loss of a child.

In short, when considering the impact of infant and child mortality upon fertility behavior and attitudes we must consider four different categories of respondents : (1) respondents living in a high-mortality community who have not experienced the loss of a child, (2) respondents living in a high mortality community who have experienced the loss of one or more children, (3) respondents living in a low-mortality community who have not experienced the loss of a child, and (4) respondents living in a low-mortality community who have lost one child or more.

Our study was purposefully designed so as to be able to secure respondents in each of these categories. Accordingly, we were able to test two separate hypotheses for our study population. The first of these is that a high rather than a low level of infant and child mortality in the community would foster high fertility both among couples who lose a child and among those who do not. Our second hypothesis was that at any given level of infant and child mortality in the community, those couples suffering the loss of a child would have for each parity level higher subsequent fertility, lower use of contraception, larger number of additional children desired, and a higher ideal family size.

In preparing for the Taiwan survey we made plans to select a locale where family-planning methods were available and where birth control was being practised. We also made plans to choose two sites differing as much as possible in their level of infant and child mortality (given the constraint that both sites had to be fairly close to Taipei). We also planned for a large sample so that the number of women who experience the loss of one or more children would be sufficient to make statistically precise statements. Finally, we were aware that we would need to achieve statistical control for many other variables which might plausibly account for any observed relationship between the two variables.

In designing the study so that interviewing would take place in two sites differing maximally in their level of infant and child mortality we gave ourselves the opportunity to separate our areal effect from the effects of differences on the individual level. For example, we made it possible to discover that after adjusting for individual differences in educational attainment, in economic status and in the experience of child loss respondents in the high-mortality area had higher fertility than respondents in the low-mortality area. Unfortunately, if this were the whole of our procedure we would not be able to state that the remaining difference in fertility behavior by area was caused by the difference in the community level of infant and child mortality. A plausible alternative would be, for example, that the remaining fertility difference by area might be due to the lower average literacy level of the high-mortality area and higher average literacy level of the low-mortality area. To discover the specific effect of living in a high-mortality area versus a low-mortality area we would have to interview substantial numbers of respondents in each of many different areas so that we would have for example, substantial numbers of respondents in high mortality, high literacy areas and in low mortality, high literacy areas. Such a survey was obviously impossible given our budgetary constraints.

On the other hand, we could seek to measure the specific effect of the community level of infant and child mortality through another means. This was to measure, on an individual level the perception of the probability of child survival. If the community level of infant and child survival was to have an influence upon fertility, it would do so through affecting the individual couple's perception of the chances of child survival in that community. Hence if we would show that the perception of child survival was related to actual child survival and that differences in perceptions of child survival were associated with differences in fertility behavior and attitudes, we could show that the community level of child survival did have an effect on fertility behavior and attitudes.

However, no one had as yet attempted to measure individual perceptions of the probabilities of child survival. Therefore, we could not be sure that we would be able to measure these perceptions reliably. Thus several outcomes of our work were possible each with its own consequences for the validity of our hypothesis. These were as follows :

1) There would be no areal differences in fertility behavior or attitudes after holding constant individual differences in educational attainment, socio-economic status, individual experience of child loss, and other variables on the individual level other than perception of child survival. In this case we would be able to reject the hypothesis that the community level of child survival was an important force affecting fertility behavior and attitudes.

2) There would be no areal differences in fertility behavior or attitudes after holding constant differences in all of the individual variables ; moreover, individual perception of child survival would be an important source of influence on fertility behavior and attitudes, and, furthermore, the individual perception would be closely related to the community level of infant and child mortality. In this case we would have confirmed the hypothesis that the community level of child survival affected fertility.

3) There would be substantial areal differences in fertility behavior or attitudes after holding constant differences in all of the individual variables including the perception of child survival ; however, individual perception of child survival could be measured only with a low degree of reliability and would not be substantially associated with fertility differences. In this case we would not have compelling evidence that the

community mortality level affected fertility ; nevertheless, we would have grounds for belief that the community level of infant and child mortality might be an important factor in explaining differences in fertility.

Our procedure for testing whether the individual experience of child loss had an effect on fertility behavior and attitudes was much simpler than our procedure for testing whether the community level of child survival had such an effect. To test this hypothesis we needed a large enough number of cases to obtain some statistical precision and we needed to hold constant those variables which might be associated with the experience of child loss and had been shown from previous studies to be importantly related to fertility behavior and attitudes. The length of lactation was one such factor that previous work had shown to be important. If a child dies, a mother who has been breastfeeding soon ceases her lactation and the period of postpartum amenorrhea associated with that lactation comes to an end. For this strictly biological reason, in a population in which prolonged breastfeeding is common, women experiencing the early loss of their baby will have a shorter interval to the next birth, other things being equal, than women who do not experience the loss of a child. The other variables which we needed to hold constant were the variables that had been shown in one or more previous studies to have associations with fertility behavior and attitudes. These included age, parity, educational attainment, birth-control knowledge, the wife's labor forces status, and husband's income.

Part 2 : Setting for the Taiwan Survey, Details of the Data Collection, and Characteristics of the Respondents

Setting for the Survey :

Interviews in the low-mortality community were conducted in Hsinchuang township and in the high-mortality community in Kungliao township. Both of these townships were located in Taipei county. It had been originally contemplated that both interviewing sites would be rural townships. Because Hsinchuang had a considerably larger population than the original choice for the low-mortality community and because it was officially classed as an urban township, it was decided that interviews in Hsinchuang would be conducted only in areas outside of the central town.

Much of Kungliao township is hilly or mountainous and the large majority of the population lives directly on the sea coast or on the small river on which the town of Kungliao is located. Only a small portion of all land can be used for agriculture and almost all of this is used for rice paddy. Because of the nature of the terrain, the roads within Kungliao are very poor. Hsinchuang township lies within the Taipei basin on the north side of the Tamshui river. Most of the township consists of flat alluvial land used for rice paddy. Although the township is situated a short distance north of the main railroad from Taipei to Kaohsiung, it is directly located on one of the main highways leading southwest from Taipei and frequent buses travel to and from Taipei. Roads within the township are good although often crowded. The town of Hsinchuang is the site of Foojen University, a Roman Catholic Institution supported in large parts with funds from West Germany, and also of the Taiwan Provincial Institute of Health.

Kungliao and Hsinchuang townships differed as much in almost every aspect of modernity as they did in infant and child mortality. The proportion of illiterates was lower in Hsinchuang than in Kungliao. Furthermore, the proportion of males engaged in agriculture or fishing was very much higher in Kungliao than in Hsinchuang. Kungliao was quite unusual in the very high proportion of all males engaged in fishing. In 1966, the last year for which data was available, 42.1 percent of all employed males in Kungliao were fishermen. Fishing is done in small boats and without the aid of modern equipment. Although the proportion of males engaged in manufacturing in Kungliao was negligible, the proportion so engaged in Hsinchuang was considerably higher than the average for all of Taiwan. There are many new factories along the highway leading from Hsinchuang into Taipei. The establishment of these factories was a basic cause of the high population growth rate in Hsinchuang and the very high rate of net in-migration.

The proportion of women 15 years old and over employed in a non-agricultural activity differs substantially between the two townships. In Hsinchuang township this proportion is somewhat higher than the average for all of Taiwan but in Kungliao it is distinctly lower.

The contrast in mortality between Hsinchuang and Kungliao was marked. The death rate for infants and young children during the five years preceding the interviews was on the average at least twice as high in Kungliao as in Hsinchuang.

Finally, consider the variables related to fertility. In 1969 the crude birth rate was actually higher in Hsinchuang than in Kungliao. However, this was not because fertility was higher in Hsinchuang than in Kungliao but because of differences in age composition. The total fertility rate per 1,000 females, which is a pure measure unaffected by age composition was 4,400 in Hsinchuang and 6,130 in Kungliao. Despite the difference between the two townships in fertility successful family-planning programs in terms of IUD and pill acceptance rates existed in 1969 in both Kungliao and Hsinchuang townships.

In summary, although the two communities had been selected because they differed so much in their level of infant and child mortality, it was impossible to approximate a maximization of this difference without also creating very large differences in all other aspects of modernization.

Details of the Data Collection

The study design was as follows. The household registration system in each township was to be used to transcribe all households in which there was an ever-married female. In all such households all ever-married women were to be interviewed. In one-fifth of the households currently-married males, if present, were to be interviewed. The households in which males were to be interviewed were the 3rd, 8th, 13th, 18th, etc., household in each lin (small sub-unit of a township). However, the study design with respect to males had to be abandoned, due to high rates of nonresponse, in favor of interviewing males in adjacent households as well.

The number of completed interviews by township and by sex was as follows :

	Female	Male	Total
Kungliao	2 677	501	3 178
Hsinchuang	4 137	863	5 000
Total	6 814	1 364	8 178

The percentage of eligibles who were successfully interviewed can be computed only for females. For Kungliao females, the percentage was 77.4 and for Hsinchuang females 78.8 percent.

A reinterview to determine reliability of response to the chief questionnaire items was a key component of the study design. The reinterview was begun in Kungliao township in November, 1970 and in Hsinchuang township in January, 1971.

General Characteristics of the Respondents

On the average, the respondents in Kungliao differed markedly from those in Hsinchuang. In Kungliao, average socio-economic status was lower, desired family size higher, actual fertility higher, child survival less assured and perceived as being less assured, and the reliance on sons as the chief support in one's old age more pronounced.

However, the differences between the two townships should not obscure certain similarities. In botl. townships the desired number of children was sufficiently high to guarantee a substantial rate of natural increase, and the preference for sons was quite pronounced. Although substantial proportions of respondents in both townships manifested their entire approval of birth control nevertheless the proportions actually practising contraception were rather low.

Part 3 : Results of the Taiwan Survey

Dependent and Independent Variables

Let us now examine the results of three Multiple Classification Analyses (Andrews et al., 1967) in which the dependent variables are respectively : (1) the number of subsequent births among currently-married women of third parity or higher and with the third birth at least one year prior to the interview, (2) current or previous use of contraception among currently-married females born in 1925 or later, and (3) additional number of children desired.

The main object of these analyses is to examine the apparent influence of : (1) the number and sex of the respondent's first three live births one year following the third live birth, (2) the number of survivors of the respondent's first three live births one year following the third live birth, (3) the number of sons born and whether or not they all survived, (4) the number of daughters born and whether or not they all survived, (5) the percentage of births who died before age 15, (6) the perception of child survival, (7) township – which serves as an imperfect proxy of the community level of child mortality.

It is obvious that the apparent effect of these variables upon the dependent variables cannot be examined without statistical control for other relevant variables. Among the most important of these other relevant variables are elapsed reproductive interval since the pertinent birth, age, the number of living sons, and the number of living daughters. The other variables which are held constant include the respondent's educational attainment (and newspaper readership), labor-force status, attitudinal preference for sons, educational aspirations for a nephew and for a niece, knowledge of birth-control, mean length of breast feeding (lactation), husband's occupation, and husband's income.

TABLE 1 – NUMBER OF SUBSEQUENT BIRTHS AMONG CURRENTLY-MARRIED WOMEN OF THIRD PARITY OR HIGHER AND WITH THIRD BIRTH AT LEAST ONE YEAR PRIOR TO THE INTERVIEW, TAIWAN SURVEY

Mean is 2.729	Value of multiple R^2 for run :	
Number of cases is 3 898	A .632	
Standard deviation is 2.261	B .633	
Rank of each predictor in terms of size of Beta	Run	
	A	B
Elapsed reproductive interval since third birth	.820	.820
Mean length of lactation of all live births beginning with the third	.156	.154
Age	.141	.139
Township	.078	.077
Educational attainment	.076	.076
Number and sex of survivors of the first three live births at one year following the mother's third live birth	–	.062
Number of survivors of the first three live births at one year following the mother's third live birth	.046	–
Preference for sons	.040	.039
Husband's income	.032	.032
Educational aspirations for nephew	.031	.030
Perception of child survival	.028	.029
Labor force status	.027	.028
Husband's occupation	.027	.027
Birth control knowledge	.006	.005

Description of the categories of each predictor in terms of its deviations from the grand mean and its adjusted coefficient:	Deviation from grand mean	Adjusted coefficient in run		Number of cases
		A	B	
Township				
Kungliao	+ 0.588	+ 0.201	+ 0.199	1 091
Hsinchuang	– 0.450	– 0.154	– 0.152	2 207
Age				
Under 25	– 2.182	+ 0.304	+ 0.292	64
25 to 29	– 1.936	+ 0.341	+ 0.333	536
30 to 34	– 1.241	+ 0.262	+ 0.262	835
35 to 39	– 0.626	+ 0.210	+ 0.208	752
40 to 44	+ 0.904	– 0.128	– 0.130	614
45 and over	+ 1.623	– 0.457	– 0.448	1 097
Number and sex of survivors of the first three live births at one year following the mother's third live birth				
3 sons	– 0.372	–	– 0.149	358
3 daughters	– 0.160	–	+ 0.163	357
2 sons, 1 daughter	– 0.431	–	– 0.142	1 136
1 son, 2 daughters	– 0.411	–	+ 0.002	1 150
2 sons, 0 daughters	+ 1.130	–	+ 0.261	170
2 daughters, 0 sons	+ 1.065	–	+ 0.227	161
1 son, 1 daughter	+ 1.050	–	+ 0.219	294
1 son, 0 daughters	+ 1.521	–	– 0.039	44
1 daughter, 0 sons	+ 1.977	–	+ 0.167	51
No surviving children	+ 1.646	–	+ 0.048	8
N.A.	+ 1.768	–	+ 0.006	169
Number of survivors of the first three live births at one year following the mother's third live birth				
3 survivors	– 0.384	– 0.052	–	3 001
2 survivors	+ 1.076	+ 0.233	–	625
1 survivor	+ 1.766	+ 0.075	–	95
0 survivors	+ 1.646	+ 0.044	–	8
N.A.	+ 1.768	+ 0.007	–	169

TABLE 1 – (CONTINUED)

	Deviation from grand mean	Adjusted coefficient in run		Number of cases
		A	B	
Perception of child survival				
Less than 85 percent survival	+ 0.677	+ 0.234	+ 0.242	239
85 to 94 percent survival	+ 0.269	– 0.005	– 0.001	1 133
95 percent or more survival	– 0.209	– 0.025	– 0.027	2 415
N.A.	+ 0.343	+ 0.085	+ 0.075	111
Preference for sons				
High preference	+ 0.045	+ 0.056	+ 0.055	1 375
Moderate preference	+ 0.194	+ 0.115	+ 0.114	810
No preference	– 0.128	– 0.099	– 0.098	1 713
Mean length of lactation of all live births beginning with the third				
No lactation	+ 0.771	– 0.088	– 0.058	6
Less than 6 months	– 0.821	+ 0.334	+ 0.334	206
6 to 11 months	+ 0.822	+ 0.567	+ 0.559	894
12 to 17 months	– 0.174	– 0.220	– 0.220	2 027
18 months or more	– 0.114	– 0.421	– 0.409	400
N.A.	– 0.474	+ 0.105	+ 0.111	365
Husband's occupation				
Fisherman	+ 0.527	– 0.028	– 0.030	575
Farmer	+ 0.585	+ 0.080	+ 0.079	1 371
Not in primary industry, worked for self or relative	– 0.267	– 0.054	– 0.054	690
Not in primary industry, worked for nonrelative	– 0.731	– 0.046	– 0.044	1 252
Husband not employed	– 0.011	– 0.139	– 0.094	6
N.A.	+ 0.021	+ 0.458	+ 0.409	4
Husband's income				
Less than NT$15 000	+ 0.637	+ 0.074	+ 0.072	1 446
NT$15 000 to NT$24 900	– 0.501	– 0.048	– 0.046	908
NT$25 000 and over	– 0.793	– 0.110	– 0.111	812
N.A.	+ 0.242	+ 0.037	+ 0.038	732
Educational attainment				
Less than primary school graduate	+ 0.470	+ 0.094	+ 0.094	2 559
Primary graduate but less than junior high graduate and never reads a newspaper	– 0.458	+ 0.003	+ 0.004	394
Primary graduate but less than junior high graduate and reads a newspaper	– 1.124	– 0.253	– 0.253	570
Junior high graduate or more	– 1.666	– 0.564	– 0.566	173
N.A.	– 0.729	– 0.348	– 0.398	2
Labor-force status				
Never worked and would not work in future	+ 0.593	+ 0.034	+ 0.036	2 130
Never worked but might work in future	– 0.347	– 0.014	– 0.015	697
Previously worked	– 1.000	– 0.014	– 0.016	845
Presently working	– 0.769	– 0.220	– 0.229	223
N.A.	–1.062	– 0.490	– 0.505	3
Educational aspirations for nephew				
Low	– 0.095	+ 0.049	+ 0.052	555
Medium	+ 0.171	+ 0.098	+ 0.096	728
High	– 0.030	– 0.041	– 0.040	2 607
N.A.	+ 0.771	+ 0.867	+ 0.827	8
Birth-control knowledge				
Low	+ 0.565	– 0.005	– 0.007	1 172
Medium	– 0.004	+ 0.013	+ 0.013	1 800
High	– 0.707	– 0.019	– 0.016	926

TABLE 1 (CONCLUDED)

	Deviation from grand mean	Adjusted coefficient in run		Number of cases
		A	B	
Elapsed reproductive interval since third birth				
1 to 2 years	– 2.611	– 2.643	– 2.647	221
2 to 3 years	– 2.279	– 2.508	– 2.495	202
3 to 4 years	– 2.016	– 2.224	– 2.228	178
4 to 5 years	– 1.717	– 1.953	– 1.959	170
5 to 6 years	– 1.416	– 1.589	– 1.595	198
6 to 7 years	– 1.237	– 1.391	– 1.392	203
7 to 8 years	– 1.137	– 1.300	– 1.300	162
8 to 9 years	– 0.853	– 1.077	– 1.077	162
9 to 10 years	– 0.729	– 0.836	– 0.846	156
10 to 11 years	– 0.327	– 0.435	– 0.431	164
11 to 12 years	– 0.273	– 0.291	– 0.289	147
12 to 13 years	+ 0.024	– 0.048	– 0.047	166
13 to 14 years	+ 0.398	+ 0.417	+ 0.426	150
14 to 15 years	+ 0.216	+ 0.323	+ 0.331	146
15 to 16 years	+ 0.345	+ 0.511	+ 0.509	190
16 to 17 years	+ 0.712	+ 0.918	+ 0.918	170
17 to 18 years	+ 1.068	+ 1.323	+ 1.328	187
18 to 19 years	+ 1.609	+ 1.791	+ 1.796	192
19 to 20 years	+ 1.815	+ 2.033	+ 2.029	171
20 to 21 years	+ 2.317	+ 2.593	+ 2.594	153
21 to 22 years	+ 2.472	+ 2.661	+ 2.656	144
22 to 23 years	+ 3.489	+ 3.650	+ 3.657	110
23 to 24 years	+ 3.481	+ 3.623	+ 3.613	81
24 years or more	+ 3.813	+ 3.880	+ 3.868	72
N.A.	– 0.729	– 0.892	+ 0.871	3

For women under age 45, the elapsed reproductive interval since the pertinent birth was defined as the interval between the month and year of that birth and the month and year of the interview. For women 45 and over, the elapsed reproductive interval since the pertinent birth was defined as the interval between the month and year of that birth and the month and year the woman reached age 45.

Number of Subsequent Births Among Women of 3rd or Higher Parity

Table 1 contains the results of two MCA runs in which the dependent variable is the number of subsequent births among currently-married women of third parity or higher and with the third birth at least one year prior to the interview. In Run A we used as a principal independent variable the number of survivors of the first three live births one year following the third live birth ; in Run B we used the number and sex of survivors of the first three live births one year following the third live birth. In both runs we also use township, perception of child survival, and preference for sons as principal independent variables.

From Table 1 we see that the average number of subsequent children is 2.73 (among women for whom the median elapsed reproductive interval was 11.9 years). Run A, which shows the effect of child loss without regard to sex, reveals this variable to be of fair importance with a Beta of .06. If there are three survivors, the adjusted number of subsequent children is .052 less than average whereas when there are only two survivors, it is .233 greater than average. Thus after adjustment for the effect of other variables, respondents with only two survivors went on to have .285 more children than respondents for whom all of the first three live births survived. In other words, respondents losing one of their first three children had made up 28.5 percent of their loss by the time of interview. This result is rather precise since the 95 percent confidence limits are only plus or minus 11.8 percent. Results for women losing more than one child are much less reliable. Respondents in the sample losing two of their first three children made up only 6.4 percent of their loss (with confidence limits of plus or minus 14.0 percent), and respondents losing all of their first three made up only 3.2 percent of their loss (with the very wide confidence limits of 31.7 percent).

In Run B we show the effect of the number and sex of survivors from the first three live births. When there have been no child deaths, there are, after adjustment, fewer subsequent births the larger the number of the first three births which were male. Adjusted subsequent fertility after three surviving sons is significantly smaller than after three surviving daughters. Furthermore, adjusted subsequent fertility after two surviving sons and one surviving daughter is significantly smaller than after one surviving son and two surviving daughters.

Unfortunately, the sample, large as it is, does not contain enough cases to examine the effect of sex of surviving children on subsequent fertility if there have been one or more child deaths.

In both Run A and in Run B of Table 1 respondents with a low perception of child survival go on to have about .24 more additional children after adjustment for other variables than those with a higher perception (the differences both in Run A and in Run B are statistically significant). However, the fact that most respondents are in the category perceiving 95 percent survival or greater means that the predictor as a whole has only a small value of Beta (.03). Preference for sons also exerts a significant effect in the predicted direction. However, the variation in the adjusted coefficients between the categories of this predictor is relatively small.

Township is also shown to have a significant effect on subsequent births. After adjustment for other variables, Kungliao respondents go on to have about .35 more births than those in Hsinchuang. If our measure of perception of child survival were completely reliable, one could state that the difference by township was due to some factor other than the community difference in child survival. However, the reinterview demonstrated that the measure of perception of child survival had very poor reliability. In a reinterview conducted approximately 12 months after the first interview, the questions on perception of child survival were repeated. The coefficient of correlation between test and retest for the question on number of survivors from 20 births was .290 (with an *n* of 5,454) and that for the question on number of survivors from 100 births was .285 (with an *n* of 4,800).

Of the control variables for Runs A and B in Table 3 only one deserves special mention – the mean length of lactation of all live births beginning with the third. In both runs this was the second most important predictor. Respondents with a very long mean length of lactation had substantially fewer subsequent births than other respondents. However, the largest number of subsequent births came from women with 6 to 11 months of lactation. Apparently, the women who did not breastfeed at all or whose mean duration of lactation was less than six months utilized contraceptive methods with greater frequency than other groups of the respondents.

Ever Use of Contraception

The three runs with respect to this dependent variable will not be presented in tabular form. The independent variables used are identical to those used for the runs shown in Table 2. The dependent variable was the proportion of currently-married females born in 1925 or later who had ever used contraception. In each of the three runs the value of multiple R^2 was .26. When one, two, or three sons had been born, respondents who did not have a son die were more likely to have practised contraception after adjustment for other variables. But the difference was only significant in the case where two sons had been born, since the small number of cases in the categories where one or more sons had died cause high sampling error. Analysis with respect to the number of daughters born and their survival, again confronts heavy sampling errors due to the small number of cases in the categories where one or more daughters died. With respect to the percentage of births who died before age 15, holding constant the number of living daughters and living sons and other relevant variables, there is a slight tendency for those who have had some children die to have greater proportion ever using contraception than that for all respondents. However, the result is significant only for the category in which 25 to 49 percent of births died.

Contrary to hypothesis, a high perception of child survival is negatively related to current or previous contraceptive use, although the differences between categories are very small and are not significant. Preference for sons is associated negatively, as expected, with current or previous contraceptive practice. Although the difference in the adjusted coefficients is not large, the proportion ever using contraception is significantly greater in the no-preference category than in the high-preference category. The difference by township in previous or current contraceptive practice holding constant other variables is substantial and highly significant. The adjusted coefficient for Hsinchuang is almost 8 percent points higher than for Kungliao.

Additional Children Desired

Table 2 presents the results with respect to the additional number of children desired by currently-married respondents with wife born in 1925 or later. The values of multiple R^2 found in each of the three runs in this table – approximately .52 in each case – are higher than those observed for any of the other dependent variables examined.

The number of sons and their survival, with a Beta of .48, proves to be the most important variable of Run A. At each number of sons born, the adjusted coefficient is lower if all of the sons have survived than if some have died. When one, two, or three sons have been born, the results are particularly strong, and are all statistically significant. For example, when two sons have been born, those who have lost one or more of them wish to have .60 more children on the average after adjusting for the impact of other variables than those who have not suffered the loss of a son.

TABLE 2 – ADDITIONAL NUMBER OF CHILDREN DESIRED AMONG CURRENTLY-MARRIED RESPONDENTS WITH WIFE BORN IN 1925 OR LATER, TAIWAN SURVEY

Mean is 0.660	Value of Multiple R^2 for run
Number of cases is 5 543	A .518
	B .519
Standard deviation is 1.079	C .523

Rank of each predictor in terms of size of Beta:	Run		
	A	B	C
Number of wife's sons and their survival	.48	–	–
Number of living sons of wife	–	.48	.45
Number of living daughters of wife	.32	–	.30
Number of wife's daughters and their survival	–	.33	–
Wife's age	.19	.19	.19
Township	.09	.09	.09
Percentage of wife's births dying before age 15	–	–	.08
Wife's labor-force status	.08	.08	.08
Birth-control knowledge	.07	.08	.07
Sex	.07	.07	.07
Preference for sons	.05	.05	.05
Husband's occupation	.04	.05	.05
Educational attainment	.04	.03	.03
Educational aspirations for nephew	.02	–	.02
Husband's income	.02	.02	.02
Perception of child survival	.02	.02	.02
Educational aspirations for niece	–	.01	–

Description of the categories of each predictor in terms of its deviations from the grand mean and its adjusted coefficient	Deviation from grand mean	Adjusted coefficient in run			Number of cases
		A	B	C	
Township					
Kungliao	– 0.008	+ 0.141	+ 0.138	+ 0.139	1 934
Hsinchuang	+ 0.004	– 0.074	– 0.072	– 0.073	3 609
Sex					
Female	+ 0.026	– 0.070	– 0.073	– 0.073	4 619
Male	– 0.030	+ 0.081	+ 0.085	+ 0.085	924
Wife's Age					
Under 30	+ 0.730	+ 0.297	+ 0.292	+ 0.301	2 236
30 and over	– 0.331	– 0.134	– 0.131	– 0.136	3 175
N.A.	– 0.517	– 0.220	– 0.218	– 0.220	132
Number of wife's sons and their survival					
No sons born	+ 1.231	+ 1.030	–	–	899
1 son born, dead before age 15	+ 0.925	+ 0.885	–	–	26
1 son born, not dead before age 15	+ 0.274	+ 0.198	–	–	1 485
2 sons born, one or more dead before age 15	+ 0.283	+ 0.283	–	–	71
2 sons born, neither dead before age 15	– 0.394	– 0.319	–	–	1 374
3 sons born, one or more dead before age 15	– 0.458	– 0.294	–	–	151
3 sons born, none dead before age 15	– 0.509	– 0.455	–	–	742
4 or more sons born, one or more dead before age 15	– 0.607	– 0.415	–	–	303
4 or more sons born, none dead before age 15	– 0.625	– 0.508	–	–	461
N.A.	– 0.457	– 0.470	–	–	31
Number of living daughters of wife					
None	+ 0.789	+ 0.616	–	+ 0.560	1 178
One	+ 0.105	+ 0.048	–	+ 0.068	1 625
Two	– 0.249	– 0.194	–	– 0.173	1 328
Three	– 0.477	– 0.353	–	– 0.342	765
Four or more	– 0.537	– 0.360	–	– 0.365	647

	Deviation from grand mean	Adjusted coefficient in run			Number of cases
		A	B	C	
Percentage of wife's births who died before age 15					
No births	+ 2.074	–	–	+ 0.373	254
None died	– 0.026	–	–	– 0.013	4 360
Less than 25 percent died before age 15	– 0.561	–	–	+ 0.047	505
25 to 49 percent died before age 15	– 0.408	–	–	– 0.160	340
50 percent or more died before age 15	+ 0.867	–	–	+ 0.094	83
N.A.	– 0.660	–	–	– 1.748	1
Perception of child survival					
Less than 85 percent survival	– 0.068	– 0.050	– 0.042	– 0.046	339
85 to 94 percent survival	– 0.020	– 0.020	– 0.018	– 0.019	1 616
95 percent or more survival	+ 0.008	+ 0.013	+ 0.111	+ 0.012	3 474
N.A.	+ 0.294	+ 0.086	+ 0.087	+ 0.091	114
Preference for sons					
High preference	+ 0.008	+ 0.042	+ 0.043	+ 0.043	1 756
Moderate preference	+ 0.022	+ 0.074	+ 0.075	+ 0.071	1 065
No preference	– 0.014	– 0.055	– 0.056	– 0.054	2 722
Husband's occupation					
Fisherman	+ 0.068	+ 0.056	+ 0.067	+ 0.072	667
Farmer	– 0.119	+ 0.063	+ 0.067	+ 0.064	1 310
Not in primary industry, worked for self or relative	– 0.008	– 0.005	– 0.010	– 0.014	1 107
Not in primary industry, worked for nonrelative	+ 0.047	– 0.044	– 0.047	– 0.044	2 447
Husband not employed	– 0.660	– 0.196	– 0.197	– 0.212	1
N.A.	+ 0.448	– 0.194	– 0.212	– 0.212	11
Husband's income					
Less than NT$15 000	– 0.009	+ 0.017	+ 0.020	+ 0.018	1 378
NT$15 000 to NT$24 900	– 0.009	+ 0.018	+ 0.017	+ 0.019	1 569
NT$25 000 and over	– 0.008	– 0.035	– 0.036	– 0.035	1 708
N.A.	+ 0.053	+ 0.017	+ 0.016	+ 0.014	888
Educational attainment					
Less than primary school graduate	– 0.185	– 0.023	– 0.020	– 0.024	2 579
Primary graduate but less than junior high graduate and never reads a newspaper	+ 0.057	+ 0.034	+ 0.034	+ 0.036	1 063
Primary graduate but less than junior high graduate and reads a newspaper	+ 0.204	+ 0.044	+ 0.039	+ 0.042	1 354
Junior high graduate or more	+ 0.241	– 0.070	– 0.073	– 0.064	544
N.A.	– 0.349	+ 0.201	+ 0.188	+ 0.182	3
Labor-force status					
Never worked and would not work in future	– 0.185	– 0.031	– 0.033	– 0.033	2 050
Never worked but might work in future	– 0.022	+ 0.039	+ 0.039	+ 0.041	1 077
Previously worked	+ 0.157	– 0.001	+ 0.002	+ 0.004	1 947
Presently working	+ 0.171	+ 0.022	+ 0.018	+ 0.011	465
N.A.	+ 4.271	+ 3.013	+ 2.984	+ 2.487	4
Educational aspirations for nephew					
Low	– 0.059	+ 0.040	–	+ 0.038	710
Medium	– 0.004	+ 0.032	–	+ 0.028	1 050
High	+ 0.012	– 0.017	–	– 0.015	3 780
N.A.	+ 0.340	– 0.489	–	– 0.536	3
Educational aspirations for niece					
Low	– 0.081	–	+ 0.019	–	661
Medium	– 0.054		+ 0.002	–	1 089
High	+ 0.031	–	– 0.004	–	3 783
N.A.	– 0.060	–	– 0.080	–	10
Birth-control knowledge					
Low	+ 0.154	+ 0.132	+ 0.136	+ 0.131	1 330
Medium	– 0.029	– 0.021	– 0.019	– 0.021	2 533
High	– 0.080	– 0.074	– 0.079	– 0.072	1 680

The number of daughters born and their survival, featured in Run B, does not have an equal impact on the additional children desired. The value of Beta is only .33 in contrast to the value of .48 for the number of sons and their survival. For each number of daughters born, women who have lost one or more daughters desire more additional births, holding other variables constant, than women who have not lost a daughter. However, the difference is significant only when one daughter has been born.

Run C tests the effect of the percentage of births who died before age 15 holding constant the number of living sons and the number of living daughters. The differences in each category are small and for the most part not statistically significant. However, if 25 to 49 percent of the births died, the adjusted coefficient for mean number of additional children desired, (– .16) is less than zero at a statistically significant level.

The differences by township are quite considerable and highly significant. In all three runs township is the fourth most important variable in terms of the size of Beta (.09 in all three runs). In all three runs the mean additional number of children desired in Kungliao after adjustment for the impact of the other variables was .14 greater than average and in Hsinchuang .07 less than average.

The adjusted coefficients for each category of perception of child survival were all small and were not significantly different from zero.

Respondents with no preference for sons wanted fewer additional children and those with a moderate or high preference for sons wanted a greater number of additional children. The differences in the adjusted coefficients for three categories of this predictor were small but statistically significant.

The Net Effect of Mortality Change Upon Natural Increase

If the level of infant and child mortality had no direct effect upon fertility, it is obvious that a decline in mortality would serve to accelerate the rate of natural increase. Conversely, it is possible that the net effect of mortality change upon natural increase might be to reduce the rate of natural increase. For this to be true, the fall in natality induced by mortality decline would have to be of greater magnitude than the decline in mortality itself.

We have hypothesized that a reduction in infant and child mortality would have two effects, a community effect and an individual effect. Let us consider first the degree to which our results confirm the effect of the community level of infant and child mortality upon subsequent fertility independent of the effect of individual child loss. We had hypothesized that differences in the community level of infant and child mortality caused individual differences in perceptions of child survival and that these individual differences in perception caused differences in subsequent fertility. According to our hypothesis there should be no direct relation between the community level of infant mortality and subsequent fertility but only an indirect relationship mediated through variation in perceptions of child survival at the individual level. Nevertheless, our results indicate that township is a more important variable than perception of child survival in explaining subsequent fertility after either the second or the third birth. A major reason why the direct relation between township and subsequent fertility still exists after control for individual perceptions of child survival is the failure to achieve reliable measurement of the latter variable.

However, it would be incorrect to assert that the true effect of the community level of infant and child mortality upon subsequent fertility in Taiwan is the sum of the township and the perception-of-child-survival effects. This is because the two townships differ on almost every other aspect of modernization in addition to differing in mortality level. For example, in 1969 the proportion of females 12 years old and over who were illiterate was 26.0 percent in Kungliao and only 10.5 percent in Hsinchuang. It is very plausible to assume that this difference in literacy between the two townships also had an effect upon subsequent fertility.

We cannot yet answer the very important question as to the effect of reduction of infant and child mortality upon natural increase in Taiwan. If the community level of infant and child mortality had no effect upon subsequent fertility, it is probable that a reduction in infant and child mortality would lead to an acceleration of natural increase because on the individual level couples apparently do not fully compensate for child loss. (Our tabulations indicate that up to the time of the interview compensation was far from complete ; it is likely however, that if we were to follow all couples up to the end of their reproductive period we would find that compensation was more nearly complete). Conversely, it is possible that a reduction in infant and child mortality could lead to a reduction in the rate of natural increase. The conditions under which this is likely are (1) that the observed adjusted township effect on fertility measured nothing more than the effect of the community level of infant and child mortality and (2) that age at marriage and the perception of child survival were both substantially influenced by the community level of infant and child mortality.

Part 4 : Results of the Analysis of the Data from Urban Morocco

The results reported here constitute a secondary analysis of the data of a sample survey carried out in October 1966 by the government of Morocco. An area-probability sample was obtained in nine different cities (Casablanca, Marrakech, Rabat, Sale, Fes, Meknes, Tetouan, Tangiers, and Oujda). Many of the results of this survey are reported in an article which appeared in *Studies in Family Planning* (Division of Statistics, Secretariat of State for Planning, Government of Morocco, 1970). Additional analysis of these data was conducted by Robert Repetto (1972) who investigated whether the sex composition of children had any effect upon fertility. He concluded that women having more sons tended to have a larger total number of live births. This finding was contrary to the expectation that strong preference for sons should lead to fewer live births among women having a high proportion of male babies.

Attention will now be turned to two runs of a Multiple Classification Analysis made from a subsample of the Moroccan respondents consisting of currently-married women under age 50 who had borne three or more live births. In each run the dependent variable was the number of live births subsequent to the third which took place up to the time of the interview. The principal independent variable of the first run was the number of the first three live births which survived either to age 10 or to the interview. The principal independent variable of the second run was the number and sex of the first three live births which survived either to age 10 or to the interview. Of the remaining independent variables used in each of these runs the most important was a measure of marital duration within the reproductive period. This was operationalized for women under 45 as the number of years actually married and for women 45 to 49 as the number of years married minus the difference between the woman's age at interview and age 45. (This measure is thus not always identical to a measure which would have been preferable – the number of years married before age 45. However, for all women under 45 the measure is identical and for most women 45 to 49 years of age the measure will also be identical. The only women for whom the two measures will not be identical are women 45 to 49 who were not married at some point after their 45th birthday but remarried prior to the interview. For these women the measure actually used is an underestimate of the number of years married before age 45). Additional variables included in the two MCA runs are the respondent's own age, literacy, birthplace, work status, age at first marriage, number of times married, birth-control knowledge, and perception of change in child mortality since her childhood, and the literacy, occupation, income and birthplace of the respondent's husband.

Before proceeding further, it will prove profitable to examine in what respect the independent variables in the Morocco runs are equivalent to those in the Taiwan runs with the same dependent variable. First of all, in the Morocco runs we do not have a variable equivalent to the township variable of the Taiwan tabulations. It would have been possible to employ city of residence as such a variable but only if data on infant and child mortality levels in these cities were available. Since such data were not available this option was not utilized. Secondly, we do not have a variable for the Morocco tabulations exactly equivalent to the perceived level of child survival. As a substitute we have the respondent's perception of change in the level of child mortality since her own childhood. Thirdly, we do not have a measure of the length of lactation for births beginning with the third. Fourth and most important, for Morocco we have measured the total number of years of marriage before age 45 rather than, as for Taiwan, the total years between the third birth and the interview. This means that for Morocco we do not control for the fact that the length of postpartum amenorrhea is shorter following neonatal death for one of the first three live births than following neonatal survival for one of these births. Hence for Morocco the total interval between third birth and interview (or age 45) is no doubt longer for women with a child death among the first three live births than for those without a child death among these births. This means that for the Taiwan tabulations we examine the effect of child loss only upon voluntary decision to delay or curb fertility whereas for the Moroccan tabulations we include the effect of child loss not only upon voluntary decisions but also upon the psychological capacity to produce another birth within a given time span.

The decision not to use the interval between the third birth and the interview for the Morocco analysis, as was done with the Taiwan data, was made because of the high proportion of women in Morocco who had been married more than once. Obviously for women married more than once the total interval between third birth and the interview might overestimate the length of time they were exposed to childbirth. Thus of all the female respondents in Taiwan only 4.0 percent had been married more than once in contrast to 23.0 percent for the female Moroccan respondents under age 50. Further consideration of the matter leads to the conclusion that the optimal (if not ideal) means of assuring comparability between the Taiwan and Morocco surveys would be additional tabulations restricted to women married only once in one set of which the interval between third birth and the interview would be entered into the equations both for Moroccan and Taiwanese respondents and in a second set of which the interval between marriage and the interview would be entered. However, to date such tabulations have not been completed.

TABLE 3 – NUMBER OF SUBSEQUENT BIRTHS AMONG CURRENTLY-MARRIED WOMEN OF THIRD PARITY OR HIGHER, URBAN MOROCCAN SURVEY

Mean is 2.704	Value of multiple R^2 for run
Number of cases is 1.849 Standard deviation is 2.189	A .339 B .342

Rank of each predictor in terms of size of Beta:	Run	
	A	B
Marital duration before age 45	.503	.502
Number and sex of survivors to age 10 or to interview of the first three live births	–	.176
Number of times respondent married	.172	.174
Number of survivors to age 10 or to interview of the first three live births	.162	–
Respondent's age	.090	.092
Husband's birthplace	.073	.075
Respondent's work status	.067	.067
Respondent's age at marriage	.062	.066
Respondent's birthplace	.061	.061
Husband's income	.044	.045
Husband's occupation	.039	.036
Respondent's birth-control knowledge	.025	.026
Perceived change in child mortality since respondent's childhood	.017	.018
Respondent's literacy	.011	.011
Husband's literacy	.004	.003

Description of the categories of each predictor in terms of its deviations from the grand mean and its adjusted coefficient	Deviation from grand mean	Adjusted coefficient in run		Number of cases
		A	B	
Respondent's age				
Less than 25	– 1.635	– 0.233	– 0.246	246
25 to 29	– 0.754	– 0.181	– 0.181	480
30 to 34	0.278	0.070	0.063	491
35 to 39	0.797	0.226	0.231	325
40 to 44	1.227	0.315	0.332	190
45 to 49	1.184	– 0.191	– 0.180	116
N.A.	– 1.704	– 1.068	– 1.059	1
Respondent's age at first marriage				
Less than 13	0.139	– 0.156	– 0.151	300
13 to 15	0.242	0.105	0.112	725
16 and 17	– 0.209	0.004	0.003	418
18 and over	– 0.360	– 0.127	– 0.147	381
N.A.	0.296	0.694	0.753	25
Number and sex of survivors to age 10 or to interview of the first three live births				
3 sons	– 0.351	–	– 0.165	164
3 daughters	– 0.070	–	– 0.110	153
2 sons, 1 daughter	– 0.243	–	– 0.125	427
1 son, 2 daughters	– 0.430	–	– 0.448	398
2 sons, 0 daughters	0.574	–	0.654	126
2 daughters, 0 sons	0.239	–	0.348	106
1 son, 1 daughter	0.332	–	0.215	247
1 son, 0 daughters	0.737	–	0.529	77
1 daughter, 0 sons	0.727	–	0.426	58
No surviving children	1.696	–	1.522	30
N.A.	0.216	–	– 0.125	63
Number of survivors to age 10 or to interview of the first three live births				
3 survivors	– 0.300	– 0.242	–	1 142
2 survivors	0.375	0.361	–	479
1 survivor	0.733	0.488	–	135
No survivors	1.696	1.519	–	30
N.A.	0.216	– 0.122	–	63

TABLE 3 – CONTINUED

	Deviation from grand mean	Adjusted coefficient in run		Number of cases
		A	B	
Respondent's literacy				
Literate	– 0.910	0.079	0.081	107
Illiterate	0.060	– 0.006	– 0.006	1 734
N.A.	– 0.829	0.216	0.226	8
Husband's literacy				
Literate	– 0.124	0.004	0.006	614
Illiterate	0.070	– 0.003	– 0.004	1 207
N.A.	– 0.276	0.063	0.041	28
Husband's occupation				
Professional or managerial	– 0.020	0.043	0.030	95
Self-employed proprietor and other white collar	0.061	– 0.094	– 0.073	370
Non-agricultural manual	– 0.022	0.051	0.046	1 147
Agricultural	0.257	0.069	0.053	78
N.A.	– 0.094	– 0.210	– 0.205	159
Husband's income				
Less than 99 Dirhams	0.067	– 0.085	– 0.093	410
100 to 199 Dirhams	– 0.094	– 0.079	– 0.072	603
200 or more Birhams	– 0.002	0.159	0.157	413
N.A.	0.071	0.039	0.040	423
Respondent's birthplace				
Same city	0.045	0.165	0.162	601
Other big city	– 0.179	– 0.142	– 0.131	141
Small city	– 0.112	– 0.152	– 0.167	179
Village	0.013	– 0.070	– 0.067	904
Outside Morocco	0.341	0.427	0.475	22
N.A.	– 0.204	0.645	0.697	2
Husband's birthplace				
Same city	– 0.046	– 0.145	– 0.151	518
Other big city	– 0.540	– 0.306	– 0.330	128
Small city	– 0.204	– 0.024	– 0.015	170
Village	0.134	0.120	0.126	997
Outside Morocco	0.185	0.245	0.145	18
N.A.	0.902	– 0.328	– 0.292	18
Respondent's work status				
Usually works	– 0.507	– 0.510	– 0.515	122
Works from time to time	0.030	– 0.091	– 0.087	128
Doesn't work	0.044	0.050	0.051	1 586
N.A.	– 0.935	– 0.471	– 0.468	13

Continued on next page

With all of these *caveats* in mind, let us now consider the results of these two Moroccan runs, which are presented in Table 3.

Let us consider first the adjusted coefficients in Run A for the number of survivors of the first three live births. After adjustment for other variables the number of subsequent births is .24 less than average if there have been no child deaths and .36 more than average if there has been one child death. Thus up to the time of interview there has been a 60 percent compensation if one child died. The 95 percent confidence limits to this percentage are plus or minus 19 percent. Compensation is less complete if two of the first three births have died. Here there is a 37 percent compensation with 95 percent confidence limits of plus or minus 16 percent. If all of the first three live births have died, compensation is 59 percent of the loss with 95 percent confidence limits of plus or minus 12 percent.

TABLE 3 – (CONCLUDED)

	Deviation from grand mean	Adjusted coefficient in run		Number of cases
		A	B	
Marital duration before age 45				
Less than 5 years	– 2.204	– 1.891	– 1.882	20
5 years	– 2.638	– 2.537	– 2.562	30
6 years	– 2.093	– 1.955	– 1.946	36
7 years	– 2.149	– 1.900	– 1.875	45
8 years	– 1.861	– 1.745	– 1.742	83
9 years	– 1.487	– 1.369	– 1.384	83
10 years	– 1.096	– 1.062	– 1.067	138
11 years	– 0.954	– 0.756	– 0.747	104
12 years	– 0.685	– 0.593	– 0.590	105
13 years	– 0.435	– 0.393	– 0.400	115
14 years	0.115	0.120	0.135	94
15 years	0.071	0.078	0.062	120
16 years	0.565	0.543	0.569	115
17 years	0.966	0.900	0.892	85
18 years	0.903	0.755	0.743	79
19 years	0.598	0.609	0.641	53
20 years	0.780	0.627	0.660	128
21 years	1.274	1.310	1.305	45
22 years	1.242	1.138	1.097	37
23 years	1.320	1.184	1.201	41
24 years	1.164	0.781	0.735	38
25 years	1.374	1.058	1.056	51
26 years	1.483	1.472	1.483	32
27 years	1.653	1.522	1.512	28
28 years	0.867	0.989	0.985	21
29 years	2.088	2.131	2.150	24
30 years or more	1.789	1.843	1.791	73
N.A.	0.450	– 0.014	– 0.007	26
Number of times respondent married				
Once	0.091	0.172	0.174	1 496
Twice	– 0.395	– 0.744	– 0.750	327
Three or more times	– 0.652	– 1.187	– 1.211	19
N.A.	0.724	1.190	1.207	7
Perceived change in child mortality since respondent's childhood				
Less now	0.020	0.027	0.026	1 111
More now	0.027	– 0.001	0.017	242
N.A.	– 0.059	– 0.060	– 0.066	496
Respondent's birth-control knowledge				
No methods mentioned	– 0.020	– 0.042	– 0.045	1 119
One or more methods mentioned	0.036	0.068	0.071	720
N.A.	– 0.040	– 0.136	– 0.103	10

These results appear to show a greater influence of child loss upon subsequent fertility in urban Morocco than in rural Taiwan since, with respect to the latter survey, we had estimated that compensation for one child lost was only 28 percent complete. However, as pointed out earlier, the Morocco tabulations are not comparable to those for Taiwan. For Taiwan the results of the effect of child loss are net of the community level of child mortality. Moreover, they are also net of the shorter interval between marriage and third birth prevalent among many of the women experiencing child loss among one or more of their first three live births. The approximate effect of neonatal loss upon the interval between two successive births can be estimated from data on the effect of lactation on the birth interval. For Taiwanese women, Jain *et al.* (1970) have estimated that in the absence of lactation, which of course would occur given a neonatal death, the average duration of postpartum amenorrhea is about seven months less than with lactation. Similar results for the Punjab in India have been reported

by Potter *et al.* (1965). Assuming the length of the birth interval is 30 months, a neonatal death would therefore reduce the average length of the birth interval by 23 percent. Of course not all child deaths are neonatal. For the urban Morocco women, among live births resulting from the first pregnancy who later died before age 10, 20.7 percent died before the end of the first month of life, 32.4 percent by three months of age, and 54.2 percent before the end of their first year of life. Similar proportions exist for the results of the second and third pregnancies. In summary, it is likely that the shorter durations of postpartum amenorrhea associated with early death among the first three live births are an important component of the observed greater subsequent fertility among urban Moroccan women experiencing child death than among those not suffering such loss. Moreover, it is also highly probable that tabulations for Taiwanese and Moroccan respondents were confined to women married only once and employing as an independent variable the interval between the third birth and the interview (or age 45) would show more identical results with respect to the impact of child loss than the tabulations we have presented for the Moroccan and Taiwanese women.

Let us next consider the adjusted coefficients in Run B concerned with the impact of the number and sex of survivors of the first three live births. Subsequent fertility is slightly greater if three daughters survive rather than three sons but the difference is not statistically significant. On the other hand, subsequent fertility is significantly larger (at the .01 level) if two sons and one daughter survive rather than one son and two daughters. Furthermore, subsequent fertility is significantly higher (at the .05 level) if two sons and no daughters survive than if two daughters and no sons survive. Thus, in general, the results presented here confirm those of Repetto that there is a tendency among the urban Morocco respondents for the total number of births to be positively associated with the number of sons. These results are in great contrast to those for Taiwan where subsequent fertility was greater the larger the number of daughters among the early births.

Finally, let us consider for both Runs A and B the results with respect to the question of perceived change in infant mortality since the respondent's own childhood. In both runs subsequent fertility is greater, but not significantly so, for women perceiving fewer child deaths now than a generation ago. This result is in apparent contradiction to the Taiwanese results with respect to perceived level of child survival at the present time.

Another noteworthy feature of these two Moroccan runs is the substantial (and statistically significant at the .01 level) inverse relation between number of times married and subsequent fertility after adjustment for other variables including duration of marriage. This rather surprising result might be due to some lack of reliability in the data concerning marital duration and/or because women of low fecundity were apt to be divorced by their first husbands.

Finally, it is noteworthy that literacy appears to be a very weak predictor of subsequent fertility among Morocco respondents. Morever, contrary to what one might expect, with other variables controlled, the respondent's illiteracy is associated (although not significantly so) with lower rather than higher subsequent fertility.

In conclusion, it is obvious that we need further tabulations both of the Moroccan and of the Taiwanese data before exact comparisons can be made for the two sets of respondents concerning the effect of individual child loss upon subsequent fertility. Nevertheless, even at the present stage of research it can be definitely confirmed that both in Taiwan and in Morocco the occurrence of child death among the first three births serves to increase later fertility.

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THE EFFECTS OF INFANT AND CHILD MORTALITY ON FERTILITY IN LATIN AMERICA

Shea RUTSTEIN, Vilma MEDICA
Centro Latinoamericano de Demografia, Santiago

SUMMARY

Conceptually the paths of influence of infant and child mortality on fertility may be classified according to the source of child mortality experience. Direct personal experience is derived from the deaths of one's own children. Indirect personal experience is obtained through perceptions of the existing level of child mortality in the local area. Societal experience of child mortality is not perceived by the couple but has been incorporated into the socio-cultural structure of the community. A further division of the paths is that between biological effects and effects involving fertility preferences. Fertility preferences encompass goals for completed family size and desires for the timing of births.

Problems for analysis of the paths arise from problems in measurement of the basic data due to an absolute lack of necessary data, and inaccuracy and ambiguity of the data. Other problems are biases in the analysis because of the failure to correct for spurious relationships due to exposure variables and socio-economic variables among others. Results of analyses on direct personal experience undertaken with PECFAL-Rural data for the rural and semi-urban areas of four Latin American countries show that child mortality has had little effect on actual fertility behavior except for a shortening of closed birth intervals with an infant death due to a biological effect. The lack of non-biological effects is attributed to the low level of use of fertility control in the areas studied. Results of further analyses show that a portion of the low level of use may be attributable to infant and child mortality.

RÉSUMÉ

Pour analyser l'influence de la mortalité infantile et de celle des enfants sur la fécondité, il convient de distinguer d'où vient l'expérience que l'on a de la mortalité des enfants. L'expérience personnelle directe est tirée des décès de ses propres enfants. L'expérience personnelle indirecte provient de la conscience qu'on a du niveau actuel de la mortalité des enfants dans la région où l'on vit. L'expérience de la mortalité, dans une société donnée, n'est pas perçue par le couple mais fait partie de la structure socio-culturelle de cette société. On peut, en outre, faire une distinction entre les effets biologiques et les effets qui font intervenir les préférences des couples relativement à la fécondité. Ces préférences comprennent les buts que se fixent les couples quant à la dimension de la famille complète et les désirs qu'ils ont quant au calendrier des naissances.

Les problèmes que pose l'analyse des cheminements tiennent aux difficultés que présentent les mesures faites sur les données de base, soit que ces

données fassent totalement défaut soit qu'elles soient inexactes ou ambiguës. D'autres difficultés tiennent aux erreurs de jugement que l'on peut faire dans l'analyse si on se laisse prendre à de fausses apparences, par exemple du fait des variables relatives au temps d'exposition au risque et des variables socio-économiques. Les résultats des analyses sur l'expérience personnelle directe faites à partir des données de PECFAL sur les régions rurales et semi-urbaines de quatre pays d'Amérique latine montrent que la mortalité des enfants a eu peu d'influence sur le comportement à l'égard de la fécondité. La seule constatation digne d'intérêt est la diminution de la durée des intervalles entre naissances lorsque s'est produit un décès d'enfant du fait d'un effet biologique. L'absence d'effets non biologiques peut être attribuée au fait que la limitation des naissances est peu employée dans les régions étudiées. D'après d'autres analyses, si la limitation des naissances est peu répandue, c'est en partie parce que la mortalité infantile et celle des enfants y sont très fortes.

RESUMEN

Desde un punto de vista conceptual los modos de influencia de la mortalidad infantil y de la niñez sobre la fecundidad, pueden ser clasificados de acuerdo con las fuentes de las experiencias. La experiencia personal directa se deriva de la muerte de los niños propios. La experiencia personal indirecta se obtiene a través de las percepciones del nivel de la mortalidad del niño en el area local. La experiencia social de la mortalidad del niño no es percibida por la pareja, pero ha sido incorporada en la estructura socio-económica de la comunidad. Otra forma de clasificar estos modos de influencia es dividirlos en efectos biológicos y efectos que involucran preferencias sobre la fecundidad. Las preferencias abarcan metas acerca del tamaño de la familia completa y deseos sobre el espaciamiento de los nacimientos.

Las dificultades para el análisis de los modos de influencia provienen de los problemas de medición de los datos básicos, a veces faltan los datos imprescindibles, otras son inexactos y ambiguos. Otros problemas están constituídos por los sesgos en el análisis provocados por la falta de corrección de relaciones espúreas que se producen entre las variables en juego, variables socio-económicas y otras. Se analizaron los datos sobre la experiencia personal directa, obtenidos en la Encuesta Comparativa de Fecundidad en areas rurales y semi-urbanas, realizada por CELADE, en cuatro países de América Latina. Los resultados muestran que la mortalidad de la niñez ha tenido poco efecto en el actual comportamiento sobre la fecundidad, excepto en el acortamiento de los intervalos cerrados entre nacimientos, con una defunción infantil debida a un efecto biológico. La ausencia de efectos no-biológicos es atribuída a la baja proporción de uso de anticonceptivos en las areas estudiadas. Los resultados de análisis ulteriores muestran que una parte del bajo uso de anticonceptivos puede ser atribuída a la mortalidad infantil y del niño.

During the last fifty years the mortality rates, particularly those of infants and children, in Latin American countries have dropped considerably. (See Appendix A). A consequence of this reduction is that through effective health policies many children have survived, thereby increasing the need for schooling, jobs, and the number of potential parents in the next generation.

However, it is possible that reduced infant and child mortality has also led to a decrease in fertility. It is this hypothesized decline in fertility which concerns us in this paper.

The paper will be structured in the following manner: first we will discuss some hypothesized ways in which fertility may be affected by infant and child mortality, then we focus our attention on

measurement problems and analytical biases ; next we review some results of analyses with cross-sectional data, and finally we present some of the results of analyses done with micro-level data for rural and semi-urban areas in Latin America.

Means by which fertility may be affected

The paths through which child mortality (1) may influence fertility originate with three sources of experience : direct personal experience, indirect personal experience, and societal experience (see Figure 1).

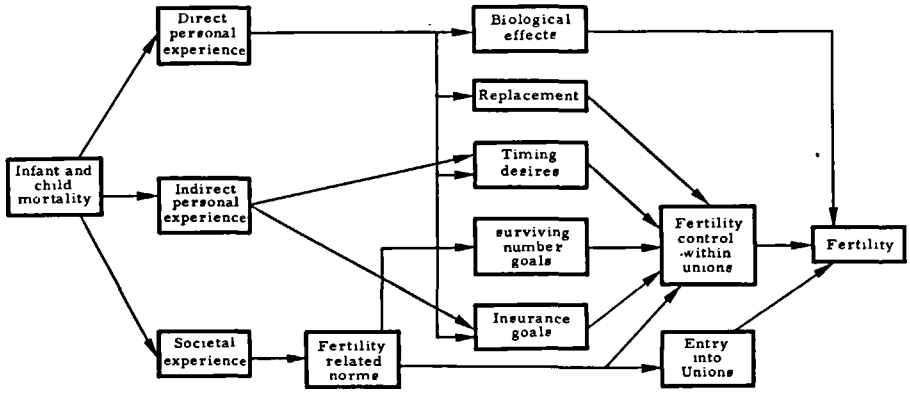

Figure 1. – Conceptual Scheme of the Paths of Influence Between Infant and Child Mortality and Fertility.

Sources of experience

– Direct personal experience – By direct personal experience of child mortality we mean the experience by a couple of the death of one or more of their own children. Obviously this is the most drastic influence of child mortality. However, because the death of a child may be experienced by a minority of couples (but see figures presented later), other types of experience may have a greater overall effect.

– Indirect personal experience – We call indirect personal experience that which reaches the couple by knowledge of child deaths that have occurred among family, friends, neighbors or the community in general or knowledge or feelings about the child mortality level in the community or local area. In other words, the perceptions about child mortality not directly experienced but which however, the couples takes into consideration consciously or subconsciously when making family size goals decisions. Like direct personal experience, indirect experience may induce changes in both surviving children goals and insurance goals and in timing desires. However, unlike direct experience, indirect experience will be taken into account when family size goals' are first formed.

– Societal experience – By societal experience we mean that experience of child mortality in the past which has now been incorporated into the socio-cultural structure. Norms on specific aspects of fertility behavior such as those on age at union (marriage), on sexual relations within marriage, and on use of fertility control may be affected by child mortality as well as norms involving family size goals. The process of translating societal experience into such fertility-related norms is somewhat obscure but probably has occurred over a lengthy period of time. We should expect norms to change with changing community levels of child mortality only after a long time lag, perhaps as long as one or two generations.

In this paper only the paths by which the direct personal experience of child mortality can influence fertility are investigated. These paths are of two types : those that act through biological effects and those that involve fertility preferences.

Biological Effects

Certain paths of influence for child mortality involve biological effects and are independent of fertility preferences. All involve only direct personal experience. Most obvious are the biological consequences of reduced intervals due to shortened periods of lactation resulting from the deaths of breastfed children. In populations where there exists a limiting type of fertility control, this shortening of lactation should only produce a variation in the timing of births, but in populations where limiting is not practised, the total number of births would be affected as well.

An apparent biological effect is that fertility may be reduced with direct experience of child mortality. Such would be the case if a health problem related to the birth of the child led to both the child's death and the mother's inability to have another birth. Presumably the relation would exist only for the last birth. The relation is apparent in that an exogenous factor, the health problem, led to both the mortality and the reduced fertility.

Fertility Preferences

Terms referring to family size goals are problematic when considered together with the possibility of child mortality. Often when family size goals are discussed a distinction is not made between the number of births (childbearing goals) and surviving children (surviving children goals). Moreover, the word surviving is problematic: surviving until when? For our purposes we will define number of surviving children as surviving until fifteen years of age (2). Once we have defined what is meant by a number-surviving goal, we may define the difference between childbearing goals and surviving goals as an "insurance" against the possibility of leaving surviving family size goals unaccomplished because of child death.

Direct personal experience acts through direct replacement, through changing goals for the number of insurance births, and through changing desires for the timing of births. Changes in the goal for number of surviving children would not occur, except as an artefact of the operational definition of survival.

– Replacement – Direct personal experience of child mortality would relate to fertility through replacement if couples have additional births in order to replace a child who has died while maintaining the original childbearing goals (i.e., this is independent of any insurance factor). Replacement could only occur in populations who limit their fertility since otherwise the decision whether to replace or not cannot be carried out.

– Insurance – Couples may desire to have additional births in order to compensate for expected future mortality. It should be noted however, that direct personal experience would only change the insurance goals if it changed future expectations. Direct experience that does not change these mortality (i.e., is in accord with these expectations) would not result in changes in family size goals. We should also realize that child mortality expectations not met for a lack of direct experience may also act to change family size goals. A problem here is that there is no single event to which we may attribute changes in expectations. Change in expectations would appear to be the result of a gradual realization process that may extend over a long period of time of child-bearing and child-raising.

– Timing Desires – A path of influence of child mortality on fertility, may be the effect on the desired timing of births. One form of insurance against the possibility of child death may take the form of a desire to have the number of desired children as soon as possible, in order to be able (for reasons of health, age, etc.) to have additional births in case of one or more children die (3). In a population where the only fertility control methods are essentially spacing rather than limiting methods (e.g., prolonged breastfeeding) the influence of child mortality through timing would reflect itself on completed family size by influencing the tempo of childbearing until menopause. Even in populations who completely control their completed family sizes, growth rates of the population would be affected through changes in the intergenerational interval.

However, for populations who only use spacing type methods of fertility control, direct personal experience could result in a decision to shorten the birth interval, in order to have a replacement birth as soon as possible. The impact of this shortening on total number of children born would depend, of course, on the age at which the child died.

Underlying Assumptions

It is logical to assume that any of the paths of influence, excluding the biological effects, can have an effect on actual fertility only if there is a control over fertility. To the extent that such control does not exist for reasons not related to child mortality, such as lack of knowledge, child mortality will not affect actual fertility behavior. However, it is well known that in practically all populations there exists the possibility for strongly motivated couples of some form of intentional fertility control. That such control is not exercised may be partially dependent on the direct and indirect personal experience and the societal experience of child mortality. Since in most of Latin America, use of fertility control methods is extremely low, we do not expect to find a substantial effect of direct personal experience on fertility.

One problem with the definition we have given above is that family size goals may not exist, or even if they do exist may not be directly related to behavioral fertility decisions or may change markedly over time for other motives. It is logical to presume that couples do not establish family size

goals per se. Since children are usually born one by one, parents need only to decide whether they do or do not want to have another child. Those that want another child need not have decided as yet on any further number of children. Even if there exists a recognized family size goal, this goal may be ambiguous. That is, the couple prefers a certain range of numbers of children, but if they have not yet reached the lower limit of the range they will decide to have another child without an explicit family size goal. The classification of influence through direct personal experience would have to be modified and limited in the case that specific family size goals do not exist. The concept of insurance births may or may not be applicable in this case.

Measurement Problems and Analytical Biases

In this section we discuss some of the problems involved in the analysis of the various paths of influence of child mortality on fertility. These problems may be classified into two basic groups : those involved in measurement of the phenomenon and those involved in the analysis.

Measurement Problems

Data that has been used in the analysis of the effects of child mortality on fertility have come from three sources : vital statistics, censuses and retrospective surveys (especially, pregnancy histories). A basic problem, in varying degrees for all three sources, is that of measuring fertility and, particularly child mortality. In analyzing the relationship between the two, errors in their measurements may be of crucial importance. As is well known, most vital statistics are deficient in the registration both of births and of deaths of children who die before the registration of their births. As the registration date of births in many less developed countries may be considerably after the date of birth, the undercount of births and child mortality is of substantial proportions. Moreover, most if not all of the data derived from censuses and retrospective surveys are deficient because of faulty declaration about children who have died ; presumably the magnitude of the deficiency increases as the respondents recall further into the past. In addition, censuses and other retrospective data sources may include random errors (in the sense of counterbalancing uncertainty) and biases (in the sense of an unbalanced shift forward or backwards) in the time location of birth and death events.

The second type of data problem in the analysis of child mortality effects is the lack of pertinent data for the correct evaluation of the paths of influence. For many countries, data necessary to evaluate indirect personal experience (family size goals, perceptions about mortality, etc.) and societal experience (norms, perception on family size goals and child mortality, etc.) are completely or almost completely lacking.

In many cases for the analysis of direct personal experience, data on variables such as educational levels, development, exposure, etc., necessary for the control of spurious relationships are also lacking. Where such data is present, its value is reduced because of ambiguities, particularly these which result from the lack of a time reference for many data. Important and typical examples of this lack of time reference are questions on lactation and on perception of child mortality, which usually contain words such as "in the past", "nowadays", "usually" (e.g., "do children today die less, the same, or more than before" ?).

Analytical Biases

Analytical biases in the study of the influence of child mortality on fertility result, primarily, from two sources : the failure to consider the two-way nature of the child mortality–fertility relationships and the failure to control for the effects of other variables that may be related simultaneously to both child mortality and fertility.

The first type of bias, the two-way relationship between child mortality and fertility, becomes especially serious when actual levels of both child mortality and fertility are used directly in the analysis, i.e., as in an analysis of the effect of direct personal experience on actual fertility behavior (4). A portion of the two-way relationship is real ; the rest is apparent and due to the nature of the data and how it is used. On the one hand, that fertility may affect child mortality is well known, examples being the U-shaped curves of infant mortality with mother's age and parity ; pregnancy-caused early weaning ; and child mortality due to increased burdens of fertility on the resources of the family and the community. On the other hand, fertility may appear to affect child mortality if the increase exposure to the risk of child mortality due to fertility is not eliminated or adequately taken into account. An example of an analysis with such a bias would be the calculation of the mean number of births for women according to the number of child deaths they have had. At the macrolevel such a bias would result if average number of child deaths and average parity were used as the variables under

analysis. A solution to the problem is to use the time sequence of the events and therefore count only those child deaths up to a certain point in time while considering only subsequent fertility behavior.

A second principal source of bias is the failure to control for the effects of those variables which are related at the same time to both child mortality and fertility. A special but very important case for the relationship between actual levels of mortality and fertility is that of the time exposure to the risk of subsequent fertility. In certain types of analysis, couples with higher numbers of child deaths are more exposed to the risk of a subsequent pregnancy. Examples are situations where the mortality rates have fallen over time, where couples of differing exposure to the risk of child mortality are grouped together (thus linking both exposure to mortality and exposure to fertility) or where not enough time is allowed for subsequent births to occur. When not specifically taken into account, other variables, especially socio-economic, may distort the relationship between child mortality and fertility. Because child mortality is so stronlgy related to the standard of living, development, education, etc., analyses of any of the paths of influence will be biased unless such variables are taken into account.

In addition to these two most important sources of bias, we should briefly mention some others. The most important of these other biases is really a conceptual bias : that of analyzing the effect of child mortality on fertility using the survival of only the immediate previous birth (5) instead of all previous births. In this case deaths to earlier-born children are disregarded even if they came after the immediate previous birth and therefore do not add to the couple's direct experience of child mortality. Thus, it is assumed that an overall divergence between actual and desired number of surviving children cannot affect fertility. Other biases may arise from a failure to consider sex preferences, existing family sex composition and the sex of children who have died. Likewise the failure to consider the age at death of the child or other then existing conditions such as family size, income, attitude and contraceptive knowledge may bias conclusions about the effect of child mortality.

Analysis in Latin America

There appear to be very few studies undertaken in Latin America that evaluate the effects of child mortality on fertility. Of the three studies known to the authors, all have analyzed aggregate (macrolevel) data, for local areas. Two of the studies were on Puerto Rico. The third analyzed Chilean data.

Macrolevel Analyses

The two studies of Puerto Rico were cross-sectional studies done by Schultz (1969), and Nerlove and Schultz (1970) as part of an investigation of the family planning process. In both studies two aspects of the child mortality-fertility relationship are conceptually discussed – one, a "replacement" motivation derived from direct personal experience (not related to changes in fertility preferences) and an "uncertainty" motivation (related to the insurance goal). However, the empirical effects of each are not estimated separately. The two studies use essentially the same data from the censuses of 1950 and 1960 and from vital statistics, pooling cross-sectional and time-series data, for geopolitical units.

In the first study, using ordinary least-squares regression, Schultz estimates the relationship between the crude birth rate and a lagged crude death rate. Variables for adult educational level, school attendance, women's labor force participation, income level, marital status, proportion of unpaid family workers, and proportions urban and working in agriculture are also included. He finds that death rates lagged one and two years have substantial effects on the birth rates. He further concludes that in Puerto Rico the death rates have a total long run elasticity effect of about 0.4 on the birth rate (i.e., a 1 percent decline in the death rate will lead to a 0.4 percent decline in the birth rate).

The second study on the Puerto Rican data by Nerlove and Schultz, included a somewhat revised model. In this work the authors dropped the variables, proportions urban and working in agriculture and added an index of female age composition. They also have taken account of the crude death rate on fertility two to five years later. The estimation procedure is changed by the inclusion of technique of two-stage least squares regression. The parameters of the equation are estimated over three more years than in the first study. They find that the crude birth rate had larger coefficients with fertility two or three years later than with fertility four or five years later. They conclude that "depending on the method of estimation, the four year effect of a once-and-for-all unit change in the crude death rate is a 0.4 to 0.7 change in the crude birth rate" (Nerlove and Schultz, p. 49). The higher response is the one estimated using ordinary least squares regression so that the results from this study do not parallel the results from Schultz's earlier study. Moreover, the authors have not considered a one year lag for crude death rates, which had the strongest effect in the first study.

The crude birth and death rates used in both studies are problematic. A major factor in the crude rates is the age structure, which in turn is mostly determined by the prior fertility rates. If prior fertility rates in an area are highly correlated with current rates (likely to occur), then spurious correlation between the crude rates

can result. The method used in the second study to control for this age structure effect was to introduce an index of the age structure as an independent variable in a multiple regression. This procedure is not wholly satisfactory, and the authors report obtaining unexpected coefficients for this variable. A better procedure would have been to indirectly standardize the crude birth rate, in the absence of more detailed age specific fertility rates.

A study involving cross-sectional data for Chile was undertaken by Da Vanzo (1971). The child mortality-fertility relationship was not, however, the main focus of the investigation. Data on the rural and urban areas of twenty-five central provinces were taken from the 1960 census and publications on the vital rates for 1958 and 1960. Since the vital rates did not correspond to the rural-urban divisions in the census, the infant mortality rates for the rural and urban areas of the provinces were estimated using a weighting procedure. Fertility is measured by age-specific mean numbers of births and 0-4 and 5-9 child-women ratios. As in the Puerto Rican studies, both ordinary and two-stage least squares regression were used to estimate the parameters over the geo-political units. Da Vanzo reports obtaining significant positive relationships between fertility and infant mortality (lagged two years) for all age groups except 15-19 and 20-24. In addition she concludes that since the 5-9 child-woman ratio is more of a surviving measure of fertility, "the fact that the coefficient of the infant mortality variable is usually significant even for the 5-9 child-woman ratio may indicate that parents are overcompensating for child deaths". However, no specific evidence for over-compensation (insurance births) is given.

An Analysis of International Differences

In order to study the effects of child mortality on fertility in Latin America on the aggregate level, we have chosen to undertake the analyses on two levels : that concerned with inter-country differences (i.e., national aggregates) and that concerned with within-country differences (i.e., local area aggregates).

In studying the effect of child mortality on fertility using national aggregates for Latin American countries, as is true for most developing regions, we encounter the problems of insufficient and/or unreliable data. Most of the data on fertility consists of crude rates, and a large proportion of these are derived from estimates based partly on previous estimates of the level of mortality, including infant and child mortality. The deficiency of reliable data is especially serious if one wishes to analyze changes over time (or even differences among countries in one time period) since the available estimates vary greatly as to their time reference, and most countries do not have a sufficiently long enough series of data points.

Constructed with data taken from appendix Table A-1, Figure 2 shows a scattergram of the crude birth rates of fourteen Latin American countries between 1925 and 1964 plotted according to the infant mortality rate of five years earlier. Because of the kinds of problems just noted, we decided to pool the data from various countries over different time periods. It there is a general relationship, however, it should be apparent with the pooled data. As is apparent, there is no overall trend in the crude birth rate, and except for Argentina and Cuba, almost all the CBR fall between 40 and 50 per thousand, very high levels. The bulk of the infant mortality rates fall between 55 and 155 per thousand, a range that would seem to be sufficient to be able to note a relationship if one existed (the slope should be positive). However, we can only note a slightly positive relationship in the data for Argentina, whose CBR vary between 22 and 32/1 000. The results of the scattergram are similar if the infant mortality rate is not lagged.

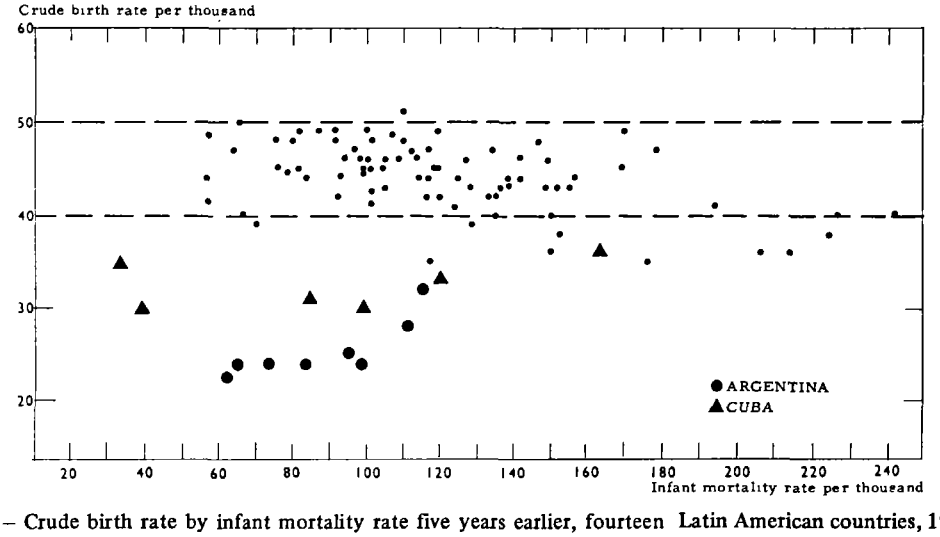

Figure 2. – Crude birth rate by infant mortality rate five years earlier, fourteen Latin American countries, 1925-1964.

For ten of the countries with data in Table A-1 simple regressions were run for each country between the infant mortality rate and the crude birth rate, which was standardized for age (6).

The data cover the period between 1920 and 1964 and are estimates of levels during the quinquennial period. Of the ten regressions only two, Argentina and Chile, showed more than inconsequent positive effects (positive coefficients) of infant mortality on fertility ; however, most of the negative coefficients were close to zero (See Table 1).

TABLE 1 – RESULTS OF REGRESSION ANALYSES OF THE CRUDE BIRTH RATE BY THE INFANT MORTALITY RATES FOR TEN COUNTRIES IN LATIN AMERICA, 1920-1964

Country	Coefficient of IMR	Constant	% Variance Explained
Argentina	+ .171	11.87	78
Chile	+ .115	29.90	16
Colombia	– .180	65.82	41
Costa Rica	– .009	46.38	4
Ecuador	+ .028	43.68	29
El Salvador	– .046	51.02	31
Guatemala	– .064	53.90	8
Honduras	– .114	55.17	62
Mexico	– .025	45.98	38
Venezuela	– .072	50.99	70

Analysis of Within-Country Differences

To be able to use more reliable data and to avoid the multiple problems involved with international comparisons, we have selected to study within-country differences with data based on the 1970 round of Censuses. Due to the availability of data at the time of undertaking this analysis, only three countries are studied, Argentina, Nicaragua and Paraguay.

The Data and Methodology

The data for the within-country analysis are taken from specialized questions on fertility and child mortality contained in the 1970 round of censuses. These questions, known as the "Brass" questions, asked about the number of children ever born, the number of surviving children, and the number of children born within the twelve-month period previous to the date of the census. With techniques developed by William Brass and refined for mortality by Jeremiah Sullivan (1972), data from Brass questions classified by age can be used to estimate the total fertility rate and the infant mortality rate. Estimates of ${}_1q_0$ based on ${}_2q_0$ and ${}_3q_0$ obtained by the Brass method as refined by Sullivan were averaged to estimate the infant mortality rate (IMR). The estimation ${}_1q_0$ from ${}_2q_0$ and ${}_3q_0$ was done using the West family of Model Life Tables (Coale and Demeny, 1966).

Although both Nicaragua and Paraguay had included the "Brass" fertility questions on births during the previous twelve months, the data available to us for Nicaragua produced unacceptable results when used with the Brass fertility technique (ratio P/F over 1.5). For this reason, estimates of the mean number of children ever born, for women of ages 20-24 (P2) and 25-29 (P3) were used as estimates of the fertility levels in Nicaragua. The same measures, P2 and P3, were also used for Argentina, where the question on births during the previous twelve months was not included in the Census.

The fertility and infant mortality estimates were made separately for the urban area, for the rural area, and for both areas together (the total area) of fifteen provinces of Nicaragua, for the rural area and the total area of 16 provinces of Paraguay, and for the 39 total areas (the provinces and the districts within the Province of Buenos Aires) in Argentina (7). The Argentinian provinces and districts were not subdivided into rural and urban areas.

To estimate the relationship between infant mortality and fertility, regression analysis was used with an age-standardized educational index added as a second independent variable. For Nicaragua and Paraguay this index was the percentage of women between 15 and 49 with five or more years of schooling. In Argentina the percentage with five or more years did not distinguish sufficiently among the local areas so that we decided to use eight or more years of schooling as the criterion. The educational index is intended to be a proxy for the general level of development of the area in order to avoid most of the spurious correlation that could result if the relationships between level of development and fertility and mortality were not taken into account.

The results from these regressions are shown in Table 2. Only for Argentina do we note positive and statistically significant coefficients for the infant mortality rate. The coefficients for this country are greater

with P3 as the dependent variable than with P2. From rows one and two, we can calculate that a decline of twenty per thousand in the IMR would cause declines of only 0.049 and 0.120 in the mean number of births of women 20-24 and 25-29, respectively. However, since the mean number of children ever born for women of these ages over the whole country are 0.801 and 1.656, the percentage reductions at these means are 6.1 % and 7.2 %, respectively. A reduction of 60 per thousand would then imply reductions of around 20 % in the number of children ever born. The inclusion of IMR in the regression equation adds about 10 % to the percentage of variance in fertility explained by the education variable alone.

In Nicaragua positive but not statistically significant coefficients of the IMR appear when P3 is the dependent variable, although for the urban areas the coefficient becomes negative upon inclusion of the

TABLE 2 – WITHIN COUNTRY REGRESSION ANALYSIS OF FERTILITY BY INFANT MORTALITY AND EDUCATION, FOR ARGENTINA, NICARAGUA AND PARAGUAY, 1970

Area	Dep Var.(a)	IMR(b)		EDUC(c)		Constant		R^2	F	ΔR^2	Simple Correlation Coefficient IMR-EDUC
		Coeff. x 1 000	T	Coeff. x 1 000	T	Value	N° of Areas				
Argentina											–.209
Total	P2	+ 2.43	1.60	– 31.73	– 6.53	1.48	39	.584	25.93	–	
	P2	+ 4.51	2.15	–	–	.74	39	.103	4.39	+ .481	
	P2	–	–	– 33.35	– 6.88	1.65	39	.555	47.37	+ .029	
	P3	+ 6.01	2.59	– 32.63	– 4.40	2.19	39	.466	16.13	–	
	P3	+ 8.15	2.95	–	–	1.42	39	.186	8.70	+ .280	
	P3	–	–	– 36.65	– 4.71	2.60	39	.369	22.20	+ .097	
Nicaragua											
Total	P2	– 3.53	– 1.23	– 20.84	– 4.69	2.87	15	.648	11.04	–	– .326
	P2	+ 0.85	0.20	–	–	1.92	15	.003	0.04	+ .645	
	P2	–	–	– 19.06	– 4.45	2.39	15	.603	19.77	+ .045	
	P3	+ 1.76	0.47	– 27.85	– 4.75	4.16	15	.694	13.58	–	
	P3	+ 7.62	1.31	–	–	2.90	15	.116	1.71	+ .578	
	P3	–	–	– 28.74	– 5.35	4.40	15	.688	28.67	+ .006	
Urban	P2	– 11.14	– 3.04	– 28.82	– 3.27	4.20	15	.538	7.00	–	– .426
	P2	– 6.04	– 1.38	–	–	2.50	15	.127	1.90	+ .411	
	P2	–	–	– 17.41	– 1.71	2.35	15	.183	2.92	+ .355	
	P3	– 6.50	– 1.54	– 37.50	– 3.70	5.57	15	.533	6.86	–	
	P3	+ 0.14	0.03	–	–	3.37	15	.000	0.00	+ .533	
	P3	–	–	– 30.84	– 3.20	4.49	15	.441	10.25	+ .092	
Rural	P2	– 0.20	0.06	0.00	0.00	2.33	15	.000	0.00	–	– .242
	P2	– 1.96	– 0.07	–	–	2.33	15	.000	0.01	0.00	
	P3	+ 3.57	0.76	– 14.73	– 0.62	3.84	15	.096	0.64	–	
	P3	+ 4.28	0.96	–	–	3.65	15	.067	0.93	+ .029	
Paraguay											
Total	TFR	+ 2.81	0.24	– 98.52	– 5.67	10.33	16	.718	16.52	–	+ .204
	TFR	– 10.56	– 0.52	–	–	8.05	16	.019	0.27	+ .699	
	TFR	–	–	– 97.66	– 5.95	10.51	16	.716	35.36	+ .002	
Rural	TFR	– 6.02	– 0.44	– 39.09	– 1.42	9.90	16	.270	2.22	–	+ .573
	TFR	– 17.21	– 1.48	–	–	9.88	16	.145	2.20	+ .125	
	TFR	–	–	– 45.99	– 2.13	9.59	16	.258	5.53	+ .012	

(a) Dependent variable :
P2 = mean number children ever born for women 20-24
P3 = mean number of children ever born for women 25-29
TFR = total fertility rate

(b) Infant Mortality Rate

(c) Education :
Argentina – % of women with 8+ years of schooling, age standardized
Nicaragua, Paraguya – % of women with 5+ years of schooling, age-standardized.

education variable. The additions to the variance explained are less than 3 % except for when the coefficient becomes negative.

In Paraguay, the total fertility rate is used as the dependent variable. The only positive coefficient for the IMR is for all areas considered together in the equation including education, but it is not significant and IMR adds less than 1 % to the variance explained.

Discussion

From the macrolevel analyses above, it appears that infant and child mortality have had little effect on fertility in most of the countries of Latin America. We have noted a positive relationship (i.e., decline in mortality implies a decline in fertility) only for Argentina and Chile, although one may exist for Uruguay, for which we have very little data. But we can find many other countries with similar infant and child mortality declines whose fertility has not declined. The reasons are unclear why in certain countries infant mortality appears to affect fertility while in the majority no such effect exists. A small part of the answer may lie in the unreliability of some of the data and the many problems involved in a macrolevel analysis of what is really individual behavior. The significant negative relationships found may be due to these problems and also due to relationships between fertility and mortality on the one hand and health conditions on the other. However, we do not feel that the basic findings would change much even if these problems were overcome. More study of the phenomenon should be done on both the aggregate and the individual level.

Microlevel Analyses

A consequence of the relative lack of studies in the field, we shall have to limit our review to a presentation of the results of studies recently undertaken by the authors at CELADE. We will discuss the research that has been undertaken on the microlevel in rural and semi-urban areas of four Latin American countries and compare the results with a similar study for all of Taiwan.

Microlevel analysis pertaining to the influence of child mortality on fertility was done using data collected in KAP-type fertility surveys in the rural and semi-urban areas (areas of less than 20 000 population) in Colombia, Costa Rica, Mexico and Peru under a program of CELADE called PECFAL-Rural. The four surveys, utilizing standardized questionnaires and coding instructions, each interviewed approximately 3 000 women of all marital status between the ages 15 and 49, inclusive. Information was obtained on various attitudes related to fertility, background variables, knowledge and use of contraceptive methods, marital history and especially valuable for us, a pregnancy history, which includes information on dates of child deaths. This pregnancy history forms the basis of the data for our analysis, along with some background and other data from the survey. In all we have between 1 400 and 2 100 women with at least one birth in each country on which to base our study.

Levels of Child Mortality and Fertility

Present levels of fertility and child mortality in the rural and semi-urban areas are relatively high. Table 3 presents age-specific fertility rates for the twelve-month period preceding the interview or approximately midyear 1968 to midyear 1969. The total fertility rates range from a low of 6 955 children per woman for Costa Rica, to a high of 7 860 for Peru. Mexico and Colombia are about midway between the extremes.

Table 3 also presents infant mortality rates, calculated by methods of Brass and Brass-Sullivan, for the four countries. These rates are lowest in Colombia and Costa Rica and highest in Peru as with the fertility rates. Using ${}_1q_0$ as a guide value, we see that about 15 out of 100 children did not reach their first birthday in Peru, while in Colombia and Costa Rica the proportion is about 8 out of 100, with Mexico somewhat higher.

However, the rates of infant mortality do not exactly describe the incidence of the experience of child mortality on the parents. Table 4 presents figures on the proportion of parents who have had personal experience with a child death. Of all women who have had at least one birth, at least forty percent have had a child die. In Peru, fifty-five percent, or over half of the mothers have had a child die. For comparisons, we have included figures for all Taiwan, taken from a similar study done by Rutstein (1971). The proportion of couples there who had a child die was less than one-fifth. This remarkable difference between these Latin American areas and Taiwan is made even more notable if we examine the mean number of child deaths per mother. The means for the Latin American areas are between 0.76 to 1.19 deaths per mother, or between *three to five times* the average for Taiwan.

The experience of child mortality is not evenly distributed. Some women are prone to have more than one child die, especially where mortality is high. In this respect we see from Table 4 that the proportion with experience of one death is more or less constant in the Latin American areas at about 23 percent. However, the proportion with two or more deaths varies from 18 (Costa Rica) to 32 percent (Peru). In Taiwan both these proportions are much lower.

TABLE 3 – INDICATORS OF FERTILITY AND INFANT MORTALITY FOR RURAL SEMI-URBAN AREAS OF FOUR LATIN AMERICAN COUNTRIES

Indicator	Rural semi-urban areas			
	Costa Rica	Colombia	Mexico	Peru
Age specific fertility rates				
Age Group				
15-19	105	132	115	138
20-24	314	336	290	353
25-29	326	331	365	395
30-34	275	340	334	297
35-39	207	223	247	235
40-44	117	102	137	116
45-49	47	16	28	38
Total fertility rate	6 955	7 400	7 580	7 860
Mean Number of births Per Woman	3.8	3.7	3.9	3.7
Per Mother	5.5	5.3	5.6	4.9
Mean of declared "most convenient number of children"	5.1	4.8	6.0	5.2
Infant Mortality Rate[a]				
Method :				
Brass	77.4	76.5	93.9	149.9
Brass-Sullivan	75.7	75.6	93.3	155.6
Sullivan-Marriage Duration	85.8	85.1	94.9	138.4
Mean of Estimates	79.6	79.1	94.0	148.0

Source : Pecfal-Rural Fertility Survey, 1969-1970.
Calculation of Fertility Rates :
Colombia : Rates of 1967-69 from Henry Elkins, "Cambio de Fecundidad en Colombia", ASCOFAME, *La Fecundidad en Colombia,* Table I, p. 31.
Other Areas : Claudio Vila, CELADE, SIEF B–1 (unpublished).

a) For each of the different methods, the estimates presented of the infant mortality rates are the means of separate estimates of ${}_1q_0$ derived from ${}_2q_0$ and ${}_3q_0$ using the West family of model life tables.

TABLE 4 – WOMEN WITH AT LEAST ONE BIRTH ACCORDING TO THEIR DIRECT PERSONAL EXPERIENCE OF CHILD MORTALITY, FOR RURAL-SEMI-URBAN AREAS OF FOUR LATIN AMERICAN COUNTRIES AND ALL TAIWAN

Number of child deaths	Latin America								Taiwan (1)	
	Costa Rica		Colombia		Mexico		Peru			
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
0	834	59.2	1 110	58.7	1 130	54.0	890	45.3	1 779	81.0
1	326	23.2	430	22.8	510	24.5	440	22.3	322	14.7
2	132	9.4	190	9.9	250	12.1	300	15.3	66	3.0
3 and more	116	8.2	170	8.6	210	9.4	330	17.1	28	1.3
Total	1 408	100.0	1 900	100.0	2 100	100.0	1 960	100.0	2 195	100.0
Total child deaths	1 070		1 480		1 720		2 340		545	
Women with child deaths	574		790		970		1 070		416	
Percentage of women with child deaths	40.8		41.6		46.2		54.6		19.0	
Mean number of child deaths : per mother	0.76		0.78		0.82		1.19		0.25	
Per mother with child deaths	1.9		1.9		1.8		2.2		1.3	

(1) Women of 20-44 years, married.

Source : Latin America : Pecfal-Rural, CELADE, 1969-70.
Taiwan : Rutstein, Shea Oscar, op. cit. Table 3.7 – KAP II.

TABLE 5 – PERCENTAGE DISTRIBUTION OF WOMEN BY EXPERIENCE WITH CHILD MORTALITY ACCORDING TO ATTAINED PARITY LEVEL, FOR RURAL-SEMIURBAN AREAS OF FOUR LATIN AMERICAN COUNTRIES AND ALL TAIWAN

Area	Attained Parity level										
	1	2	3	4	5	6	7	8	9	10	11
Costa Rica											
N° of child deaths											
0	92 %	82 %	73 %	64 %	53 %	47 %	40 %	38 %	31 %	23 %	14 %
1	8	17	22	28	33	33	32	31	34	30	21
2 +	–	1	5	8	14	20	28	31	35	47	65
Colombia											
N° of child deaths											
0	91	81	70	61	51	44	37	32	29	25	21
1	9	18	25	28	30	31	33	31	28	29	24
2 +	–	1	5	11	19	25	30	37	43	46	55
Mexico											
N° of child deaths											
0	88	76	65	56	47	41	33	27	21	20	16
1	12	22	28	31	33	33	30	28	29	24	24
2 +	–	2	7	13	20	26	37	45	50	56	60
Peru											
N° of child deaths											
0	84	65	49	38	29	20	16	9	6	4	2
1	16	29	33	32	30	28	23	19	13	10	9
2 +	–	6	18	30	41	52	61	72	81	86	89
Taiwan											
N° of child deaths											
0	96	90	83	76	65	56	47	–	–	–	–
1	4	9	15	20	26	31	53	–	–	–	–
2 +	–	1	2	4	9	14					

Source : Latin America : Pecfal-Rural Fertility Survey, 1969-70.
Taiwan : Calculated from S. Rutstein "*The Influence of Child Mortality on Fertility in Taiwan*", unpublished Ph.D. Thesis, University of Michigan, 1971, Tables 6.1 and 6.2.

Experience of child mortality is strongly related to exposure through numbers of births. Differences in overall proportion with child mortality may be due, in part, to differences with respect to number of children born. To correct for these differences in exposure due to number of children born, Table 5 shows the figures of child mortality according to number of births (parity level). For example, from the Table we see that, of women at the third parity, one half in Peru had had a child die while only slightly more than a quarter in Costa Rica had had the same experience. In the same manner we note that at the sixth parity level over one half of women in Peru had two or more child deaths while only one-fifth of women in Costa Rica had such experience. With respect to experience with child mortality, the women in Peru are clearly in the worst position while those in Costa Rica are in the best. Colombia and Mexico, with percentages between the extremes tend much more towards the situation of Costa Rica. However, all of the Latin American areas compare unfavorably with figures for all Taiwan. Only 14 percent of Taiwanese women between their 6th and 7th birth had had two children die.

Paths Analyzed and Type of Analysis

The microlevel analyses that have been undertaken involve only those paths of influence relating fertility to direct personal experience of child mortality. Indirect personal experience and societal experience were not studied because of a lack of adequate data (8). The paths studied are both those involving family size goals and those not involving such goals.

To study the effects of child mortality on actual fertility behavior we have used as the dependent variable the parity progression ratio (9). We believe that this dependent variable introduces the least amount of analysis bias when properly controlled for the effects of truncation and is especially useful in eliminating the effects of the reverse causal relationship from fertility to child mortality and in analyzing the effects of child mortality with respect to existing family composition. As our independent variable we use the number of

deaths of children 0 to 14 years of age, inclusive, that occurred before the conception that gave rise to the increase in parity. For example, if a woman had had four births, her value on the independent variable would be the number of child deaths she had experienced before the conception of her fifth child. If the woman did not have another birth then logically the value of the variable is the total number of child deaths she has experienced. In this way, we take into account only the situation upon which a decision to have another birth could have been based. Two biasing factors still have to be controlled for. The first of these is the truncation of length of time exposed to the risk of a subsequent birth. In other words, some women may not as yet have had another birth, although they will in the future, because the interval between these births was truncated by the date of interview. We have controlled for this truncation effect by including the time exposure, measured by date of the parity from which the woman is progressing, in a multivariate analysis. This variable also controls for time trends and effects due to age of mother. The second biasing factor to be controlled for is those non-intervening variables which are causally related to both fertility and child mortality. We have controlled for this spurious relationship by including various socio-economic variables in the multivariate analysis.

The multivariate technique used is Multiple Classification Analysis (MCA), (Andrews, et al., 1967). This technique was selected for its ability to handle non-interval variables and non-linear relationships, as some of the control variables are non-interval and we suspect that the relationships with the independent variable and the controls are non-linear. We do not think the effect of the experience of two child deaths is twice that of the experience of one death.

For the observations of each category of all included independent variables, the MCA program provides both simple (unadjusted) means and means that are adjusted by controlling for the effects of the other independent variables. Since MCA is a form of dummy-variable regression, the implied model is additive rather than interactive, but interaction terms may be included as independent variables. The results of MCA presented in this paper are in the form of adjusted means, although some researchers present the deviations of the adjusted category means from the grand mean of all cases.

Expectations Regarding the Results

The non-biological paths relating direct personal experience of child mortality to fertility depend upon the use of some form of fertility control. We have taken the use of contraception as an indicator of the use of all forms of fertility control within marriage since the data are unreliable on such other forms as abstinence and induced abortion. In the areas under study, the declared use of contraception is very low, ranging from a maximum of 35 percent of women with at least one birth who have ever used a contraceptive method (Costa Rica) to a minimum of 10 percent (Peru). In light of this situation we believe that experience of child mortality *should not have a strong effect* on the parity progression ratios, and that the effect that does exist should be greatest in Costa Rica and least in Peru.

A second expectation is that the effects of child mortality, as shown by the parity progression ratios, will vary according to the parity level attained by the couple. Parents who have very many fewer children than desired are likely to have another child no matter what their experience with child mortality. In the same sense parents who have had many more children than desired are not likely to increase their likelihood to have another birth, unless child mortality has reduced their number of surviving children so as to be close to their family size goals. Thus we expect that the strength of the relationship between child mortality and actual fertility behavior should rise to a maximum around attained parity levels near to the mean desired family size and diminish in strength as the parity level is increasingly different from this mean.

Results

Table 6 presents the parity progression ratios (PPR) according to direct personal experience of child mortality for various levels of attained parity for each of the rural-semi-urban areas included in the investigation. A comparison is made with results obtained for Taiwan using the same procedure. The parity progression ratios are adjusted for the effects of time exposure to the risk of a subsequent birth through the use of the date of the parity from which the progression is calculated (called date of previous birth for short). Additional controls used were the level of education of the woman, the quality of housing, husband's occupation, sector (rural or semi-urban) and perception of changes in child mortality. The socio-economic variables were included to avoid spurious relationships since both child mortality and fertility are related to level of living.

As can be clearly seen, the overall probabilities of having another birth are very high and approach those for a natural fertility population, supporting further the conclusion that fertility control is used very little. Looking at the parity progression ratios classified by number of previous child deaths, we see little difference between the ratios. Indeed the only increases in the PPR due to child mortality appear to occur in Peru, the country with apparently the least amount of fertility control, and in Costa Rica, the country with the most

fertility control. The other two areas, Colombia and Mexico, show in general no increase and for many parity levels show a decrease (10) when the number of child deaths increases.

Now we look more closely at each individual country. For Costa Rica, it can be noted that there are only three parity levels (four, five and ten) in which the experience of one child death increases the parity progression ratio over the PPR for women with no such experience. At four other levels a one child death decreases the PPR and at three levels there is no difference. Summing algebraically, the differences result in a + .14 overall increase ; however, all of this overall difference is due to the difference at parity level ten, which has the smallest number of women.

The situation is very much different if we consider differences in PPR between no experience and experience of two or more child deaths. Here we have increases at six parity levels, no parity levels in which the PPR decreases with increasing experience, and two parity levels at which there is no difference. The overall difference (the algebraic sum of the difference) is + .26. However, more than half of this overall difference comes from the final two parities, which have relatively small numbers of cases.

For Peru it can be noted that there are positive differences in PPR at four parity levels, negative differences at three levels and no difference at one level, for differences in PPR between experience of no and one child death. Owing to the fact that the positive differences are in general much larger than the negative differences, the overall difference is a plus .15. It is interesting to note that in these comparisons, the parity levels nine, ten and eleven can not be included because there are not enough women at these parity levels for women to be able to calculate reliable parity progression ratios without experience of a child death (11). The fact that there are not enough cases of no child deaths at these parity levels may signify that an analysis of the effect of child mortality at these levels may be irrelevant.

TABLE 6 – ADJUSTED(a) PARITY PROGRESSION RATIOS ACCORDING TO EXPERIENCE WITH CHILD MORTALITY BY ATTAINED PARITY LEVEL FOR RURAL-SEMI-URBAN AREAS OF FOUR LATIN AMERICAN COUNTRIES AND ALL TAIWAN

Area	Attained Parity Level										
	1	2	3	4	5	6	7	8	9	10	11
Costa Rica											
Child Mortality Exp.											
0 deaths	.95	.92	.90	.88	.87	.86	.87	.81	.78	.52	*
1 death	.92	.90	.90	.92	.92	.86	.85	.81	.76	.66	*
2 + deaths	–	*	.90	.91	.90	.86	.90	.83	.84	.61	.41
Colombia											
Child Mortality Exp.											
0 deaths	.92	.90	.90	.87	.89	.83	.84	.83	.76	.66	.58
1 death	.89	.91	.90	.89	.84	.88	.83	.83	.75	.57	.54
2 + deaths	–	*	.86	.85	.84	.80	.81	.79	.75	.77	.44
Mexico											
Child Mortality Exp.											
0 deaths	.95	.95	.94	.92	.92	.91	.86	.80	.81	.80	*
1 death	.95	.92	.93	.92	.94	.90	.86	.86	.69	.63	.63
2 deaths	–	.92	.94	.90	.93	.89	.85	.85	.76	.64	.47
Peru											
Child Mortality Exp.											
0 deaths	.92	.92	.93	.87	.80	.83	.70	.65	*	*	*
1 death	.93	.92	.92	.85	.86	.80	.75	.74	.66	*	*
2 + deaths	–	.93	.89	.87	.85	.80	.80	.75	.72	.58	.50
Taiwan											
Child Mortality Exp.											
0 deaths	.97	.91	.81	.66	.56	–	–	–	–	–	–
1 death	.97	.94	.88	.73	.70	–	–	–	–	–	–
2 deaths	–	*	.91	.87	.66	–	–	–	–	–	–

* Base less than 25 women

– Not applicable or not available

(a) Adjusted by MCA with the inclusion of the following control variables : Date of previous birth, education, housing quality, husband's occupation, sector, fear of child mortality

Source : see Table 4.

TABLE 7 – PROJECTED MEAN NUMBER OF ADDITIONAL BIRTHS (a), TOTAL NUMBER OF EXPECTED BIRTHS, AND INCREASE IN PROJECTED BIRTHS, ACCORDING TO DIRECT PERSONAL EXPERIENCE OF CHILD MORTALITY, BY PARITY LEVEL ATTAINED FOR RURAL-SEMI-URBAN AREAS OF FOUR LATIN AMERICAN COUNTRIES AND ALL TAIWAN

Area	Attained Parity Level									
	1	2	3	4	5	6	7	8	9	10
Costa Rica										
N° of additional births Child Mortality Exp.										
0 deaths	5.73	5.03	4.47	3.96	3.51	3.03	2.52	1.90	1.35	.72
1 death	5.73	5.23	4.81	4.35	3.72	3.04	2.54	1.99	1.46	.92
2 + deaths	–	*	4.88	4.42	3.86	3.28	2.82	2.13	1.56	.86
Increase in births due to experience of										
1 death	0	.20	.34	.39	.21	.01	.02	.09	.11	.20
2 + deaths	–	*	.41	.46	.35	.25	.30	.23	.21	.14
Colombia										
N° of additional births child mortality exp.										
0 deaths	5.45	4.92	4.47	3.97	3.56	3.00	2.62	2.12	1.55	1.04
1 death	5.30	4.95	4.44	3.93	3.42	3.07	2.49	2.00	1.41	.88
2 + deaths	–	*	3.91	3.54	3.17	2.77	2.46	2.04	1.58	1.11
Increase in births due to experience of										
1 death	–.15	+.03	–.03	–.04	–.14	+.07	–.13	–.12	–.14	–.16
2 + deaths	–	*	–.56	–.43	–.39	–.23	–.16	–.08	+.03	+.07
Mexico										
N° of additional births child mortality exp.										
0 deaths	6.69	6.05	5.36	4.71	4.12	3.48	2.82	2.28	1.84	1.28
1 death	6.39	5.72	5.22	4.61	4.01	3.27	2.63	2.06	1.40	1.03
2 + deaths	–	5.63	5.12	4.45	3.94	3.24	2.64	2.10	1.48	.94
Increase in births due to experience of										
1 death	–.30	–.33	–.14	–.10	–.11	–.21	–.19	–.22	–.44	–.25
2 + deaths	–	.42	–.24	–.26	–.18	–.24	–.18	–.18	–.36	–.34
Peru										
N° of additional births'child mortality exp.										
0 deaths	5.04	4.48	3.87	3.16	2.63	2.29	1.76	1.52	1.33	.90
1 death	5.20	4.59	3.99	3.34	2.92	2.40	2.00	1.67	1.26	.90
2 + deaths	–	4.66	4.01	3.51	3.03	2.57	2.21	1.76	1.35	.87
Increase of births due to experience of										
1 death	.16	.11	.12	.18	.29	.11	.24	.14	–.07	0
2 + deaths	–	.18	.14	.35	.40	.28	.45	.24	.02	–.03
Taiwan										
N° of additional births'child mortality exp.										
0 deaths	3.51	2.62	1.89	1.32	.94					
1 death	4.08	3.13	2.32	1.65	1.28					
2 + deaths	–	*	2.61	1.88	1.16					
Increase in births due to experience of										
1 death	.57	.51	.43	.33	.34					
2 + deaths	–	*	.72	.56	.22					

(a) Calculated using parity progression ratios from Table 6.

– Not applicable or not available

* Base less than 25 women

Source : Latin America : Pecfal-Rural KAP survey, CELADE, 1969-70.
Taiwan : Calculated from Rutstein, op. cit. 1971.

Observing the differences in PPR between no experience and experience of two or more deaths, four positive and two negative differences can be noted. At one parity level there is no difference. The overall difference is a + .19.

For Mexico and Colombia the situation is generally one of negative differences in the parity progression ratio. For Mexico there are only two positive, five negative and three zero differences in PPR between no and one child death categories.

Between categories for no and two or more child deaths there are again only two parity levels with an increase, six with a decrease and one with neither. The overall differences are a minus .26 and a minus .23 respectively between zero and one death and between zero and two or more deaths.

The situation for Colombia is similar to that for Mexico. Here there are three positive, six negative and two zero differences, with an overall difference of –.15, for differences in PPR between women with no child deaths and women with one death. For differences in the PPR's between women with two or more child deaths and women with no deaths, there is an increase at only one parity level (ten) and decreases at eight ; the overall difference is –.25.

In order to get a different view of the differences between the parity progression ratios and to get an idea of the effect on completed fertility, the ratios were used to project the mean total number of additional births women would have, given their experience with child mortality. The projections calculated for each parity level are shown in Table 7. The procedure of calculation is given in Appendix. These projections result in numbers of additional children different from those actually given birth to by the women. Apparently similar results could be obtained by calculating at each parity level the mean number of additional children actually given birth to by the women classified by their experience with previous child death. However, two factors would make problematic interpretations of the results of such a procedure : the effects of truncation and omissions would be much more severe than in the case of calculating the parity progression ratios, and the results may be influenced by *subsequent* child death experience. In general the projections show that in Costa Rica and Peru, as direct personal experience with child mortality increases, the mean number of additional births also increases. In Colombia and Mexico the opposite is true ; increasing experience leads to a decline in the mean number of additional children. However, all but one of the increases or decreases are less than half a child. Therefore, even women with the highest increases due to child mortality severely underreplace their lost children.

It is interesting to note that the projected mean numbers of additional births (and therefore the total numbers of expected births) are greatest in Mexico and least in Peru with Costa Rica and Colombia almost equal. For example, for women who have had three births with no child mortality experience, the projected mean number of additional births is 5.4 for Mexico, 4.5 for both Costa Rica and Colombia, and 3.9 for Peru, resulting in 8.4, 7.5 and 6.9 total expected births, respectively. These figures compare with 1.9 additional births (4.9 total expected births) for Taiwan.

The parity progression ratios have shown whether or not a woman has an additional birth ; however, the rate of growth of the population also depends on the timing of the births a woman has. The smaller the intervals between births, the smaller the interval between generations (12), and therefore the more rapid the growth of population on any given number of years.

An analysis using the PECFAL-Rural data of the effect of child mortality on closed pregnancy intervals, principally through the biological path, and presumably not strongly related to fertility preferences is part of a study undertaken by Cesar Fernandez (1974). In this analysis experience of child mortality is measured by the result of the previous birth (13) : still alive, died under one year of age, or died after one. The dependent variable is the mean length of time between this birth and the following conception for all parity levels considered together.

From the results presented in Table 8, we see that there is a substantial shortening of the interval when a child dies before its first birthday. The decrease in average interval varies from 3.5 months (Colombia) to 6.2 months (Peru). As the shortening due to a death after one year of age is relatively small (from 0.1 months in Colombia to 1.5 months in Peru), we believe that most of the decrease in the intervals is due to biological rather than motivational effects.

Further support for a biological causal sequence comes from the fact that in Peru, the only area where a death after one year of age substantially shortens the interval, a majority of the women breastfeed for longer than one year. It is also the only country of the four studied where a large proportion breastfeed for more than eighteen months. Unfortunately no analysis using the PECFAL-Rural data has been done to evaluate the effect on birth timing excluding biological effects.

The non-biological paths of influence depend primarily on whether or not there exists the possibility to control fertility. The decision to have another birth or to have that birth sooner involves the decision to use a method to control fertility. It is important, therefore, to analyze the use of fertility control methods as affected by child mortality.

TABLE 8 – MEAN CLOSED PREGNANCY INTERVAL BY SURVIVAL OF PREVIOUS BIRTH FOR RURAL-SEMI-URBAN AREAS OF FOUR LATIN AMERICAN COUNTRIES AND TAIWAN

Survival of previous birth	Mean Pregnancy Interval (a) in months				
	Costa Rica	Colombia	Mexico	Peru	Taiwan
All births	14.41	16.32	17.31	19.57	16.92
Alive at interview	14.91	16.65	17.84	20.70	17.28
Died before first birthday	10.56	13.15	13.20	14.47	11.40
Died after first birthday	14.75	16.54	17.44	19.20	17.04

(a) Excluding gestation.

Source : Latin America : Fernandez, cited in text, Table I. Taiwan : A.K. Jain, "Pregnancy outcome and the time required for next conception", *Population Studies* 23 : 423, Table I.

TABLE 9 – MCA ON CONTRACEPTION : USE OVER, PARITY AT FIRST USE, CONTINUANCE, AND USE AT INTERVIEW, ADJUSTED MEANS(a) BY CHILD MORTALITY EXPERIENCE, FOR RURAL-SEMI-URBAN AREAS OF FOUR LATIN AMERICAN COUNTRIES AND ALL TAIWAN

Area and child mortality experience	% ever used	Mean parity level at first use	% continuing use when interviewed	% using when interviewed
Costa Rica	34.6	–	71.7	24.8
N° of deaths				
0	38.3	5.03	73.2	26.8
1	32.2	5.70	76.7	23.3
2	29.6	5.50	85.5	14.5
3+	15.4	*		
Colombia	19.6	–	67.1	13.2
N° of deaths				
0	29.0	–	66.6	13.9
1	17.0	–	68.2	11.6
2	20.5	–	70.5	13.2
3+	16.4			
Mexico	10.9	–	49.5	5.4
N° of deaths				
0	12.3	–	50.9	6.3
1	10.9	–	36.4	4.0
2	9.3	–	*	*
3+	3.8			
Peru	9.8	–	67.6	6.6
N° of deaths				
0	12.1	–	64.0	7.7
1	9.1	–	69.6	6.3
2	8.6	–	78.9	6.2
3+	7.3	–	*	*
Taiwan(b)	62.2	4.34	82.8	51.5
N° of deaths				
0	64.0	4.28	82.0	52.5
1	56.0	4.71	81.0	45.4
2+	61.9	4.86	88.6	54.8

(a) Adjusted for age, number of births, date of last birth, marital status, fear of child mortality, education, use of mass media, housing quality and husband's occupation.

(b) *Source* : Calculated from Rutstein, op. cit. 1971.

* Base less than 25

– Not available

To study some of the effects of child mortality on fertility control, we have chosen ever use of contraceptive methods as the dependent variable and the number of child deaths experienced as the independent in a first analysis. A second analysis studies when contraception began. Then in a third analysis the continuance of use is studied. Unfortunately the second type of analysis covers only Costa Rica at present. All three analyses were done using MCA. In these analyses age of mother, total number of births, date of the last birth, marital status, education, mass media consumption, housing quality, husband's occupation and perception of change in child mortality were included as independent variables to control for spurious relationships. The results of these analyses are presented in Table 9.

The overall percentage of mothers who have ever used a contraceptive method varies from a high of 35 percent in Costa Rica to a low of 10 percent in Peru. For all countries, direct experience with child mortality lowers the proportion who have ever used contraception. The largest absolute reduction, 14 percent, comes in Costa Rica while the smallest, 4 percent, comes in Colombia and Peru. Taking into account the overall level of use, the largest relative reduction (42 percent) is in Mexico. Colombia has the smallest relative reduction in use due to child mortality experience. Compared to Taiwan, the women in Latin American areas have made much less use of contraception. However, the relative reduction in use due to child mortality is generally greater in Latin America than in Taiwan.

To see if experience of child mortality delays the first use of contraception among those who ever do use, the following procedure was used : for each parity level reached, and for each category of experience with child mortality, the adjusted mean proportion that began to use contraception before the next birth, out of those who had reached the parity level without previous use of contraception, was calculated by use of MCA. From these proportions, the mean parity level at first use was calculated as the weighted average of all those who ever use (14). The calculations reveal that in Costa Rica, experience with child mortality does delay first use. The delay is approximately 0.7 of a child if there has been experience of one death and half a child for two deaths. A delay was also found for Taiwan.

Continuance of use of contraception, once that use has begun, is in general higher with experience of child mortality. Mexico, where continuance is low in general, has the only reduction in percent continuing with an increase in experience. Perhaps a reason that continuance of use is higher among women with experience of child mortality is that fewer of these women ever use contraception and those that do use, begin later. Therefore these women are more sure of what they want when they do begin and as such are less likely to discontinue once they begin. The dependent variable in this analysis is the proportion of women who used a contraceptive method when interviewed out of those who have ever used a method.

By multiplying the adjusted proportions who ever use contraception and the adjusted proportions continuing such use, the adjusted proportions using contraception when interviewed were calculated and appear in Table 9. In the Latin American countries under study, the percentage of women using contraception at the time of interview is reduced with increasing experience. The largest decrease comes about in Costa Rica. Usage by women with 2 or more deaths is almost half as much as by women with no child deaths. The reduction with child mortality is more consistent in the Latin American areas than in Taiwan, where a higher proportion of women with experience of two or more child deaths used contraception at interview than women with no experience.

Discussion

We have seen from Table 3 that the rural-semi-urban areas of the two countries with the highest infant mortality rates, Mexico and Peru have the highest fertility rates while the country areas with the lowest mortality rates, Costa Rica and Colombia, have the lowest fertility rates. It would be incorrect, however, to attribute the high fertility of the former to their relatively high rates of child mortality without further evidence, given the two-way nature of the relationship and the various confounding factors that may intervene. It is therefore imperative to analyze the various paths of influence of child mortality to determine whether, how and by how much fertility is affected. Of the three sources of experience with child mortality, direct and indirect personal experience and societal experience, only direct personal experience has been analyzed largely due to the lack of adequate data for analysis of the other two. The other two sources of experience may be related to fertility in the rural-semi-urban areas if not in all areas of Latin America given the high child mortality levels encountered during the survey (1969-70), which are undoubtedly lower than in the past, and given the high levels of direct personal experience of the women in the survey as shown in Table 4.

Results have been presented to show the effects of direct personal experience of child mortality on replacement of lost children, on the timing of births as a biological reaction, and on use of contraception. The results indicate that in only two of the four rural-semi-urban areas of the countries does there exist an increase in the probability of having an additional birth, (parity progression ratios, PPR) with increasing experience of

child mortality. In the other two areas there are decreases in the parity progression ratios. Moreover in the two areas where there are increases in the ratios, these are small and do not occur at all parity levels. We believe that part of the reason that the PPR may decrease with increasing experience is that a woman with a child death may have health problems that led both to the death of the child and to lowering her probability of having another birth. This health factor may also lead to lowered increases in the PPR as more women with child mortality who want another birth may not be able to have one. Since Peru has presumably the worst health conditions as implied by the infant mortality rates, the presumed effect should be greatest there and least in Colombia and Costa Rica. However, our results are not able to support this hypothesis. For Costa Rica and Peru, the areas with positive differences in the PPR, the increases reach local peaks around parities three to five, the numbers which over half of the women in both country areas have declared as most convenient. The biological response to child mortality, which is mainly a timing phenomenon, is seen from Table 8 to exist for all areas as expected.

Obviously child mortality cannot exercise a behavioral effect on actual fertility unless the possibility of some form of fertility control exists. It is equally obvious, though, that child mortality may play a significant role in the decision of whether to use a form of fertility control or not. In all societies there exists the possibility of delayed entry into regular sexual union (age at first marriage), voluntary abstinence and celibacy. The decision about the use of such forms of fertility control are strongly regulated by the norms of the society. It is probable that societal experience of child mortality has played a large, if not primary, role in the formation and maintenance of such norms. With respect to forms of fertility control once a regular sexual union has been established, there is more of a possibility that knowledge of the techniques and the materials employed in the methods are not widespread, although withdrawal and abortion are believed to be generally known.

Since fertility control within marriage is necessary for a behavioral response in actual fertility to direct personal experience of child mortality, it could be a precursor to such a response. Evidence of differences in control according to child mortality experience may be able to indicate the beginning of such behavioral responses even though changes in actual fertility may not yet have occurred. It is in this sense that the relationships between child mortality and the use of contraception are examined.

In general it was found that direct experience with child mortality decreases the proportion of families who have decided to use a contraceptive method and, at least in Costa Rica, postpones the beginning of use for those who do decide to use. There is evidence, however that once women with child mortality do begin use of contraception, they are more likely to continue using a method. We have interpreted these results to mean that women with child mortality experiences are using contraception more for limiting than for spacing births than are women with no direct experience. The overall result is that at any one time (such as when interviewed) women with experience are slightly less likely to be using a contraceptive method.

In summary we conclude that where it exists, that is Peru and Costa Rica, the increase in actual fertility as a response to direct experience of child mortality is small, much less than that necessary for the replacement of children lost to mortality. The small response is to be expected given the low overall levels of contraceptive use in these areas. There is some indication from the results obtained on contraception that as the knowledge and materials of contraception become widespread, direct experience of child mortality may begin in the near future to affect fertility levels in those countries, Mexico and Colombia, that have not as yet shown such effects. Further decreases in child mortality in these areas would be little offset by decreases in fertility due to reductions in direct personal experience. Therefore, unless reductions in indirect personal experience and societal experience would bring sufficient concomitant decreases in fertility, such a mortality decrease would bring substantial increases in the rate of growth of the population. Further investigation into the existence and time lags of those other paths of influence is strongly in need, as well as deepening the analyses with respect to direct experience.

ACKNOWLEDGEMENTS

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The data for the analyses were originally collected by each country under the coordination of CELADE with funds from the Population Council. The authors are thankful to Arthur Conning, Alan Simmons and Johanna de Jong for their invaluable comments on earlier versions of the paper.

APPENDIX A

TABLE A-1 – CRUDE BIRTH RATES[a] (CBR) AND INFANT MORTALITY RATES (IMR) FOR VARIOUS LATIN AMERICAN COUNTRIES, 1920-1970 (Rates per Thousand)

Country		1920-1924	1925-1929	1930-1934	1935-1939	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965	1966	1967	1968	1969	1970
Argentina	CBR	34	32	28	25	24	24	24	24	22-23	–	21	22	22	–	–
	IMR	115	111	95	98	83	74	65	62	60	57	54	58	–	–	–
Bolivia	CBR	–	–	–	–	45[b]	45	41	–	43-45	–	44	44	44	44	44
	IMR	–	–	–	82	101	123	99	84	–	77	77	–	–	–	–
Chile	CBR	40	41	38	36	36	35	36	39	34-36	–	32	31	27	25	30
	IMR	241	224	206	213	176	150	128	117	113	102	103	92	92	88	79
Colombia	CBR	42	43	42	42	42	43	44	45	41-44	–	36	45	45	45	45
	IMR	105	133	120	116	152	142	113	101	90	82	60	78	70	–	–
Costa Rica	CBR	45	47	45	44	43	43	46	49	45	45	41	40	36	34	33
	IMR	178	169	156	144	131	100	87	76	73	76	65	62	60	67	62
Cuba	CBR	42	36	33	31	30	29	30[b]	–	34-36	–	–	27	27	27	27
	IMR	163	120	85	99	–	39	–	33	37	38	38	40	41	48	38
Ecuador	CBR[a]	48	49	49	48	46	46	46	47	47-50	–	45	45	45	45	45
	IMR	–	170	147	149	142	127	112	107	96	93	90	87	86	91	77
El Salvador	CBR	47[b]	47[b]	44	43	44	44	48	49	47-49	–	45	44	43	42	40
	IMR	134	139	139	125	114	102	82	80	70	71	62	63	59	63	67
Guatemala	CBR[c]	48	49	46	44	45	49	51	49	46-48	–	–	43	43	43	41
	IMR	87	94	93	104	119	109	100	97	90	93	89	89	92	91	87
Honduras	CBR	44[b]	44[b]	41	42	45	46	49	50	47-50	–	–	49	44	44	44
	IMR	–	101	92	99	109	92	65	57	48	41	38	36	34	37	–
Mexico	CBR	41	40	41	42	43	45	46	48	44-45	–	44	43	43	43	43
	IMR	226	194	135	128	119	105	92	78	70	55	52	72	64	68	69
Nicaragua	CBR	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	IMR	–	–	105	96	111	102	77	72	60	52	55	45	46	45	–
Panama	CBR	40[b]	37	36	37	39	39	40	44	41-42	–	38	39	39	38	37
	IMR	–	–	–	–	70	66	56	57	49	45	45	43	40	40	41
Paraguay	CBR	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	IMR	–	–	–	–	–	98	–	–	–	42	40	37	52	33	33
Peru	CBR	–	–	–	–	46	47	48	49	44-45	–	40	42	42	42	42
	IMR	–	–	–	113	117	109	100	99	87	74	67	62	–	–	–
Puerto Rico	CBR	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	IMR	–	–	128	123	106	78	64	52	45	43	37	31	29	30	29
Uruguay	CBR	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	IMR	106	101	99	94	86	57	54	50	45	50	43	50	54	49	43
Venezuela	CBR	41[b]	43[b]	40[b]	38	40	44	46	48	46-48	–	42	41	41	41	41
	IMR	155	150	152	135	117	98	75	64	50	48	47	41	46	47	49

– Not available

(a) Age and sex standardized from 1920 to 1959

(b) Not standardized

(c) All rates not standardized

Sources : Crude birth rates, 1920-1959 : Collver, *Birth rates in Latin America : New estimates of historical trends and fluctuations*, Institute of international studies, res. series n° 7, University of California (Berkeley), 1965.

Crude birth rates, 1960-1970 ;
and infant mortality rates : United Nations, *Demographic yearbook*, various years.

APPENDIX B

Calculation procedures

Expected Additional Births

The calculation of the number of expected additional births from parity progression ratios is a procedure analogous to the calculation of life expectation in a life table. Then the formula

$$w_x = \prod_{i=1}^{x-1} p_i$$

gives the number of women reaching a parity level x, w_x (corresponding to l_x), as the product of the parity progression ratio at each level, p_i, up to level x (corresponding to $1 - qx$).

Summing from below,

$$S_x = \sum_{i=x+1}^{n} w_i \qquad (n = \text{last level considered})$$

then gives the number of additional women-levels attained, S_x, (corresponding to T_x) by women reaching level x. Dividing each S_x by the corresponding w_x gives the expected number of additional births for women attaining parity level x.

In the few cases at the highest parity levels where the PPR were not available separately by number of deaths due to the small number of cases, the overall PPR for the level was used instead.

Time of First Use of Contraception

A somewhat similar procedure to that described above was used to calculate the mean parity level of first use of contraception. If p_x is the proportion of women beginning use of contraception between parities x and $x + 1$, then

$$NU_x = \prod_{j=1}^{x} (1 - p_j)$$

is the proportion of non-users at parity level x. The mean parity at first use, MPFU, given by

$$MPFU = \frac{\sum_{x=1}^{n} (1 - NU_x) . x}{\sum_{x=1}^{n} (1 - NU_x)}$$

where n is the last level used in the calculation. Since P_{7+} pertains to all women above the seventh parity level, we have arbitrarily chosen a value of 8 to use in the calculation.

NOTES

(1) We will use the term child mortality to refer to mortality of both infants and children up to 15 years of age. The term infant mortality refers to mortality of children up to one year of age.

(2) Other definitions have been used : a common one is survival until one or both parents are dead (see Immerwahr, 1967). However, this definition is somewhat ambiguous and would be different for each couple and would change with changing mortality rates. The limit of survival we have selected is fixed in time and is the same for all couples. We have chosen 15 years of age as the dividing line between childhood and adulthood.

(3) An indication of this type of thinking has been noted as one of the reasons in avoidance of permanent sterilization such as vasectomy and in the reluctance to accept certain family planning methods for fear of possible fecundity impairments even when the parents do not want any more children.

(4) The problem exists either with absolute number of births and deaths for analysis on the microlevel or with birth and death rates for macrolevel analysis.

(5) An example would be to consider what happens to fertility after the fourth birth by the result of the fourth birth only, ignoring the results of the other three births.

(6) The age standardization avoids a possible bias from changes in the age distribution due to the lowering of general mortality levels, which in turn are correlated with the decline in infant mortality.

(7) Because the estimates were based on samples of the census data, reliable estimates could not be obtained for one province in Nicaragua and Paraguay, three provinces of Argentina and the urban areas of Paraguay. These data points were therefore not included in the respective regressions.

(8) An attempt to use a question on the perception of changes in child mortality as a measure of indirect personal experience produced inconsistent results : fertility and use of contraception were higher for women who perceived changes in either direction than for women who perceived no change in child mortality or could not give a reply (a substantial proportion). The variable was therefore used only as a control but no results are reported.

(9) The parity progression ratio is defined as the proportion of women having $n + 1$ or more births out of those having at least n births.

(10) This decrease may be due in part to health problems related to the birth causing both the death of the child and the sterility of the mother. However, it may also be due in part to a feeling of discouragement following the child's death eliminating the wish to have another child who also may die.

(11) We have taken 25 as the minimum base for the calculation of the parity progression ratios.

(12) When the date of beginning childbearing is constant. Direct personal experience cannot affect the onset of childbearing as women only experience the death of a child after they have begun childbearing. However, both the birth intervals and the age of beginning childbearing are probably affected by indirect personal experience and community experience.

(13) Since we will only review the results related to child mortality all previous terminations of pregnancies are live births.

(14) Since the last parity level (7) included use of contraception at all higher levels, an arbitrary level of eight was assigned. See Appendix B for the original proportions.

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THE INFLUENCE OF SPECIAL MORTALITY REDUCTION PROGRAMS ON FERTILITY : AN INITIAL LOOK AT SOME EMPIRICAL DATA AND MEASUREMENT PROBLEMS

Robert J. LAPHAM, Nicholas H. WRIGHT, M.D. and Anna S. QUANDT *
The Population Council

The task assigned for this background paper is to review the influence of special mortality reduction programs on fertility in areas not experiencing substantial economic and social development. Particular attention is to be directed to the influence of maternal and child health programs. Three basic questions may help focus the discussion. First, what is the empirical record ? Have special mortality reduction programs reduced mortality, and for the study areas covered by such programs, what data are available on other parameters that may have changed, including fertility ? Secondly, what measurement problems must be faced, and at least understood if not solved, in the use of empirical data as the basis for *tentative* answers to the "influence" question ? Thirdly, is there any evidence in these studies that mortality reduction by itself is a sufficient condition for fertility decline, and if so, in what particular settings and/or under what conditions ? Cutting across these core questions are the interrelationships between mortality and fertility control programs, which often are introduced simultaneously, as for example with the several integrated maternal and child health family planning (MCH/FP) programs that have been and are being promoted in many places in the recent past and at present.

The following paragraphs are an initial attempt to focus on these basic questions. Unfortunately, the empirical record is thin, in part because of the relatively recent introduction of several programs, combined with a need for data over several years. The measurement and theoretical problems are substantial, and a combination of difficult measurement and scanty data does not leave us with much interpretative potential. There are exceptions to the general lack of data, however, and three examples are presented in some detail : the Etimesgut project in Turkey, the Khanna study in India, and a combined DDT spraying campaign and general malaria eradication program in Sri Lanka in the late 1940's. Notes are added on a few other examples, including the Narangwal project in India. Measurement and theoretical problems are taken up in a subsequent section.

1. Some Empirical Data

At first glance, and at a very general level, there is a fairly clear association between the infant death rate and the crude birth rate (a crude but available fertility measure). Figure 1 presents the zero-order relationship for 74 countries of the developing world for which reasonable estimates of both measures are available, and the data are summarized in Table 1.

The general tendency is for a positive relationship between crude birth rates and infant mortality, although the variation is substantial. (Two standard deviations around the regression line would include a wide area on this chart : also the relationship appears more curvilinear than linear, and one curve that fits the data reasonably well is indicated on Figure 1). Only two countries with infant death rates above 50 have birth rates below 30 (Mauritius and Chile). Among countries with infant death rates over 100, the crude birth rates are in the high 30's up to 50+, with one exception (Gabon, with the highest estimated infant death rate among the 74 countries and a crude birth rate of 33). Note that the reverse is not true, however. Among developing countries with moderate to low infant death rates (defined as under 50), the crude birth rates range from 20

(*) Mr. Lapham and Ms. Quandt are respectively Chief of Evaluation and Staff Associate with the MCH Family Planning Program. Dr. Wright is the Council's representative in Thailand. Appreciation is expressed to Dr. Elizabeth Whelan, a part-time consultant with the MCH Family Planning Program and consultant for this program, for assistance with one part of this paper.

to above 40. This may relate to the "lag" problem discussed below. Ideally, we would like a set of time-series charts, showing over time the changes in infant death rates and in crude birth rates.

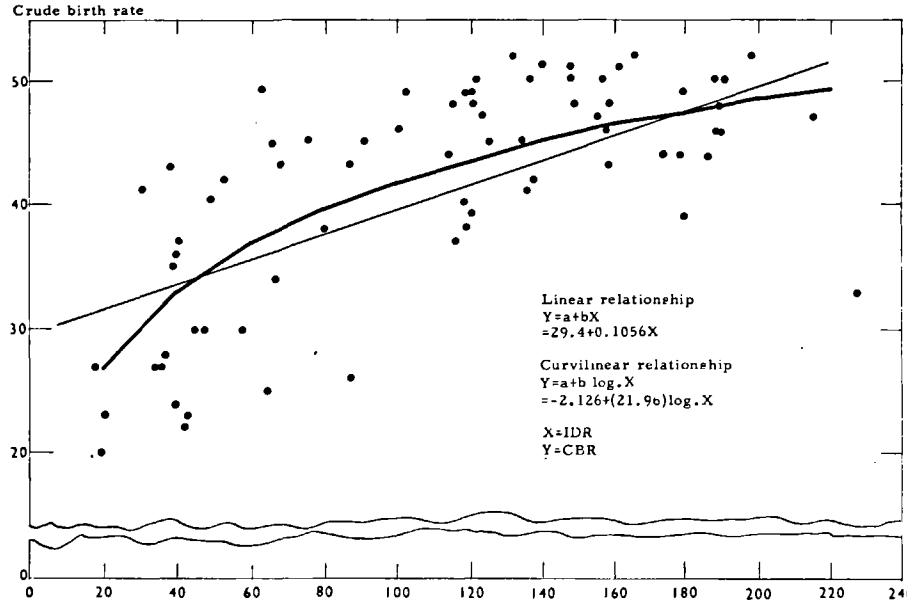

Figure 1 – Crude Birth Rates Compared with Infant Death Rates for 74 Countries of the Developing World.

Sources : Population Reference Bureau, Inc., "1973 World Projection Data Sheet" ; *UN Demographic Yearbook 1972* ; and miscellaneous other sources for adjusting infant death rate data. (e.g. Tabutin article in *Population* 29 : 1, 1974 re Algeria).

TABLE 1 – NUMBERS OF COUNTRIES CLASSIFIED BY ESTIMATED CRUDE BIRTH RATES AND INFANT DEATH RATES : 74 COUNTRIES OF THE DEVELOPING WORLD

Crude Birth Rate	Infant Death Rate			
	Under 50	50-99	100 and over	Totals
	Number of countries	Number of countries	Number of countries	Number of countries
35 and over	6	8	44	58
Under 35	11	4	1	16
Totals	17	12	45	74

Another zero-order relationship of interest is between the infant death rate and the level of contraceptive use in a population. Figure 2 presents the available data for 20 countries for which reasonable estimates of contraceptive use are available. The relationship is quite clear. Countries with high infant death rates have low levels of contraceptive use, but countries with lower infant death rates cover a considerable range on the "use" scale. Again, the relationship appears to be more curvilinear than linear.

Now let us turn to specific projects designed to influence infant and child mortality.

A) The Etimesgut Project

The Etimesgut Project began in 1966 in the Etimesgut District of Turkey, a mountainous area east of Ankara, with a 1973 estimated population of about 65 000 (Fisek, 1974. The following summary and findings from the project are based on this report by Dr. Fisek.) Just over half of the area is rural, with 56 percent of the population living in 84 villages averaging 430 persons, and the remainder residing in two towns of between 10 000 and 20 000 population each. The program has been and continues to be oriented to the delivery of integrated health and family planning services using "auxiliary nurse-midwives and general practitioners as the primary change agents" (ibid., p. 210). Specified schedules of services are performed by the auxiliary nurse-midwives (ANMs) for antenatal care, delivery and postpartum care, child care and family planning. Each ANM is responsible for a population of approximately 2 000. An important aspect of the program is the emphasis on home visitation by the ANMs. Medical officers provide supervision and they continually train the ANMs, provide medical services, and provide initial family planning services (prescribe pills and insertions of

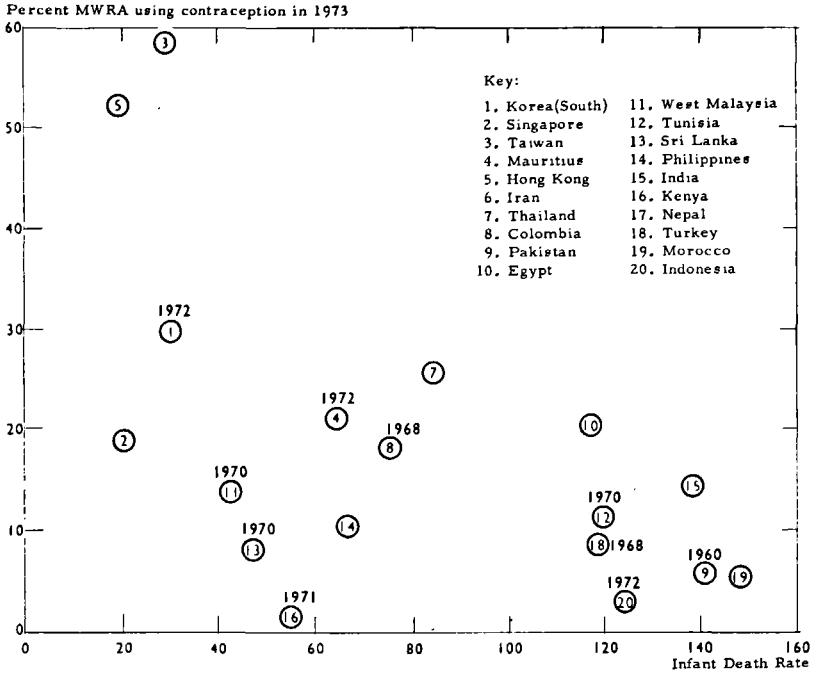

Figure 2 – Percent of Married Women of Reproductive Age Using Contraception Compared with Infant Death Rate, in 20 Countries with Family Planning Programs 1973 unless otherwise specified.

Sources : Population Reference Bureau, Inc., "1973 World Projection Data Sheet" ; *United Nations Demographic Yearbook 1972 ;* and miscellaneous other sources for adjusting infant death rate data, e.g., Nortman Dorothy, "Population and Family Planning Programs : A Factbook," *Reports on Population/Family Planning,* no. 2 (1973, fifth edition), (1972, fourth edition), The Population Council.

IUDs, with some insertions permitted by supervised paramedical staff). Supervisory nurses assist the physicians with coordination and supervision. Male and female public health nurses are attached to each health unit that serves from 3 000 to 9 000 persons. The male public health nurse takes a biannual census and is responsible for rural sanitation and a school health program. Clerks are also assigned to the health units. Some of the relevant average population per service worker ratios in this project are :

		1973
Average population per :	physician	5 017
	nurse	2 608
	ANM	1 919

(ibid, Table 2, p. 212)

A major project component has been the collection of relevant data over the years. In addition to service statistics, this project calls for continuous population registers for the district, with records of births, deaths, and migrations, and twice-yearly updating of household record forms. KAP surveys were conducted in 1967 and in 1973.

The changes in both health and fertility reported by Fisek are significant, indeed striking. Table 2 shows that from 1967 to 1973 the crude death rate declined by a third, and life expectancy increased about six years for males and over eight years for females, for a one third decrease of infant mortality, from 142 to 93 per thousand over the six years, but the annual rates jump around a bit in the 1971-1973 period (due to high incidences of pneumonia and diarrhea in 1972, explains Dr. Fisek), and it may be helpful to look at three-year moving averages.These declined 22 percent, from 125 in the 1967-69 period to 98 in the 1971-1973 period, or roughly 5 percent a year. Of note is the proportion of the decline in the crude death rate due to decreased infant mortality : 48 percent of all 1967 reported deaths, and 39 percent of all reported deaths in 1973, are infants under age one. Two thirds of the decline in the crude death rate occur because of the decline in infant deaths. ($10.3 - 7.0 = 3.3$; $2.25 \div 3.3 = 68$ percent).

The fertility measures, crude and specific, show substantial declines also (table 2). The crude birth rate went down an average of about one point a year, but this decline occurred primarily in the most recent four years, i.e., the rate was steady around 35 during the first three years of program activity. Likewise, the total fertility rate and the general fertility rate show major declines, beginning in the fourth year, with the 1973 levels down a fourth from the 1970 levels. The KAP studies show high levels of contraceptive use in both

TABLE 2 – ETIMESGUT PROJECT, TURKEY : LEVELS AND CHANGES OVER TIME OF SELECTED HEALTH AND FERTILITY MEASURES

Year	Health Measures				Fertility Measures b)		
	Crude death rate b)	Infant Mortality rate b)	Life expectancy at birth (years)		Total fertility rate	General fertility rate	Crude birth rate
			Male	Female			
1967	10.3	142	55.9	57.7	4 946 a)	169.9	35.1
1968	9.6	121	57.1	63.6	5 045 a)	168.0	34.7
1969	8.8	111	62.8	63.8	4 940	167.0	35.4
1970	8.2	103	61.2	65.9	4 425	152.0	32.9
1971	7.1	88	62.5	67.5	4 250	144.8	31.9
1972	8.2	112	58.3	63.3	3 970	135.3	29.5
1973	7.0	93	62.1	66.5	3 721	121.5	29.4

* *Source* : Nusret Fisek. "An Integrated Health/Family Planning Program in Etimesgut District, Turkey", *Studies in Family Planning* 5 : 7, July, 1974, Table 7.

[a]TFRs for 1967 and 1968 are estimated from total births and the age distribution of women. The distribution of births by age of woman was assumed to be the same as reported in 1969.

[b]Per thousand.

1967 (50 percent ever used and 50 percent current users among married women of reproductive age) and in 1973 (74 and 54 percent ever users and current users respectively) with a considerable change, however, between 1967 and 1973 from traditional methods to newer methods.

Figure 3 combines the fertility experience (total fertility rate) with the infant mortality experience (annual and three-year moving average infant death rates), and illustrates the continuous health improvement from the early years of the program, but the lag before fertility began to decline. Fisek advances three possible reasons for the observed lag period : "(1) that family planning services were inefficient at initial stages ; (2) that fertility only began to decline once a marked decline in child mortality had occurred ; and (3) that previously unknown methods of contraception were being introduced, and acceptance of them was gradual", (ibid., p. 219), but he discounts the first as a valid explanation for the Etimesgut project. Regarding the child survival hypothesis, Fisek states :

"The impact of child mortality on fertility is a long debated subject... At first sight, our observations may seem to suggest that reductions in child mortality are a factor motivating fertility control. However, if the decline of fertility after the lag period that we observed was due to an increase in motivation after the decline in infant mortality, it would be logical to expect considerable change in the percentages of contraceptive users between 1967 and 1973. But this is not the case. Current users increased by only 8 percent in seven years. The major factor affecting fertility was the switch from traditional methods to the new, effective methods". (ibid., p. 219).

Fisek suggests the hypothesis that many women observed the early family planning acceptors for some time before deciding that no health hazards were involved, and he points out that "even after seven years, the fear of health hazards is still one of the most important reasons for not using contraceptives, especially IUDs and orals" (ibid.). Fisek concludes that the lag period was due to the time needed for the learning process.

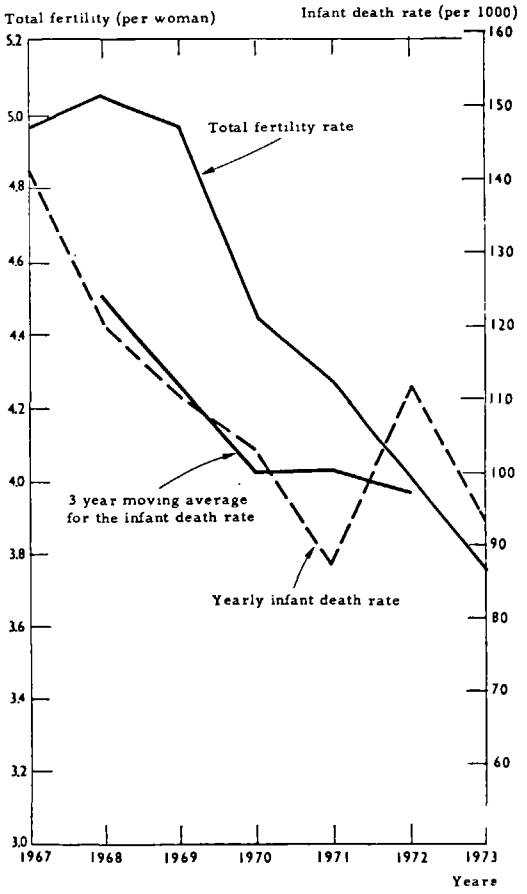

Figure 3 – Total fertility and infant death rates : Etimesgut District, 1967-1973.

Source : Nusret H. Fisek. An integrated Health/Family Planning program in Etimesgut District, Turkey. *Studies in Family Planning 5*, no. 7 (July, 1974) : 215.

We might add that the lag in this project is a very short period to support a child survival hypothesis (fewer children dying leading couples to reproduce fewer children). There has to be recognition at the familial level that infant (and child) mortality really is declining, and three or four years seems a very short period of time for this process to be recognized and internalized to the point of producing conscious and specific fertility-reduction behavior. This would seem to be particularly relevant with the Etimesgut project, where the infant death rate in the most recent period is close to 100. Thus, families looking around among friends and relatives in their villages and neighborhoods still see roughly one in ten children dying before the age of one,

B) The Khanna Study

The Khanna Study was initiated in 1954, located in the Ludhiana District of the Punjab State in the northern part of India (Wyon and Gordon, 1971). (The following summary of some of the findings in the Khanna Study is based primarily on this monograph, plus a personal discussion with Dr. Wyon). The project area is "densely populated by people deriving their livelihood mainly from a fertile soil watered by the annual monsoon rains and by irrigation from canals and wells" (ibid., p. 48). The primary study was conducted from April 1956 to March 1960 in a population averaging just over 12 000 persons during this period. Of the 1960 populations, 7 979 lived in test villages, and 4 386 in control villages where services were similar except that family planning was excluded. (A second control group with a 1960 population of 4 934 had only measurement activities, during the programmatic period of the study, i.e., no data are available on the 1960's for this latter group). The main programmatic effort was preceded by two years of pilot testing, in one and then two villages, and for four years after 1960 contraceptives continued to be promoted and supplied, but as the responsibility of the village residents rather than a project effort. The final analysis was completed in 1969. Data for the period up to 1960 were collected on an ongoing prospective basis ; data for the 1960's were collected by means of a retrospective survey carried out in 1969.

Several key findings from the Khanna study are summarized in Table 3. The basic data are from Wyon and Gordon (1971), with the standard errors calculated by us. The differences between the test and control groups are not statistically significant for either the mortality or fertility measures (at the level of two standard errors), but the differences over time are substantial in both groups. The crude death rate and the crude birth rate declined substantially during the primary-project-effort period, and then these rates remain approximately constant during the 1960's at the level attained around 1960. The rate of infant and early child mortality, which as measured here is the number of children dying before reaching age two per 1000 live births, declined by a fourth to third during the period of main project inputs. (This measure is good to use when sample or project populations are small and hence where the infant death rate is affected by a few cases, and also in general when there are high mortality probabilities in year two of a child's life, as is often the case in developing societies). Note that the difference between test and control populations in the level of infant and child mortality for the 1956-68 period is not statistically significant at the .05 significance level, i.e., 240 ± 28 and 200 ± 36 could easily be samples from the same population.

The Khanna study does not suggest a prior decline in mortality followed by a decline in fertility, as we see with the Etimesgut data. Because of the group population sizes the data must be summarized as multi-year rates, but the data suggest other parameters leading to declines in both mortality and fertility. Wyon and Gordon show the increased age at marriage among women in the decade 1956-58 to 1966-68 (Section C.1 table 3) although the change in the late 1950's seems minimal. A finding similar to the Etimesgut Project is that overall level of contraceptive use remained approximately constant during the project input years (Section C.2 table 3). There was a slight increase in use by 1969, with modern methods beginning to be used. Of note is the increase over time in the use of "folk" methods, including abstinence, rhythm, coitus interruptus and condoms, which leads Wyon and Gordon to suggest that Khanna families have the means to limit family size when they see that it is in their self-interest to do so. The use of foam tablets, with or without accompanying use of "folk" methods, had disappeared in the project villages by 1969. (Foam tablets were the principal method of family planning introduced and supplied by the project until 1964).

To look further at the possible response of Khanna study families to differential rates of child survival, Wyon and Gordon compared the fertility patterns of women with varying child mortality experience. The first panel (Section A) of Table 4 classifies the wives ages 40-59 and of parity 6 and higher by the number of surviving children among the first 6 live births. Wyon and Gordon point out "that women who have the most surviving children from their first six live births had fewest live births beyond parity 6, a statistically significant finding" (ibid. p. 198). The difference is about one live birth less for women who lost none or one child among their first 6, when compared with women who lost 4 or 5 of their first 6. At first glance, as Wyon and Gordon note (p. 198), these data seem to support the hypothesis that low loss of children among low parity births "motivates parents to limit subsequent childbearing" (ibid). However, the differences here

TABLE 3 – KHANNA STUDY, INDIA : LEVELS AND CHANGES OVER TIME OF SELECTED MEASURES OF MORTALITY, FERTILITY, AND RELATED VARIABLES 1957-1968*

A. Mortality Measures

1. Crude death rate[a]

Years	Test group		Control group		Total population	
	Rate	Standard error	Rate	Standard error	Rate	Standard error
1957-59	18	± 0.87	15	± 1.07	17	± 0.68
1960-62	12	± 0.70	12	± 0.94	12	± 0.56
1963-65	13	± 0.71	13	± 0.97	13	± 0.57
1966-68	12	± 0.67	12	± 0.92	12	± 0.54
2. Infant and early child mortality-up to age 2 : Probability of dying within two years after birth						
1956-58[b]	240	± 14	200	± 18	230	± 11
1960-62[b]	160	± 13	140	± 18	150	± 10
1963-65[b]	140	± 12	140	± 17	140	± 10
1966-67[b]	140	± 15	150	± 22	140	± 12
B. Crude birth rate						
1957-59	38	± 1.3	38	± 1.7	38	± 1.0
1960-62	33	± 1.1	30	± 1.5	32	± 0.9
1963-65	34	± 1.1	32	± 1.5	33	± 0.9
1966-68	32	± 1.1	29	± 1.4	31	± 0.9

C. Other Related Variables

1. Age at marriage of women (in years)

Years	Test and Control Groups combined	
	Women emigration for marriage	Women immigration for marriage
1956-58	17.5	17.9
1960-62	18.1	17.6
1963-65	19.0	18.3
1966-68	19.8	19.4

2. Use of Contraception

	Methods of contraception				
Test group	Folk Methods[d] (including condom) only percent	Foam tablets with or without folk methods percent	Modern methods[e] percent	None percent	Number of women
1957	8	18	0	74	492
1959	12	16	0	72	554
1969	24	0	7	69	941
Control group					
1969	17	0	8	75	472

(a) Mean rate for specified years, per 1 000.

(b) Births in these years.

(c) Mortality up to age 2, per 1 000 live births. These rates are based on reported probabilities rounded to 2 decimal places.

(d) Includes abstinence, rhythm, withdrawal, condom.

(e) Includes IUD, vasectomy, salpingectomy, pills (oral steroids).

* *Source* : John B. Wyon and John E. Gordon. *The Khanna Study : Population Problems in The Rural Punjab.* Cambridge, Massachusetts : Harvard University Press, 1971, pp. 297-298, 301-302.

TABLE 4 – KHANNA STUDY : SELECTED RELATIONSHIPS BETWEEN CHILD MORTALITY AND FERTILITY, FOR WIVES AGES 40 TO 59 IN 1959, TEST AND CONTROL VILLAGES COMBINED.

A. Wives of parity 6 or higher, classified by survivors among first 6 live births

Survivors Among the 1st 6 Live Births	Mean Number of Live Births After Parity 6	Mean Numbers of Live Births, All Parities	Mean Number of Surviving Children, All Parities	Number of Wives
0	(3.5)	(9.5)	(2.5)	6
1	3.1	9.1	3.1	22
2	2.9	8.9	3.6	47
3	2.5	8.5	4.9	106
4	2.4	8.4	5.7	116
5	2.2	8.2	6.5	106
6	2.0	8.0	7.3	57

( ) = *figures based on a very small number of cases*

B. Wives ages 40 to 59 with selected numbers of early parity births, and child mortality experience, classified by subsequent live births and related indices.

Minimum Number of Early Parity Births	Deaths Among Minimum Number of Early Parity Births	Mean Number of Live Births Beyond the Minimum	Mean number of Total Live Births (cols. 1 + 3)	Mean Number of All Survivors	Number of Wives
3	0 or 1	4.4	7.4	5.0	391
	2 or 3	4.9	7.9	4.0	195
	difference	0.5	0.5	1.0	
4	0 or 1	3.4	7.4	5.8	299
	2 to 4	4.2	8.2	4.3	251
	difference	0.8	0.8	1.5	
5	0 or 1	2.8	7.8	6.3	224
	2 to 5	3.3	8.3	4.6	181
	difference	0.5	0.5	1.7	
6	0 or 1	2.1	8.1	6.8	163
	2 to 6	2.6	8.6	4.8	297
	difference	0.5	0.5	2.0	

Source : John B. Wyon and John E. Gordon. *The Khanna Study : Population Problems in The Rural Punjab.* Cambridge, Massachusetts : Harvard University Press, 1971, pp. 199-200, Tables 23 and 24.

are not great, and given the high levels of child loss before age 2, many of whom die as very young infants, it is fair to suggest that at least part of this differential can be explained by shorter periods of postpartum amenorrhea brought about by the cessation of lactation when an infant dies. Chen and Mosley (1974) advance this general argument, suggesting that extended periods of postpartum amenorrhea associated with lactation are extensive in countries like Bangladesh and India (17 and 19 months in some examples they give), and they suggest that the higher parity levels obtained by high-child-mortality couples can be attributed to a substantial degree to the shorter intervals of infecundity experienced by the wives in these couples.

Section B of table 4 reclassifies the wives ages 40-59 by numbers of early-parity births and by two basic categories of child death experience-wives who lost none or only one child, and wives who lost two or more children among the early parity births. The same general pattern emerges,: A slight tendency for a total number of live births when there is greater mortality among the early-parity births, but the differences average only 0.5 or 0.6 live births. This is hardly enough to support a child survival hypothesis. The principle effect seems to be that higher child mortality experience leads to a smaller total number of survivors in the Khanna study population.

C) Malaria Eradication and Health Programs in Sri Lanka

In Sri Lanka, formerly Ceylon, infant mortality declined rapidly after World War II, principally due to the control of malaria through spraying of DDT, resumption of food imports, continued extension of maternal and child health services to rural areas, and general "development". (Frederiksen, 1961 ; Newman, 1965 ; Meegama, 1967 ; Gray, 1974). Thus we do not have one specific program as in the earlier examples, but a large, and more general effort to reduce mortality with particular emphasis on the reduction of the incidence and prevalence of malaria. The levels of mortality decline were much greater in the less settled, poorly developed, dry zone areas where malaria was endemic than in the densely settled, more developed Southwest coast where malaria was non-endemic. Whereas the Island-wide decline of the average infant mortality rate between 1937-1945 and 1946-1960 was 45 percent, four districts in the formerly endemic malaria zone showed declines of over 60 percent (Newman, 1965). Sri Lanka's infant mortality rate dropped below 100 (92) for the first time in 1948 and below 60 (58) in 1959. By 1970, it was 48 (Department of Census and Statistics, Sri Lanka). The data base is not without problems, but its quality is sufficiently good to permit an initial review of the tempo and degree of possible fertility response to this very rapid decline of infant mortality to low absolute levels.

Sri Lanka is not a case study of infant mortality falling in the absence of development. By the 1953 Census, 69 percent of the population over 10 years were literate (Department of Census and Statistics, Sri Lanka). During the immediate post-War years, the Government, as a matter of social policy, embarked on a steadily more successful effort to make health and educational services available to the rural population. By the early 1960s almost all births occurred in hospitals or under professional supervision. Per capita gross national product increased rapidly from the end of the War until the early 1950s, when it plateaued. (Frederiksen, 1961). Finally, the suppression of malaria in the former endemic zone opened up much new land for agricultural development. The net migration into these areas and their subsequent rapid development has been well-described (Frederiksen, 1962 ; Abhayaratne and Jayewardene, 1967). It is in these areas that mortality fell so dramatically over a short period of time.

Fertility and mortality trends are seen in Figures 4, 5 and 6. Figure 4 shows national infant mortality rates and crude birth rates by year from 1937 to 1971, plus general fertility rates for women 15-44, and by year 1953-1965 for women 10-49. The sharp fall in infant mortality after 1945 is seen in the context of generally downward trend. The crude birth rate rose in the late 1940s and 1950s but fell consistently after 1959. The general fertility rate also began to decline around 1960. The data suggest that, on an Island-wide basis, fertility decline began about 10 years after infant mortality reached the level of 100 deaths per 1000 live births per year.

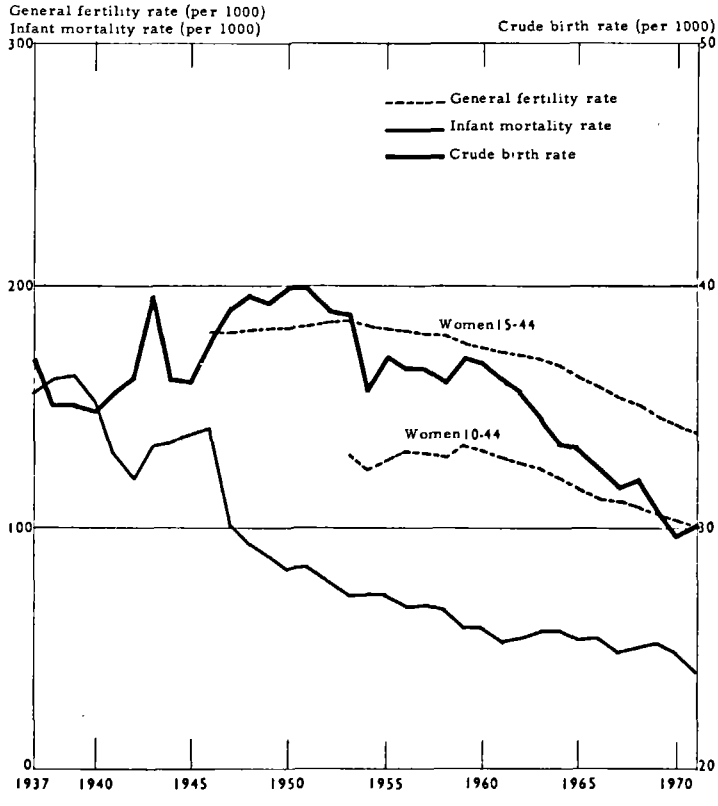

Figure 4 – Sri Lanka : Selected vital data, 1937-71.

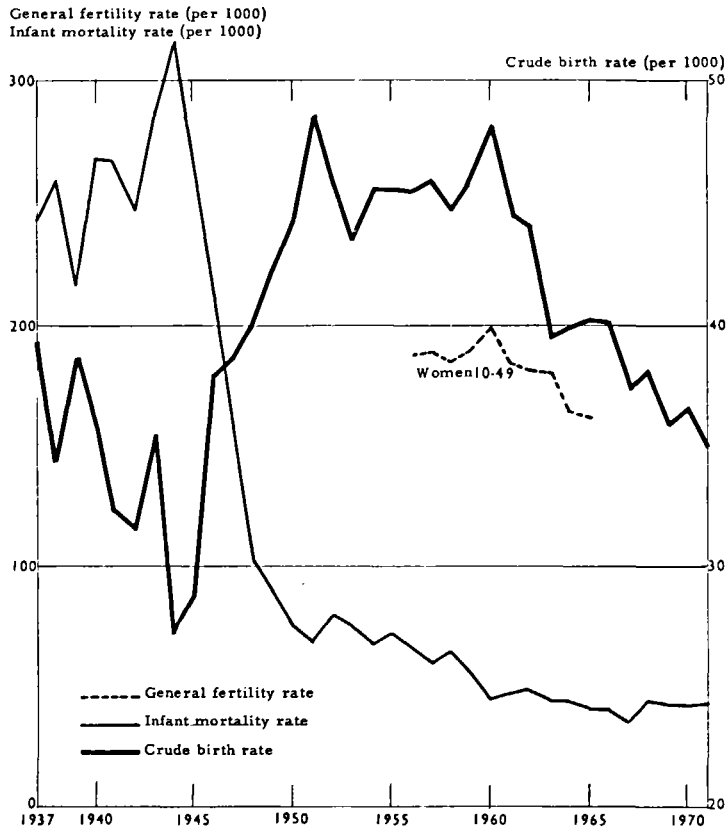

Figure 5 – Sri Lanka, Anuradhapura district, crude birth, general fertility, and infant mortality rates, 1937-71.

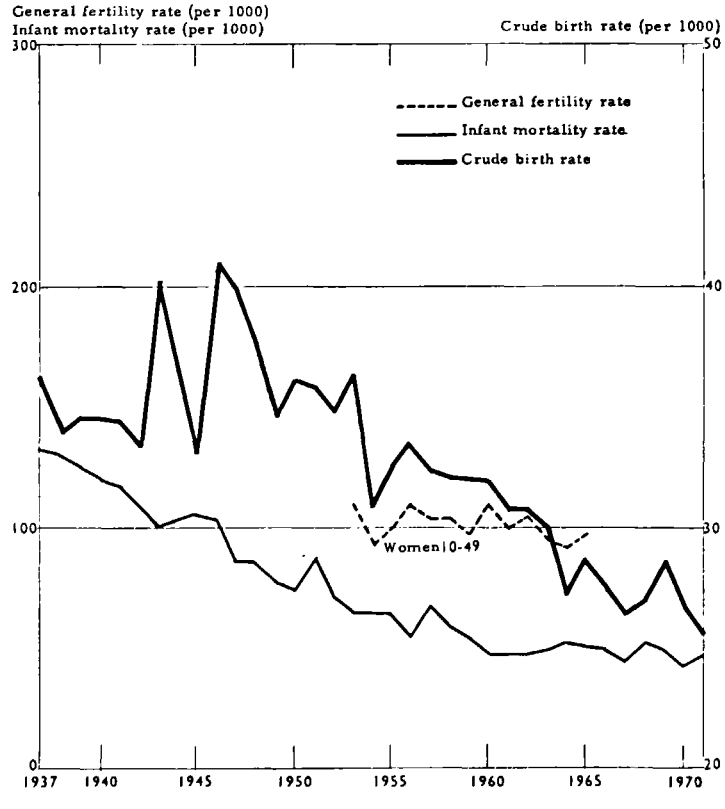

Figure 6 – Sri Lanka, Galle district, crude birth, general fertility, and infant mortality rates, 1937-71.

Previous analysis has shown, however, that the modest decline in the Sri Lankan birth rate between 1953 and 1963 was entirely due to demographic factors, principally marriage delay (Wright, 1968). From 1963 to 1968, some marital fertility decline can be shown, although marriage delay remained important (Wright, 1970). This suggests a lag of at least 15 years between infant mortality decline and marital fertility decline. Since 1968, the birth rate has declined more rapidly and there is increasing marital fertility decline.

In order to look at these relationships more closely, two of Sri Lanka's 22 districts have been selected for specific analysis. These districts experienced malaria eradication and health programs as part of the national effort. Vital data comparable to Figure 4 appear in Figures 5 and 6, although general fertility rates for women 15-45 have been omitted. Anuradhapura (Figure 5) represents the endemic malaria zone where mortality declined rapidly and was followed by substantial agricultural development. Anuradhapura is the largest of the four districts where average infant mortality declined over 60 percent from 1937-1945 to 1946-1960 and hence it may depict the trends in vital rates with more stability. In Anuradhapura there is no sizeable Hindu or Moslem minority group to complicate the interpretation of the vital rates.

Galle (Figure 6) represents the non-endemic malaria zone where almost two-thirds of Sri Lanka's population lived in 1946. It is located on the better-developed Southwest coast. Infant mortality and fertility were lower in the early part of this analysis, but average infant mortality nonetheless declined by 36 percent between 1937-1945 and 1946-1960. Except for sharing an overwhelmingly Bhuddist, Singalese population, the two districts are very different in their characteristics as the demographic changes progressed after 1946.

In Anuradhapura the infant mortality rate exceeded 300 in 1944 and dropped to 100 by 1947, and continued falling, although much more slowly, to 1960. Fertility appeared to increase through the 1950s, but finally began to decline in the early 1960s. The Galle district shows much less dramatic change. Infant mortality was half that of Anuradhapura's in the pre-War period. In Galle, fertility did not rise in the late 1940s and began to fall by 1955. Despite the sharp decline in infant mortality from very high levels, fertility in Anuradhapura began to decline only about 15 years later. In Galle, infant mortality was reduced less rapidly from a lower initial level. Fertility began to decline within ten years after the infant mortality rate first reached 100.

TABLE 5 – SRI LANKA : SELECTED DEMOGRAPHIC CHARACTERISTICS, ANURADHAPURA AND GALLE DISTRICTS, AND NATIONAL DATA, 1946 AND 1953.

	Population			Sex ratio : Males per 100 Fermales 1953	Percent Currently Married Women 15-44 1953
	Total Size 1946	Growth Rate 1946-1953	Density per Square Mile, 1953		
		(percent)			
Anuradhapura	139,534	64	55	135	85
Galle	459,785	14	804	97	56
Sri Lanka (total)	6,657,339	22	320	111	69

Table 5 presents selected, key differences in the two districts. The significant migration of men into Anuradhapura district to open up new lands is clear. In 1953, 85 percent of women in the reproductive years were currently married, compared with 56 percent in Galle. The difference in the proportion of women currently married accounts for the large gap in the 1953 general fertility rate between the two districts :

District	General Fertility Rate, 1953	
	Actual	Adjusted for Current Marital Status
Anuradhapura	215	175
Galle	155	191
Sri Lanka	186	186

The increased crude birth rate observed in Anuradhapura district thus appears to be an artifact and may obscure the beginning of fertility decline. Better birth registration in the former endemic areas after 1946 almost certainly contributed to the apparent birth rate increase.

When districts are ranked according to the degree of infant mortality decline in the 1937-1945 to 1946-1960 period and the extent of recorded crude birth rate decline 1940-1944 to 1965-1969, no relationship is apparent. Table 6 presents the position of 18 districts that did not undergo geographic division during the 30 year period. Incomplete birth registration during World War II may distort the relationships. However, comparing the change in the general fertility rate between 1953 and 1963 with the infant mortality decline produces a similar pattern.

TABLE 6 – SRI LANKA : EIGHTEEN DISTRICTS CLASSIFIED BY AVERAGE INFANT MORTALITY DECLINE (1937-1945) AND PERCENT CHANGE IN CRUDE BIRTH RATE (1940-44 TO 1965-69)

Percent Average Infant Mortality Decline 1937-1945	Percent Change in Crude Birth Rate 1940-44 to 1965-69					
	Increase	Decrease				
	0-9	0-9	10-19	20-29	30 +	Totals
	Numbers of Districts					
30 - 39	0	0	3	2	1	6
40 - 49	1	0	1	1	0	3
50 - 59	0	2	3	1	0	6
60 +	0	0	2	1	0	3
Totals	1	2	9	5	1	18

It appears that fertility decline in Sri Lanka lagged at least 10-15 years behind significant infant mortality decline and did not proceed rapidly. Even in an area (Anuradhapura) where infant mortality fell dramatically over a short period of time, fertility decline did not begin earlier. It is possible, however, that this area illustrating rapid change in mortality may be atypical. Rapid in-migration with the opening up of virgin land may have created a "boom" psychology and stimulated fertility. Certainly fertility was driven up by the high proportion of women currently married in the decade of the 1950s. It is also possible that recorded fertility before 1945 was too low both in Galle and Anuradhapura, especially the latter area, due to incomplete birth registration. A post-enumeration survey done after the 1953 Census suggested 12 percent under registration on an Island-wide basis, but did not give district figures (Department of Census and Statistics, Sri Lanka, 1953). By 1967, birth under-registration was estimated to be between one and two percent (Aponso, 1970). These are some of the methodological and measurement problems that must be faced when looking for relationships between infant mortality and fertility changes.

Is this fertility response a rapid or slow adjustment to changes in mortality ? Given the level of development in Sri Lanka compared to other countries of the region it seems a slow response. However, in the then recent historical experience of fluctuating high infant mortality (1935-1936) the response might be considered fast. There are no historical data on how people in Sri Lanka perceived the mortality decline in personal terms. It seems reasonable to suppose that some time was required before couples became convinced that the new conditions were likely to be stable. In the context of the late 1940s and 1950s "development" may have exerted a pronatalist effect, blurring the perception of mortality decline. Expansion was the order of the day.

There was no serious official concern given to rapid population growth in Sri Lanka until the mid-1960's. Even then the public family planning program developed slowly and there was little, if any, official support for fertility reduction, or any efforts to sensitize the population to the new demographic conditions through the mass media. With stronger public programs, as now exist in several countries (including Sri Lanka), one might speculate that fertility reduction could follow significant mortality decline more quickly than was true in Sri Lanka 10 to 25 years ago. The Etimesgut project data suggest a quick response, but as noted earlier with the "lag" period too short to be meaningfully interpreted in that setting. Clearly the question of fertility response to infant mortality decline does not have good answers.

D) Other Projects

1. Cholera Research Laboratory. The Cholera Research Laboratory was established in Dacca, Bangladesh in 1960 to develop measures for the prevention and eventual eradication of cholera. (The information on the Cholera Research Laboratory presented here is based on Mosley, et al., 1970, and personal conversation with Dr. Wiley H. Mosley). By 1966 the study area covered 132 villages with a total population of 112 000 in

Matlab Thana, Comilla District, East Pakistan. In this study area, field workers made daily household visits to make inquiries about the occurrence of acute diarrheal illness and ambulance service was provided to a field hospital for treatment of severe, acute diarrheal cases. A census was conducted in March and April of 1966, and from that time a field staff maintained daily surveillance over the population.Records were kept of births, deaths, and migration, providing reliable figures on infant mortality and fertility over a seven year period.

Trends in the infant mortality rate and the total fertility rate from 1966-67 to 1972-73 are shown in Table 7. Neither fertility nor infant mortality shows a marked decline over these seven years. Infant mortality in 1966-67 was measured at 111 per thousand and remained between 124 and 131 throughout most of the period. This is probably because the treatment of cholera tends to affect children over age one. The diarrhea suffered by children under age one tends to be chronic and related to malnutrition while older children suffer acute diarrheal illness. The total fertility rate fluctuated between 5.9 and 6.7 except for 1972-73. The only remarkable fluctuations in the time series reflect the disruption of the 1971 war in Bangladesh : in 1971-72 infant mortality rose ; also the number of conceptions declined, producing a lowered total fertility rate in the following year.

TABLE 7 – TRENDS IN THE INFANT MORTALITY RATE AND THE TOTAL FERTILITY RATE, MATLAB THANA, BANGLADESH, 1966-67 TO 1972-73.

Rate	Year						
	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73
Infant deaths per 1000 live births	111	125	124	128	171	147	128
Total fertility rate per woman	6.7	6.3	6.3	6.0	5.9	6.0	5.5

Source : Dr. Wiley H. Mosley, personal communication.

The Cholera Research Laboratory is of particular interest since it provides high quality time-series data on births and deaths in a population of 112 000. However, the empirical record from the Cholera Research Laboratory shows no effect on infant mortality while the program for the treatment of acute diarrheal diseases has been in effect.

2. The Narangwal Experiment in Health and Family Planning. The Narangwal experiment began in the Punjab in 1965 and continued until 1974. The program was conceived as a research project to test the effectiveness of integrating family planning services with differing packages of health services. The project was divided into four test areas, each with a different set of health services plus family planning services, and each with a population of about 5 000. A fifth area served as a control.

One of the important research hypotheses that the Narangwal experiment set out to investigate was the effect of a decline in child mortality on family planning acceptance. Early results indicated that infant and child mortality did decline in the villages where child care was provided, and the researchers expected to see an effect of reduced infant mortality on fertility.

Taylor (1973) suggests that "it will not be easy to prove the child survival hypotheses because of the complexity of the multiple variables involved. For one thing it is well known that family planning itself contributes to improving child health ... To test the hypothesis we must try to separate out the [effect of the family planning program] from attitudinal changes related to expectations of child mortality in these villages".

Time series data were collected on fertility and mortality. In addition, the study included surveys on attitudes and beliefs about child survival. The results of these inquiries are expected in the near future.

3. The Danfa Comprehensive Rural Health and Family Planning Project, Ghana. The Danfa program began in 1970. It provides maternal and child health care, health education and family planning services to a rural population of 50 000 in an area 20 miles north of Accra. Information on events will be collected by several sources and the investigators will evaluate the effect of the program on infant mortality and on fertility. In addition, 25 % of the area is to serve as a longitudinal cohort from which information will be collected on morbidity, child care, maternal practices and knowledge, attitudes, and practices of family planning. The first interviews were conducted in 1970 and reinterviews have been scheduled for 1974 and 1976.

4. Additional Studies. Other programs are just getting underway, including the Maternal and Child Health and Family Planning projects under the Taylor/Berelson program in Turkey, the Philippines, and Indonesia. In these projects, time-trend data will be collected on fertility and infant mortality.

Other studies, while not based on special mortality reduction programs, have investigated relationships between infant mortality, fertility and related variables, e.g. Rutstein (1971), Adlakha (1970) and Sullivan (1972).

II. Measurement Problems

Certain measurement problems have been listed in the project descriptions. These and other difficulties are discussed below.

A) Need for time-trend data.

This is a methodological problem in a general sense. It is difficult and costly to set up specific mortality-reduction projects that can continue for several years, and in which careful measurement processes are built into the project design and then carried out by means of high quality data collection procedures. Hence, existing data can and should be utilized whenever possible, with due attention to problems of under-registration and under-reporting. Also, in addition to specific projects, perhaps we should turn the question around, that is look at time-trend data for countries or areas where such data exist (as in Sri Lanka) and seek to determine what inputs may have caused any changes noted in fertility and infant mortality.

B) Survey and/or registration measurement systems improving or diminishing in quality over time

It cannot be assumed that measurement instruments applied in particular situations will be consistent over time. For example, an apparent decrease in infant mortality could be due to an infant mortality measurement system that is decreasing in quality. Vital rate estimation procedure projects may start off with difficulties that get solved, leading to more complete measurement of vital events, but then supervision and control can become lax so that completeness declines. Such changes in data-collection quality are often unknown, and the greater this is so, the less that can be said about actual trends in vital rates. Dual-system sample vital rate measurement systems provide one approach to this problem, by using each system as check on the quality and changes in the other system, but dual systems involve more work plus a matching operation.

C) Obtaining information on early infant deaths

A particular measurement problem is "catching" in the measurement system those live births that are followed by death in the neo-natal period and especially in the first few days after birth. Stoeckel (1972) has shown that contrary to impressions about the timing of infant deaths in developing societies, the distribution of infant deaths throughout the first year of life in a rural thana of Bangladesh is not greatly different from western infant mortality patterns, i.e., a high proportion (61 percent) of neo-natal deaths among all infant deaths.

From the standpoint of the parents in such settings, it is often viewed as meaningless, for example, to go several kilometers, and then wait while forms are filled out, in order to officially register a child who died within a few days or even weeks of its birth. For data collected by special registration or survey systems, the recording or reporting of such events presents a special challenge that involves precise instructions, substantial and careful control and supervision of field operations, a willingness to keep searching for additional such events (among others), some procedure for an independent check on potential missed events, and a general working assumption that in the best of circumstances (and in the absence of a perfect or near perfect civil registration system) a moderate to substantial number of births/early deaths are likely to be missed and hence special attention is required to bring this number down to a minimum.

D) Perceptions of changes in infant and child mortality, and the "lag" problem.

These are related to the child-survival hypothesis, which does not seem to be supported by the empirical data available from the special mortality reduction programs reviewed here, except the Sri Lanka data, and even there the timing is a decade or more during which time many other things were changing. From the measurement standpoint the perception of change in infant deaths is particularly subject to response error (e.g., psychological blocks regarding the memory of unhappy experiences), response bias (e.g., it is not good to talk about child deaths, or the treatment of an early infant death as a non-event), and the mixing of personal experience with community experience when trying to measure perceptions. Also, there are the general problems associated with measurement of attitudes and perceptions, with instrument problems and interviewer error more likely to cloud the true picture.

E) Other societal changes and influences affecting both infant mortality and fertility.

The causal relationships are not at the zero-order level, with exogenous factors affecting fertility and mortality, and also perceptions about mortality. This suggests the collection of other sets of data, such as urbanization trends, modernization measures, availability of fertility-control methods, changes in sanitation practices, general levels of nutrition, and so on.

F) Lactation and postpartum amenorrhea affected by infant mortality, and effect on subsequent fertility behavior.

This part of the analytical study of relationships between infant mortality and fertility is beginning to receive attention. Lactation questions are not difficult to add to surveys (although a caution is that women may not know how much they lactate nor how often they breastfeed their children), and a question on return of menses is also possible in most circumstances. Recall problems are present, but these questions could be asked more often in studies of infant mortality and fertility. Other problems here are the effects of nutrition on lactation, and on amenorrhea.

G) Effects of fertility-reduction programs and inputs on infant mortality/fertility relationships.

The problems include measuring fertility control inputs, what proportions of these are replacements (perhaps more efficient methods) for earlier attempts at fertility control, and measuring the degree to which fertility control affects infant mortality by increased spacing and the possible effect of spacing on the nutritional status of mothers and children.

The solutions to these and other measurement problems that arise in the study of relationships between infant mortality and fertility deserve more attention.

3. Summary

The empirical record on specific mortality-reduction programs shows that some projects seem to be able to reduce infant mortality. The available data are scanty, especially with regard to time-trend data. The reduction of fertility following a decline in infant mortality varies from a very few years in the Etimesgut project to a decade and more in Sri Lanka, but these efforts are not comparable, with many and different other variables involved in each setting. One of our initial questions was : is there evidence in these studies that mortality reduction by itself is a sufficient condition for fertility decline ? The data summarized here do not permit a positive answer. There are slight indications that fertility declines if infant mortality declines, but other factors are changing in each case so that a statement of causal relationship is not warranted.

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FINAL REPORT
(Summary of Discussions) *

by Rev. Francis C. MADIGAN, Director
Mindanao Center for Population Studies, Cagayan de Oro City (Philippines)

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Conceptualization

For purposes of this seminar, infant mortality was defined in its usual sense as the ratio of child deaths before first birthday to the number of live births during the time interval specified. However, in order to analyze more appropriately the volitional effects upon fertility of infant and child mortality, child mortality was defined not only in its usual sense as relating to deaths of children 1-4 years of age, but also in different contexts as mortality relating to children 0-4, 0-9, 1-9, 0-14, or 1-14. In the following, attempts have been made to specify the sense used by participants on different occasions. However, this was not always practicable to do and therefore caution should be exercised in interpreting suggestions, approaches, and conclusions relating to "child mortality", unless the sense is clear from the context.

(*) Only matters raised by discussants and by participants during the open forums are summarized here. Unless discussed at some length during open forums, material in the background papers is not included on the assumption that readers will have already examined these.

Differences in mortality are caught much better by division at age one month than by division at age one year, one participant argued persuasively. Therefore, abolition of the traditional division of the mortality of children into infant mortality (0-1) and child mortality (1-4 years of age) and substitution of a division into 0-1 month and 1 month to 3 or 4 years was advocated.

Difficulties admittedly are found in the traditional distinction into under one year of age and ages one to four, and the suggested distinction has much intrinsic merit in the ideal order. Nevertheless, observed other participants, neo-natal mortality is probably the least reliable measure of death in countries with low quality data. Further, the traditional distinction is found in data from the past, and many nations present data today in a form that permits only the traditional distinction. Further, while declines in child mortality between ages 1-3 may not be large enough to exert much influence upon levels of fertility (as had been stated), it was observed nevertheless that cumulative effects of mortality in childhood between 1-9 years of age can be substantial, and an index of mortality covering ages 0-4 or 0-9 presents greater opportunities for observation of parents' perception of child loss and parents' tendency to replace such loss. It was recognized however that an index covering ages 0-9 requires careful controls to prevent birth concentration effects upon child mortality from contaminating measurement of child mortality effects upon voluntary restriction of fertility.

The focus of the seminar reported here was specified to be the volitional effects of infant (0-1) and of child (1-9 years of age) mortality upon levels of fertility.

A familiar distinction, between aggregate and individual data, is important in the present subject matter. This distinction between macrolevel studies, between data which study large units such as populations of a district, a province, or a nation and data which study individual families is not directly concerned with size of sample (although aggregate study samples are almost invariably larger), but rather with focus or lack of focus upon the responses of individual families to situations like loss of a child. Aggregate study results might be expressed, for example, in terms of birth rates while family studies might be expressed in terms of parity progression ratios, that is, the proportion of women of a certain parity who go on to have a subsequent live birth. Women by parity might be sub-classified into those with no deceased child and those with one, two, or three deceased children.

Four kinds of effects of infant and child (ages 1-9) mortality upon level of fertility were distinguished at the seminar. These were : biological-physiological effects (involuntary influences largely operating through abbreviated breast-feeding and consequent cessation of postpartum amenorrhea), replacement effects (volitional replacement of a deceased child), insurance effects (volitional behavior attempting to anticipate child deaths), and societal effects (volitional behavior induced by societal norms or reorganization of previous societal norms reflecting response to infant and child mortality levels) which frame the sociocultural context of reproduction in which couples find themselves.

The latter three concepts may also be expressed as personal experience of child loss (concerned with the replacement effect), fear of such loss without personal experience (concerned with an insurance effect), and community perception of change in levels of mortality (concerned with societal effects). Problems of measurement and especially of scaling fears of loss and community perception of loss may present themselves whether the data were gathered by direct or indirect questions.

A spurious effect of infant and child mortality may also be distinguished. This effect of fertility upon mortality, although operating in a reverse direction from that upon which the present seminar focuses, can be misinterpreted as a volitional effect of mortality upon fertility. This effect can be due to "birth concentration" which may be described as the bearing of two or more children within a shorter interval of time than advisable for health reasons. While it is not yet possible to define concentration of births more precisely than this because its mode of operation upon mortality is still not clearly understood, birth concentration is widely recognized to increase the mortality risks of children exposed to it.

Interbirth intervals were defined as the number of months and/or days between actual childbirths.

No satisfactory definition of rural residence in contradistinction to urban was reached at the seminar, and participants sounded the caution that researchers comparing populations under this rubric should be careful that the contexts are at least substantially similar. For example, in parts of Africa many women are classified by the census as "urban" if their husbands work in towns or cities, although in fact the wives remain continually resident in the rural areas where the husbands come from.

Several concepts proved useful in the discussion of historical studies or of modern area studies. One, a "threshold" hypothesis, attempts to explain the often observed time lag between a decrease in infant and child mortality and a subsequent fertility decline by the need for the mortality decline to become large enough to make the people concerned realize they can and should have fewer births to satisfy their family goals. Before this threshold (of a large enough mortality decline to impress the people) has been crossed, the hypothesis states, fertility change may be minimal or non-existent.

A second seminar concept of possible methodologic and analytic value was a "carelessness" hypothesis. Used as a null hypothesis, it would attempt to explain both high fertility and high child mortality as effects of a third variable, carelessness. Women whose children die for lack of appropriate attention may also prove equally careless in practising family planning.

Also of possible utility was a third distinction between mortality declines due to introduction of externally developed technologies such as epidemiological techniques, and mortality declines based principally upon bettered sociocultural and/or economic conditions internal to the society.

Finally, the concept of "stopping rules" may be useful in the present topic. By a stopping rule is meant a cultural principle indicating a permissive, appropriate, or more compulsive point at which number of living children in the family is viewed as "enough". Not all cultures of course have explicit stopping rules.

Levels of Study

It was felt rather generally at the seminar that analysis of aggregate data is not as promising for the study of the relation of infant and child mortality upon fertility as is analysis at the micro or family level.

The phenomena under study can have two-way interactions. High child mortality can spur high fertility and high fertility can occasion high child mortality. These effects cannot easily be separated in cross-sectional aggregate studies.

Can simultaneous relationships of mortality to fertility be tested by use of longitudinal aggregate data? It would appear from Korean data used to exemplify the argumentation that only individual data can perform this function. Nevertheless, longitudinal trends in child mortality and fertility still remain powerful tools to indicate an association between these variables in the society as a whole. Changes in infant and child mortality (1-9) may relate to age of women at first marriage and to other intervening variables. Therefore, much can be learned from aggregate studies, which in our present question are needed to illuminate background factors and possible sources of bias.

The importance of societal mechanisms is the manner in which they keep average completed family size near a certain norm or average size ("stopping rules").

Macura's paper in the present seminar upon estimation of retrospective time series of child mortality, as well as research similar to this on retrospective fertility estimation, is important in this context because it makes it possible to derive aggregate–level measures of mortality and fertility over time, provided the data are not grossly biased. (One of the participants cautioned however against overdependence upon models. He pointed out that methods used to correct fertility and child mortality may themselves be correlated). Retrospective data collected in some countries, particularly in the African countries, are defective to a great extent, however. Brass has done a paper relevant to the subject on the correction of errors over time upon time series developed from maternal histories, and work is now going on upon this problem at Princeton University.

In fact, aggregate data are the relevant level for studying societal effects. If the societal level effect operates through norms shared by populations within culturally homogeneous areas, one participant observed, it may even be advisable to aggregate data into larger units rather than to disaggregate them into smaller areas, making the relevant unit of analysis the entire cultural area which may extend to regions or even countries rather than just provinces or towns.

Another participant however entirely disagreed with choice of large areas as units of ecological relationship analysis. Obviously, small areas can be reaggregated but large areas cannot be disaggregated, and in his view the only justification for not choosing the smallest units possible would be cost since the higher the heterogeneity, the less useful the analysis is likely to turn out.

Briefly, then, the approach favored for studying volitional effects of infant and child mortality upon level of fertility is that of family studies, that is, through analyses of individual fertility and child mortality. While prospective and quasi-prospective studies were recognized as more conclusive because of control possibilities, especially with large-size samples, retrospective family studies with relatively small samples were foreseen as likely to be more frequent in view of cost factors.

As put by one participant, the effect of many relatively small studies which point in the same general direction, despite execution in widely differing areas and cultures, is the most likely source of firm answers to the seminar questions.

Biases of Retrospective Studies

How biased are retrospective studies likely to be by recall and other errors of the data or of interpretation ? By way of answer, the measures used in each study as indices must be looked at critically in order to assess the degree to which they may be affected by stochastic biases, post-partum infertility, effects of fertility (through "birth concentration" effects of pregnancy upon nutrition of the earlier child, lessened care and attention shown this preceding child, etc.) on mortality, and other biases. Simulation model results have shown surprisingly large amounts of such "nuisance effects" and if not guarded against, such biases may weaken, if not invalidate, the conclusions of some family studies. In general, biases or nuisance factors which give trouble in computer simulation are twice as likely to give trouble with observational data. On the other hand, as already observed, repetition of many family studies, all or most indicating a relation in the direction hypothesized, especially when carried out in diverse lands and circumstances, would bring powerful support to the hypothesis.

Several participants thought that while some memory errors were unavoidable, attempts can be made to minimize recall bias. For example, the WHO coordinated survey being carried out in nine countries separately analyzed the last pregnancy where memory errors are minimal. In India, a longitudinal study two years in length (in connection with the same coordinated WHO survey) with six weeks' periodic questioning was carried out to correct memory error in the retrospective studies.

Further, recall of births and deaths has been studied in the southern Philippines by the Research Institute for Mindanao Culture (RIMCU) of Xavier University. Results indicate that urban recall errors at 18 months seriously exceed those at 12 months, but that the difference between urban recall at 6 and 12 months is not great, nor is the difference between rural recall at 6 and 18 months great. The study suggests that women do not so much forget children who died 12 to 18 months ago as place them in incorrect time relation to the present (shifts across the time boundary in either direction).

A participant expressed rather strongly his view that the retrospective studies of the World Fertility Survey (WFS) on the relation of infant and child mortality to fertility would hardly justify their costs because their sample sizes, a few thousand cases, would mean shortage of cases to cross-classify or otherwise distribute into cells.

Others however did not sympathize with this view and felt that the WFS surveys might throw considerable light upon relationships between child mortality and level of fertility, especially if, despite differences of countries and cultures, the results of most WFS studies should point in the same direction. The WFS schedules and sample sizes, it was observed, can also be modified by particular countries. All agreed however that it would be of great advantage if the WFS data (which will begin to accumulate in a year or so) could be so used through appropriate methodologies and analyses as to establish clearly what effect conditions and changes of child mortality have upon reproductive behavior.

A powerful new method, thought one participant, is at hand to increase the usefulness of retrospective studies, namely, the Cho-Grabill Own Children approach. If the census of a country should include several questions required for the methodology, if the proper mortality data is available, and if age reporting is relatively accurate very large size samples would become available, which would permit control over many sociocultural and economic variables while providing abundant cases to fit cells of the analysis.

Measures, Techniques, and Methodological Observations

It seems desirable, observed one participant, that all basic assumptions of research be carefully explicitated in CICRED-inspired studies upon the current seminar topic. This might well include assumptions relating to choice of the topic of research.

Indices used to measure infant and child mortality have been various. Among these have been infant and child mortality rates strictly defined, death rates under 5 (both central and life table types, i.e., ${}_5M_0$ and ${}_5Q_0$), death rates under 10, and even under 15, number of child deaths by parity of mother, standardized proportions of deceased children by parity of mother, and number of infants and children who have died in relation to median interval from their own to subsequent birth.

It was asserted by one participant that for study of biological and replacement effects, death before 5 years of age is a better index than death before 10. Another participant, however, while agreeing that dangers of reverse-effect biases (fertility effects upon infant and child mortality) were greater with older children, argued that reverse-effect biases could be prevented and that being so, deaths before 10 or even 15 gave a better and more substantial picture of infant and child mortality effects upon level of fertility.

Among indices used to measure fertility have been crude and more specific birth and fertility rates and ratios, parity progression ratios, completed family size, median intervals between births by parity, average pregnancies per woman and total pregnancies per woman at ages 40-44.

In calculating mean length of interbirth intervals, it was observed, the arithmetic mean does not seem the right measure to use because of spacing variations. The harmonic mean on the other hand can handle spacings more appropriately.

Some of the techniques used to compare infant and child mortality with fertility have been total, partial, and multiple correlation, zero and higher order linear regression, curvilinear regression, parity progression ratios by women with no child, one child to three or four children lost, and median intervals between childbirths by parity by age of woman.

With regard to measurement of voluntary effects of infant or child loss upon fertility, numerous points of caution were raised. First, was the difficulty of using stable population theory and/or model life tables in connection with estimates of fertility and then correlating birth and death indices. Since the stable population estimate and the model life tables include mortality considerations, correlations between fertility and mortality estimates will be affected. In addition, model tables may lead the unwary user to assume a decline in mortality at 0-1 and 1-4 years of age which does not actually exist in the study population (because of graduation).

Secondly, it is important to study carefully the methodology to be used to measure impact of an infant or child death upon birth interval and upon the subsequent child birth. If one has chosen 0-9 years of age as a an index of child mortality and if a child dies at age 8, it seems unlikely that his death will affect length of birth interval between his own and the subsequent birth, although it may shorten the interval between the last birth before his death and the birth subsequent to that.

With regard to studies with low coverage of infant and child deaths, the common point was again remarked that if, e.g., coverage is known to be about 70 per cent, bias cannot be estimated by negative knowledge (the 30 per cent are not known to be a-typical) but only by positive knowledge (the 30 per cent are known to be typical or the extent of non-typicality is known).

Finally, consistency of differences in child mortality effects over time upon fertility may appear much more impressive than they actually are if measurements are repeated upon the same women. The consistency in this case is of course at least partly due to repeated measurement of the same experience, not independent experience.

Methodological Observations. At various points during the seminar, helpful observations were made upon methodology. These remarks tend to be rather disparate in subject but are grouped together for convenience in this and several following paragraphs. Several participants pointed out that the useful element of slope (in connection with correlation and regression analysis) should be kept in mind in connection with the seminar topic. On the (unreal) assumption that replacement of deceased children is complete, if the expected slope is considered, it is clear that the influence of mortality upon fertility is likely to be swamped by other influences at the aggregate level. For example, given infant mortality ranging from 100 to 200 infant deaths per thousand live births, complete replacement of children might mean a crude birth rate as high as 36 instead of 33 births per thousand (without replacement), if the same proportions are preserved in mortality and fertility per thousand. That is, major differences in infant mortality would be associated with minor differences in fertility even at maximal replacement at the family level. This is probably why such diverse results are obtained in terms of correlation at the aggregate level. The expected relation is weak and the slope can easily be buried beneath other characteristics. Yet this does not mean that a real influence is not present. Further if we get a larger slope than this, the implication is that societal level effects are operating.

Data from the 1906 French census was cited in order to examine the relation of level of infant mortality and completed family size. The conclusion was that this study and other evidence, e.g. Mormon studies, suggest that level of child mortality is more related to final family size than to birth order. The higher the infant mortality, the larger the completed family size. By 1906, contraception was widely practised in France, a point which emphasizes voluntary aspects in completed family size in these data.

Findings like lower parity progression ratios for couples who had experienced a death than for those who had not (Rutstein-Medica data for Peru and Colombia) are questionable. The explanation offered of health problems which were responsible for both the child deaths and the lower fecundity of these women does not help much. It does not answer the question why one finds such effects in one country but not in another. A possible answer is supplied by diseases which decrease fecundity at the same time that they cause increase in child mortality. Such are congenital syphilis and malaria. In India, in areas which had been endemic for malaria, it was observed that fertility increased slightly after malaria had been controlled.

One participant felt that study of replacement effects demanded that parity progression ratios of families with (n) children who had experienced no infant or child mortality should be compared with parity

progression ratios of families with (n) children who had had an (n + 1)st child but had lost it through death. The comparison of families with (n + 1) children without a child death with families with (n) children because of a child death seemed to him a less valid and fair comparison. If one assumes that (n) children give their parents a certain amount of satisfaction (y) while the (n + 1)st child gives a different and perhaps lower amount of satisfaction (z), then the probability of replacement (P_z) is different (and often less) than the probability of replacement (P_y). Two participants disagreed with this suggestion however.

Dichotomizing the experience of the previous child by survival or by death, and associating each experience with subsequent fertility in terms of average interval to next birth is one measure that has been used advantageously to meet the problem of how to prevent effects of birth concentration (associated with higher mortality) from contaminating measurement of voluntary effects of mortality upon fertility. Another is the number of child deaths by parity of mother up to parity three or four.

A measure to distinguish "excess fertility", i.e., the voluntary effects of infant and child mortality upon fertility was suggested in Table II of the Lery-Vallin paper as :

$$\frac{\text{Column 1} - \text{Column 2}}{\text{Column 2}}$$

A participant suggested as an alternative measure to this a measure which he felt was more indicative of the extent to which families actually replace a dead child, and which would eliminate the "celling effect" produced by the impossibility of exceeding 1 (unity). He used the alternative measure to demonstrate (from Table III of the paper) that farmers actually exhibited larger replacement effects than did professionals. The measure was :

$$\frac{\text{Column 1} - \text{Column 2}}{1 - \text{Column 2}}$$

However, not everyone (including the authors) agreed that the new measure was superior to that suggested in the paper.

Bias may reverse in direction if controls are used and it was observed that it is well to keep this in mind for interpretation of results. This of course is a general phenomenon not confined to the present material. The factors to be controlled in human sciences rarely can be controlled completely and therefore partial controls through indicators rather than the exact variable to be controlled, must be employed. As a result, the element not relevant to the characteristic one wishes controlled tends to vary in random fashion, and the stochastic effect produced tends to reverse the direction of bias from that of the uncontrolled variable.

When underreporting of infant deaths occurs, the magnitude of the replacement effect is artificially reduced, observed one participant, not artificially inflated as another participant had assumed. A woman who has actually lost a child which is not reported is placed in the no-child-loss category, and if she actually replaces the deceased child, then average subsequent fertility of the no-loss group is artificially increased while replacement effects are decreased.

It was observed that the plotting of child mortality against age of mother at first marriage will yield a U-shaped curve. Therefore a participant felt that this curve would not be appropriate for the study of child mortality as a function of mother's age at birth of child. However, another participant pointed out that appropriate analysis could still proceed by dichotomizing the observations into two segments by mother's age at child birth, e.g., 15-30 and 30 and above, and then by analyzing separately each of the two segments.

It was likewise observed that the effect of fetal mortality on subsequent fertility appears to have a tendency towards a U-curve distribution. Pregnancy parity progression ratios tend to be low when no or many fetal deaths are experienced.

Discriminant analysis might well be used to explore determinants of fertility, suggested one participant. Division of units of study into groups classified by fertility, by mortality characteristics, or by relationships would make it possible to look for measures which could distinguish between these groups and thus to define the conditions which imply the presence of the child mortality-voluntary replacement effect (or the "insurance" effect). Multiple regression or discriminant analysis however should be employed with care, observed another participant. While multiple regression might indicate that child mortality explains most of the variance in fertility, it may also be possible to interpret the same data to mean that fertility changes can explain most of the variance in child mortality. The problem is to determine whether the path of interaction leads from mortality to fertility or from fertility to mortality. A mechanism may exist through which high fecundity and high child mortality are biologically related. If so, analysis could not distinguish such biological effects upon replacement from volitional effects, except perhaps by such second order distribution studies as are alluded to in the Brass paper. Given mainly volitional effects, the form of the distribution of numbers of child deaths by age and parity of mother should be influenced in different ways than if the effects had been mainly non-volitional. For example, such an approach might be used to separate the effects due to

"carelessness" of some women and the effects due to deliberate "replacement" or "insurance". However, such effects might possibly be more easily separated by gathering supplementary data.

The results of correlation analysis on the aggregate level (particularly zero-order correlation) were observed very closely in numerous study results by one of the participants. Particularly because of rough measures such as the crude birth rate to measure fertility, he concluded that correlation analysis of mortality influences upon fertility is likely to yield non-reliable results, particularly when fertility decline lags behind declines in infant mortality and lag correlation coefficient methodologies are not carefully worked out.

Another participant supplemented this conclusion by observing that despite the frequent mention at the seminar of correlation and regression techniques used in various studies, the inadequacies of these techniques for use in study of mechanisms of such dynamic and complex relationships as the seminar topic are so obvious that some other statistical approaches should be adopted or worked out.

In this connection, one participant suggested that partial correlation and regression coefficients should be standardized. He suggested this be accomplished by division of the partial coefficient by the standard deviation of either the independent or the dependent variable (whichever in context would be more appropriate).

Techniques of multivariate analysis are becoming increasingly popular in studies of the present question, and are out-distancing the conventional cross-classification and standardization approaches. Multiple-stage, least-squares regression techniques have been employed in some models of the child mortality-level of fertility relation, but more recently multiple classification analysis has begun to dominate the scene. It may be the most effective way of handling the type of data dealt with in the relation under discussion and offers many advantages over rival techniques, particularly earlier ones. It utilizes dummy variables ("in" or "not in" categories), makes no assumptions of linearity unlike multiple (linear) regression, and is very flexible. Path analysis may also prove useful for study of the relationship of mortality to fertility.

One of the problems at present of use of multiple classification analysis is the limitation imposed by computer programs which can handle only additive effects. However, a colleague of Professor Brass, Professor Osborne, has recently developed a multiplication multiple classification program. This better fits the data into the subgroups in many cases. The program thus far has been applied to study the effects of mother's age, parity, and birth spacing upon still-births and the components of child mortality.

Control Over Intervening Variables

Failure to control sociocultural and economic variables like mother's age and education, occupation of main breadwinner, and socio-economic status of family can result in data without comparability which are incapable of pooling. Urban and rural should be defined in some consistent way to assure comparison of similar units cross-culturally.

While cross-cultural and cross-national studies were urged where such comparisons of family data are made, great care must be taken in conceptualization of the family. The stem family of Europe, the joint family of India, the patriarchal family of pre-revolutionary China, and the extended family of the Philippines, for example, must not be aggregated together since they represent family types that differ structurally. Such diverse types of extended families can be expected to affect demographic and related social behavior differentially, such as age at first marriage, marital customs, and the value of children. For these and similarly cogent reasons, emphasis was again and again laid upon the importance, not only of statistical and demographic considerations, but of controlling for important sociocultural and economic variables. Probably no other theme was as repeatedly underscored during the seminar.

Much more careful usage of sociological methodology in the study of volitional effects of child mortality upon fertility was advocated by several participants. Depth interviews and better conceptualization of sociocultural and economic variables were seen as part of the strategy for attacking the problem. Evidence is absent from the European historical studies, one participant observed, that declines in childhood mortality are sufficient in themselves to trigger direct falls in fertility, without the assistance of other intervening factors. Such declines in childhood mortality may however be part of a complex of contributing causes, especially if the threshold hypothesis is kept in mind.

Stressed in this connection was the importance of family-size norms and expectations among other sociocultural values and attitudes in connection with a "replacement" or an "insurance" effect. Among such sociocultural and economic considerations many felt that education of mother played the dominant role. With regard to questions on desired/expected best family size, it was urged that in some cultures, the sex composition of surviving children may have considerable influence upon decisions affecting further fertility. Another distinction urged was that between populations in which a substantial proportion of married couples practise contraception and populations without such a substantial proportion either because contraceptive

knowledge is largely absent or contraception for some reason is not practicable at time of study. Age at marriage was mentioned as a societal mechanism regulating family size (i.e. age at marriage is raised if child mortality falls low and the converse), although it was realized that societal pressures upon nuptiality and fertility are not likely to change rapidly nor therefore to change average family decisions within short periods.

To study the existence of voluntary effects of child mortality on fertility, are populations needed in which the practice of contraception is substantial? If the maximum percentage of couples who have ever practised contraception is less than perhaps 35 per cent, a means of studying voluntary effects in such populations would be division of the sample into two parts, those practising and those not practising contraception. Contraception however is not the only means by which societal pressures for fewer pregnancies are made effective. Besides delayed marriage, it was noted that in some cultures pregnancy or at least child-birth is avoided through traditional practices of abstinence, through residence of wife with parents for a considerable period after childbirth, and through abortions. Breast-feeding customs also cause variations in post-partum amenorrhea.

Lactation and consequent post-partum amenorrhea were recognized as important biological-physiological factors to control when attempting to study voluntary effects of infant and child mortality upon fertility, particularly since the sociocultural and economic aspects are so closely linked with length and effects of lactation (undernourished women). Studies in Nigeria for instance have revealed a variation in length of breast-feeding from 6 months or even none at all up to 3 1/2 years.

One participant felt however that demographic literature has attributed greater influence to breast-feeding on interbirth intervals than the clinical evidence can support. He believes that the average interbirth interval was lengthened in any significant way only when the breast-feeding was engaged in by undernourished women.

It was further suggested that the effect of lactation upon post-partum amenorrhea is not constant in all populations and research upon this point would be useful.

Short interbirth intervals, it was noted, experienced by families which might at first sight seem primarily due to infant mortality may actually have been more due to fertility than to mortality. That is, pregnancy while the child born previously is very young may lessen care for the previous child and lead to its death. It seems possible that a woman who did not practise contraception with great care might also be one who did not take good care of her children's health. If verified, this would link infant mortality and level of fertility closely together.

With regard to this "carelessness hypothesis", a multiple classification analysis of the determinants of child mortality (under age 5) was carried out in the Heer-Wu Taiwan study. The most important single variable was whether a sibling had died. This is congruent with the hypothesis that maternal carelessness and incompetence may be a common factor both in the deaths of each of the two children and in an increase in fertility.

A participant pointed out the danger that such inverse effects will be interpreted as a positive relation of child mortality to fertility through volitional effects if birth concentration is high, and the expected interbirth period varies. This would affect measurement of births due to replacement following a child death by inclusion of spurious replacement births. While such inverse effects (births preceding, not following a death) might be small, still differences caused by replacement effects, especially in historical studies, may also be quite small. If one tries to avoid such inverse effects by controls, sensitivity may be lost.

How important, it was questioned here, is the need to keep distinct three sources of experience : direct personal experience, indirect personal experience, and societal experience and pressures. While analytically separable, they are not distinct in the real experience of couples, and are not mutually independent.

The attempt to study and control intervening variables, while definitely the right approach, asserted one participant, may be of particular importance in tropical Africa where effects of child mortality upon fertility may work especially through sociocultural and economic improvements. Here in rural areas additional children may not add much to costs of support and attention because of the structure of society and the family forms. Matrilinear and patrilinear family and kinship systems are different from both European and Asian models. Social structures and norms vary between different social groups. In many types, even if the father or mother dies, the brother or sister can take over responsibilities for the children and may even continue to propagate children.

Declines in child mortality in today's developing countries, it was said, can be attributed in large part to governmentally sponsored programs of medical, epidemiological, and other health care in contrast to the European declines which occurred as integral parts of overall social and economic transformations of society. This means that developing countries today offer unique opportunities for study of the effects of child nutrition instructions, of practices of midwives, of increased hospital utilization, and of mother's health upon the level of child mortality. Such studies, carried out at the micro level with small samples may reveal the

dynamics and mechanisms by which levels of infant and child mortality are involved in the decline of fertility. The India Population Project of the World Bank in two indian provinces has set up such studies of the relationship between fertility and mortality. Survey work in rural areas of northern India has indicated a positive relationship between child mortality within early married life and subsequent fertility. Small longitudinal follow-up studies could provide data necessary to study this relationship.

Another participant suggested however that possibilities of externally induced declines in child mortality can be greatly exaggerated and remarked that fundamental social changes must take place before such declines can take place.

These considerations led to the remark that more than one type of demographic transition exists, among which the present seminar topic leads one to distinguish (a) the classical transition, (b) the accelerated transition, and (c) the delayed transition.

Another intervening variable to which attention has already been called is nutrition. For example in Papua, New Guinea, mean age at menarche among poorly nourished mountain folk can be as late as 18.7 years of age and mean age at menopause may be as much as 4 years less in the highlands than among the more well nourished lowlanders. Altogether, this totals to a difference of 6-7 years in length of the fecund period between the poorly nourished mountain folk and the people living in the more highly developed island areas.

However, there are intervening variables between nutrition and fertility, and it is necessary to proceed carefully. Another seminar might be planned to study the effects of nutrition and perhaps of other SES variables upon fertility. The nutritional element in effects upon fertility and upon mortality could well be the next target of concerted research. It may be added that infant mortality is often considered as an indicator of standard of living. If in fact it is such, this means that discrimination of effects upon fertility of standard of living from effects of infant and child mortality may well be difficult.

Certain particular causes of death were believed by one participant to be more apt to influence parents not to replace deceased children. Except where such causes of death are common, however, and can be shown truly to influence parents greatly, this control was not thought of primary importance in present research upon the topic.

A relationship between infant mortality and age at marriage was suggested on the grounds that earlier marriage causes higher levels of infant mortality. Another participant noted however that incidence and level of infant mortality by age of mother has a U-shaped distribution. It therefore appears doubtful that age at marriage produces differences in levels of infant mortality. The general point is however well taken. The possibility that fertility effects on nuptiality differences produce mortality differences must always be considered.

Attention was also called to the effect of infant and child mortality upon the equilibrium of the sexes and the chances of marriage. Infant mortality and the mortality of children one to fifteen years of age varies by sex from country to country. Changes in child mortality could produce a structural effect upon the population and cause an imbalance in the "marriage market". If men are likely to belong to an older cohort than the women from whom they select their brides and if child mortality should have declined rapidly in the past, the result could be a surplus of women who cannot easily find husbands.

One participant attempted to show at this point that a reduction in child mortality can have an immediate effect upon age at marriage, as follows : if a man wants to marry, he may choose to marry either an older or a younger woman. If child mortality is high, this man may choose to marry a younger woman capable of bearing a large number of children. If child mortality is low, he may choose to marry the older woman to avoid costs of birth control. Moreover, if a woman is older at marriage, she may have had time to earn for herself a larger dowry. In Taiwan, for example, age at marriage for females has risen substantially and the new pattern is for girls to work before marriage in order to earn money for their dowries.

Such effects of change in child mortality upon nuptiality and upon marital fertility need further study, especially declines in mortality occasioned (a) by widespread modernization or (b) by other factors without widespread modernization. Especially in the second set of declines, change may lead to sharp conflict between wanted fertility or population patterns and traditional social institutions and norms. How strong this conflict must be on the societal level before individual couples are influenced to choose contraceptive solutions, that is, before the relation between the macro and micro level is activated, can perhaps be specified by research. This should focus first on societies in widely different social and agricultural conditions, and later should be very carefully specified for experimental investigation.

Care must be taken in defining the society or the community concerned when a societal or a community mortality rate is to be computed which will then be assumed to have an impact upon the fertility behavior of individual couples. If the society or the community defined for the rate is not the society or community which serves as a reference group for the couple concerned, the presumed effect of this societal or community mortality rate will be invalidly measured.

Research should be directed toward discovering how declining child mortality induces the practice of contraception. Dependency has been suggested, but when the burden of dependency is viewed correctly, i.e. longitudinally, not cross-sectionally, the increase by itself (e.g., 16 per cent or less) is usually not important enough to be very decisive. Given a specific family goal to have at least one son reach his father's age, when infant and childhood mortality decline, the fulfilment of certain criteria may be assumed which cause the family to conclude that they can reduce fertility and still attain this goal. For understanding a decision to limit further births, however, other criteria must be considered such as the undesirability of dividing the family farm, which however must be divided if two sons survive. Two goals would therefore be in conflict, and the family would have to weigh these two goals and decide whether to have only one son and whether to use family planning to avoid having two sons. Since the parents cannot delay decision until the first son has reached young adulthood or perhaps even adolescence, it must use indicators that the first son will survive, and a study model of the decision must use these same indicators, e.g. (a) whether the first son has reached age 10, or (b) whether a second son is born while a first is still alive. Families cease reproduction when such indicators are satisfied. Is the rate of growth greater when no such "stopping rule" exists than when one does exist ? What is the effect upon population growth of a "stopping rule" ? Research along such lines should continue.

Several useful cognate areas of research were further noted, such as sterility and sub-fecundity, and the implications of these as well as of birth concentration for replacement effects.

The assumption that under some conditions in stages of early industrialization and/or modernization, an increase in income will increase the demand for more children, has often been justified (as in Retherford's paper) by the experience of developing countries, where the fertility of farmers is said to vary directly with their income. If so, can the fact seen everywhere that the poor have more children be explained ? A reconciliation of such apparent contradictions was sought in data from modern rural societies in terms of a relation which is U-shaped. For example, the national surveys of Turkey indicate that fertility is high among low income rural families, is considerably lower among middle status farmers, but is very high for rural families in the highest income bracket (who are however a small minority). Thus a more equitable distribution of land, for example, may be expected to reduce fertility.

Economic Models

How useful is a micro-static economic supply and demand model in study of parents' decisions whether to replace a child or to insure by a birth the possible loss of a child ? A gambler's choice may be quite different, for example, than a decision based upon the objective probabilities of the risks confronting him, and may be greatly determined by the particular concrete circumstances of the moment. For this reason one participant felt that an objective economic model was not sufficiently able to take account of real factors entering into decisions whether or not to have another child for replacement or insurance reasons, as it changes too much the grounds on which the decision is made. Babies are not consumer durables. What are the net utilities therefore of including them under that rubric ? Social and institutional norms which have very little in common with the purely economic supply and demand relationship greatly influence fertility. In addition, the supply and demand relationship is static whereas the relationship of child mortality to volitional fertility is dynamic. Nevertheless, such a model may approximate results of the real relationship, and this possibility should be explored in observational studies. However, one participant felt that research should proceed along lines of desire rather than along lines of demand versus costs in the present seminar question, because desire determines fertility, not demand, although demand may set a minimum number of children beyond which desire and costs begin to be weighed in a balance. Among costs which must be considered are the psychological painfulness of acting against traditional norms, and possible attenuation of male (or female) status, which in some societies increases with number of children. On the other hand, costs in care of additional children must also be considered such as adequate food, housing, attention, and education.

It was maintained by another participant however that a static economic model can be useful if the element of choice is retained. Whether or not results obtained can approximate real results can only be determined empirically. Whether desire is more important than demand when the relation of child mortality to volitional replacement or insurance effects is the point of study, is debatable at least. The question of replacement is a decisional question to be responded to by the family and for this reason, the economic framework would seem to be the right one. Various social dimensions might of course be added, but these would make analysis much more complex.

A third participant suggested that it might also be useful to consider an economic model approach through marginal utility costs.

Relationships Between Mortality and Fertility Levels : Historical Studies

The results of analyses of historical data of those European countries covered during the period of their demographic transition in the Princeton European fertility project at the present time permit no firm conclusions to be drawn upon the relationship between infant and child mortality (0-14 years) and fertility. The data indicate however that a decline in *infant* mortality (0-1) is not prerequisite for a decline in fertility. In half the provinces of Germany, the fertility decline occurred about nine years before the decline of infant mortality, in Belgium substantial limitation of birth preceded the decline in infant mortality by at least 25 years, and mortality in Sweden decreased from about 200 infant deaths per thousand live births before 1800 to 130 infant deaths in 1871-80 without any decline in fertility. The European experience therefore may be of limited value for insights into the relationship between infant mortality (defined strictly) and fertility in developing countries today.

Quite different however seems the relationship between child mortality (0-9 or 1-9, or even 0-14) and level of fertility. One participant stated that he knew of no European country that had experienced a significant decline in fertility wherein a substantial decline in child mortality (0-9 or 0-14) had not first taken place. This finding seems to have met with the substantial agreement of the participants, although the lag of fertility decline behind the falling rate of child mortality in some countries was added as a qualification, as well as the possible need of the assistance of other intervening variables.

A participant noted that the fertility decline which preceded decline in infant mortality in about half the German provinces most probably followed a decline in child mortality (1-4 or 1-9 years of age), although the appropriate data to show this have not yet been tabulated. R. Lesthaeghe has shown that when the mortality of children over one year old is substituted for infant mortality, the fertility decline which in almost every Belgian province had preceded the mortality decline then became subsequent to the mortality decline in half the provinces. E. A. Wrigley has shown that in England the decline in infant mortality lagged behind the decline in the death rates of children and older persons. Another participant declared however that a significant conclusion from the European historical studies is "the absence of evidence" that declines in childhood mortality are of themselves sufficient to set in motion direct falls in fertility without the assistance of other intervening factors, although he conceded that childhood mortality declines may be part of a causal complex. Possibly this participant meant infant mortality (0-1 years of age) in these remarks, although he used the term, child mortality.

This lag of decline in fertility behind decline in mortality, it was thought, deserves careful study. A "threshold effect", previously referred to, may be of substantial importance in this lag. In some but not all European countries, as just stated, the decline in infant mortality (0-1 years of age) considerably preceded the decline in fertility, whereas various diverse relationships were found in other countries. In Sweden, data for the years 1850-1890 show higher urban than rural fertility.

These Swedish urban and rural differentials, one participant thought, might well be due to biases in the data affecting age and marriage structure rather than genuine differentials. Cross-sectional and longitudinal analyses of effects of infant mortality decline upon changes in average age at first marriage are desirable. The Princeton data on European demographic transitions, if analyzed to examine this relationship, might provide valuable insights and results. One such study, carried out by the Soviet demographer Novoseliskij in the 1920's, involved a cross-sectional study of provinces of the Russian Empire around 1900. It showed a very substantial negative correlation between level of infant mortality and average age at marriage. The coefficient described was a total, rather than a partial, coefficient. Another participant however thought that the Swedish urban-rural differential might be real and due to an increased "demand" (in the economic sense) for urban children during early stages of the Industrial Revolution. This interpretation was challenged by others. One participant thought in fact that parents who had lost children due to the hard conditions of the early Industrial Revolution might well have lost the desire to replace these children under such conditions. Another observed that such an increase may have been partly due to a slight increase in fecundity during these early years of the demographic transition but that a fertility increase may well have developed because of modernizing influences which, before couples knew how to practise contraception, broke down cultural traditions that formerly had moderated fertility. For example, it might no longer be practicable for a working mother to go home for prolonged visits to her mother at time of childbirth, to observe customary abstinence periods or to breastfeed her child as had been traditional. Further, induced abortions might have shortened birth intervals. Since the position of the various churches of pre-industrial and early industrial Europe was severe upon abortion, such abortions would very likely neither be reported nor appear in the parish register. Thus the quality of birth intervals calculated from parish records might have been affected.

Knodel's research, based on small areas however, shows that in 19th century Bavaria in districts where breast-feeding was not practised, a very strong correlation existed on the aggregate level between level of infant mortality and level of marital fertility. Since breast-feeding was not practised, the correlation cannot be due to the intervening variable of post-partum amenorrhea. Since this same research finds little relationship for

the same areas at the individual level between infant mortality and fertility, the results suggest operation of a substantial independent societal-level effect.

Vital statistics for the United Kingdom are currently under analysis for light upon the child mortality-fertility relationship. The country has been divided into a dozen regions with some claims to homogeneity, and time series over the 130 years between 1840 and 1970 have been established. The analysis has examined rates of fall in mortality and fertility.

Results have been as follows : (1) correlations are strongly positive (up to about .70) over the period of rapid fertility decline, and at a maximum where there was no time lag (i.e., where changes in mortality and fertility rates were simultaneous) ; (2) over a twenty year period, child mortality increased but the correlations remained constant, due to the interaction of data for regions with the smallest increase and the largest decline in mortality ; (3) despite large variations in child mortality, the initial drop in fertility occurred almost simultaneously in every region.

These results suggest that the direct effects of decline in childhood mortality were small and that sociocultural and economic changes were affecting both child mortality and level of fertility measures. The United Kingdom experience in (#3) above suggests that a long lag between decline in child mortality and decline in fertility seems less likely today.

The simultaneous changes in infant and child mortality and in fertility in England between 1840 and 1900 may have been due to factors affecting both variables. But the result might also have occurred because a threshold in child loss had been reached.

The declines in both fertility and mortality being sharp at onset at about the same time in the different regions of England and Wales, despite large variations in conditions, inclines one to suspect that the determinants were common to the whole country.

Study of European fertility change may permit conclusions about appropriate actions in developing countries. Level of child mortality at which fertility began to fall was quite variable, in the United Kingdom as high as 20 per cent in some parts of England. Most developing countries now have a child mortality level considerably lower than the levels at which fertility fell in several European regions.

Two components of change in child mortality, it was suggested, may affect level of fertility. These are : (a) actual change in rates and (b) change in the concepts of the people about changes in child mortality. The latter component can be obtained neither from historical nor from aggregate data in general.

Australian data, under study at the Australian National University, exhibit a lag of 20 to 30 years between onset of a decline in infant and child mortality in the 19th century and an eventual decline in fertility. With a lag of this magnitude, one participant argued, it is difficult to imagine a causal relationship between the two factors. More likely the underlying factor, common to both, is societal change.

The discussion of the Retherford paper pointed up the importance of migration for its relationships to fertility (rural-urban migration especially). It is not clear whether migration was taken into account in the analysis of the historical data of the Princeton European fertility project and information upon this point is desirable.

For purposes of this seminar, i.e., distinguishing voluntary effects of infant and child mortality upon level of fertility, separating the effects of contraception upon fertility from those of abortion and abstinence is not very important in historical studies. What is important however is the separation of voluntary effects from purely physiological effects. The difficulties of making such a separation in data not gathered precisely with this end in view are evident. This problem extends of course not only to historical data but to any data gathered for other purposes than that of this seminar or for closely allied topics. Another difficulty is that historical samples tend to be small and it is hard to draw firm conclusions from small samples.

One participant expressed the view that historical data very likely contain various unmeasured biases caused by infrequent visits of religious authorities (priests or ministers) to remote parts of their parish territories, delay of rites (e.g. baptisms and funeral rituals), misreporting of ages, and out-and in-migration of population, and while field checks can help to remove sources of bias in contemporary studies, such field verification is not possible in connection with historical data. However, in reply it was pointed out that tests have been elaborated for measuring quality of historical records while parish records of the past were probably kept better in many cases than contemporary parish records. German and Canadian parish records were very accurate and precise. English parish records, although problematic, are still usable. Family reconstruction techniques yield data upon completed family histories, it was noted, which leave no guesswork about the final outcome of a couple's reproductive period, unlike survey data for women less than 45 years of age. These completed histories are based upon events which were recorded as they occurred with no problems of recall of events such as characterize retrospective survey data.

CICRED was urged to try to have established, or to help try to have established a computerized data bank for parish statistics of demographic potential. This would make possible a more extensive analysis of such records by historical demographers.

Relationships Between Mortality and Fertility Levels : Modern Area Studies

Much has already been said upon this topic in preceding sections that will not be repeated here. Data from studies in many diverse areas of the world were discussed and compared.

One participant thought striking the similarities of the reported Bangladesh and Pakistani study results with the results reported from the European historical studies. He also pointed out that since the Lery-Vallin paper indicates that replacement effects increase in populations with low fertility and widespread birth control, future research should focus upon that point of the demographic transition at which this mechanism begins to operate.

The Pakistani and Bangladesh study reported in the background paper is in fact more an attempt to study volitional effects of infant mortality upon birth spacing, rather than a study of family limitation and of child replacement. One should in general, noted one respondent, be particularly cautious about Pakistani age data because families commonly do not correctly recall age of children in years completed, much less in months. Median birth intervals may be seriously biased without such precautions.

It was observed that a longitudinal study, holding sociocultural and economic variables constant, might reveal data that seem to support the hypothesized voluntary effects in tropical Africa. However, a higher percentage of children who died are omitted from reports in tropical Africa than of those children who survive which leads to gross underestimation of infant and child mortality. Omissions, errors, and response errors confound results. Variations in fertility are also due to culturally mediated social values. In addition, polygynous marriages also contribute to low reported levels of fertility and child mortality. Rural-urban residence, migration, and other sociocultural and economic variables may outweigh the effects of child replacement.

In Africa, as already noted, one may well ask whether the rural-urban distinction can stand up to expectations. In short, the data do not seem able to support an investigation into voluntary effects of child mortality upon fertility, although they are useful for many subsidiary reasons.

A participant observed that high fecundity in interaction with the breakdown of traditional taboos on sex may be an important determinant of fertility in Africa. Urban residence, if it tends to prevent mothers from visiting and staying with their own mothers after birth in order to "recover their own strength" and until their child is "strong enough", may cause urban fertility to rise, rather than fall, as a result of the break-down of sex taboos.

Another participant remarked that new data available make possible and desirable a revision of comparisons for tropical Africa.

Physiological effects seem particularly important in some countries of tropical Africa. However level of fertility in Nigeria is so high that even though lactation ranges up to 36 months and more, a shortening of this interval due to infant or child death does not appear to increase fertility appreciably.

The mortality transition in India and in most Asian countries took place during the first half of the twentieth century before the occurrence of substantial modernization, mostly because of epidemiological and other health measures. On the other hand, where a fertility decline occurred, this started (with some exceptions) in the 1960's. The gap was one of 30 to 50 years in many cases. Increase in age at marriage, wide diffusion of educational achievement, and modernization are important reasons commonly attributed to this decline.

Cross-regional comparisons of joint levels of fertility and mortality in most Asian countries may prove not very helpful, it was remarked, because too little is known of Asian rural-urban differentials. Particular cautions should be sounded against the use of crude rates for this purpose because of the effects of age structure upon the crude death rate.

Data on age are highly erroneous in many Asian societies, and coverage of infant and childhood deaths is very poor due to recall errors, psychological motivations, and sociocultural outlooks.

Data on fertility and mortality declines in Singapore and Hong Kong were presented by a discussant. These declines were large both in Singapore (from 45 births per thousand in the mid-1950's to 22 per thousand in 1970 and from 75 infant deaths per thousand live births to below 20 deaths per thousand in the past two decades) and in Hong Kong (from 27 births per thousand in 1950 to 37.4 in 1958 and then to below 20 in 1971, and from 100 infant deaths per thousand live births in 1950 to nearly 20 deaths in recent years). While age structure changes can account for a substantial part of the fertility changes in both cities, analysis of data for these cities in terms of volitional effects of child mortality on level of fertility would be valuable.

The mechanisms which operate in many countries of Africa are different from those of Asia, Latin America, and Europe and often even from other countries of Africa. The data must therefore be examined carefully before a method is chosen for applying secondary analysis techniques to them.

A statement regarding population policy is made in the Medica-Rutstein paper, namely, that a decrease in infant and child mortality will induce an increase in the population growth rate unless indirect personal experience and societal pressures supply a sufficiently restraining influence. This conclusion seems of relatively low importance in fact because infant and child mortality are very unlikely to fall much lower than at present levels in many Latin American countries in the absence of change in socioeconomic standards of living. But if this takes place, it is generally felt that a resulting decline in level of fertility will ensue.

The two cited macro-studies on Puerto Rico and the third on child data cover less than five per cent of the Latin American population. The micro-level analysis called PECFAL-RURAL covers 1/3 of the Latin American population but is restricted to rural and semi-rural areas. However almost 60 per cent of the Latin American population is urban. For example, 25 per cent of the Brazilian population lives in 9 metropolitan areas, and the figures for Argentina, Chile, Colombia, Mexico, Uruguay, Venezuela, and other Latin American countries are higher.

It is therefore more important to investigate the behavior of urban populations in Latin America, as CELADE did 10 years ago (see Fertility in Metropolitan Latin America).

A study of 1,328 married women of almost totally urban Sao Leopoldo County done by CEDOPE (USINOS, Sao Leopoldo), concerned with the relationship of infant and child mortality, showed that 67 per cent of the women 15-44 years of age were using contraception and indicated a consistency between desired number of children, known pregnancies; and live births, namely, 3.79, 3.93, and 3.27 per woman. Total fertility in Brazil (see 1970 census) was 4.97 births per woman 15-49 years of age.

A cross-cultural longitudinal study of infant and child mortality in several Latin American regions from May 1968 to June 1970 by the Pan American Health Organization (see Patterns of Mortality in Childhood, ed. Puffer and Serrano) probably is relevant to the seminar topic.

Relationships between Mortality and Fertility Levels : Mortality Reduction Projects

This topic was largely confined to a discussion of the background paper upon it, and to the projects presented in this paper.

1) The Introductory, Cross-sectional Analysis

First, it was pointed out that the initial cross-sectional analysis of data from 74 developing countries did not blend well with the main topic of the paper, effects of special mortality projects on fertility. Secondly, since this initial analysis employed total correlation and zero order regression as measurement techniques, the coefficients resulting are flawed with the usual defects of this approach :

1) Correlation is a measure of association, not of causation. Variation in either variable can be "explained" by the other variable. Even partial and multiple correlation, and higher order regression are not advisable for investigating voluntary effects of mortality decline on fertility levels for secondary analysis of cross-cultural data.

2) The data consist mainly of estimates based upon stable population theory or model life tables. Use of model life tables implies the existence of high levels of correlation whereas in fact they are low here. Such estimates therefore assume intercorrelations between the concerned variables, as mentioned earlier in this seminar. Correlations between these estimates and significance tests on these correlations are not therefore of great value.

3) The simulation of longitudinal interactions and of time series by means of cross-sectional data is not advisable.

4) While correlation and regression can be used on cross-cultural data (providing estimates are not based as in this paper on stable population or model table analysis), great caution must be exercised in secondary analysis and comparisons of international data. Otherwise serious biases may intrude into the data because of variation in sociocultural and economic contexts, different definitions of terms, diverse research purposes.

5) Variables to be correlated must be such as to minimize dangers of effects produced by intervening variables or these intermediate variables must be controlled, e.g., correlation of newspaper circulation (as an index of modernization) with infant and child mortality and/or with birth rates.

With regard to all of the following studies in general, participants again pointed to the important possibility of a lag in fertility decline which might not appear in the results of a mortality reduction program that was not on a very long-term basis, to the distinction between the effects on fertility of a decline in infant mortality (0-1 years of age)(1) and of a decline in child mortality (0-4, 0-9, or even 0-14 years of age), and to

(1) That is, below one year of age. Age one here (as elsewhere in this summary) is used as an upper "true" limit which is not completely reached.

the distinction of "replacement" effects from "insurance" and from "societal" effects. The participants were reminded once again that it is unnecessary that young wives or young couples experience infant or child mortality personally for higher or lower levels of such mortality in their communities to affect their decisions on fertility.

2) The Cholera Research Laboratory, Dacca, Bangladesh

The data of this study presented in the paper are not complete. Further, inclusion of this Bangladesh project in the background paper seems to have been unwarranted since neither infant mortality nor fertility declined during 7 years. The project is largely limited to the attempt to reduce mortality at ages above one, with little planned impact upon infant (0-1) mortality.

Secondly, levels and trends of infant and child mortality and in fertility at the start of the program must be determined and kept in mind. This would permit judgment on the question of whether a decline in fertility during the period of mortality reduction represents a break with previous trends or merely an extension of them.

Third, a small bias toward positive correlation exists because mortality influences population age structure. That is, a more youthful population results from low levels of infant and child mortality than from higher levels. A smaller proportion of the people are therefore in the reproductive ages, and because of this, the crude birth rate tends to be lower. Determination of the extent of this bias would be useful research. Meanwhile, caution should be observed in interpreting correlations, particularly where differences in levels of infant and child mortality at different times are large while differences in crude birth rates at these times are small.

3) The Danfa Comprehensive Rural Health and Family Planning Project, Danfa, Ghana

This project was not designed to test hypotheses about the relation of level of fertility to infant and child mortality rates. It rather aims to deliver maternal and child health services to the rural population of the area. However, its data may shed light on the seminar topic because infant mortality was reduced in the area.

4) The Khanna Study, Ludhiana District, Punjab State, India

The study was initiated early in the Indian population program (1954) and in localities where the population problem was relatively small. Despite the literature on the project, it does not seem to fit well into the context of the background paper under consideration. It has changed neither fertility nor mortality as Table 3 of the paper makes clear. After what may have been peak years (1957-1959) in both test and control areas, the crude death rates, the infant mortality rates, and crude birth rates of test and of control groups are very similar. Table 4 is the only table particularly relevant to the seminar topic. A suggestion is found here that as survivorship increases, fertility subsequently decreases. However, the study used the first six live births as a cut-off point. This masks too much of the interaction and too few women are found in the zero and one child surviving groups.

5) The Taylor-Berelson Projects

More details are needed on these projects which are being activated in Indonesia, in the Philippines, and in Turkey. The Philippine project is a family planning program which works through maternal and child health services and therefore should make an impact on both infant and child mortality and upon level of fertility. It does not appear however to have been set up in order to test the impact on level of fertility through birth restriction of a decline in the level of infant and child mortality, although its data may shed light upon this relationship.

6) The Etimesgut Project, Etimesgut District, Turkey

It appears from Figure 3 and Table 2 that infant mortality declined from 142 to 121 deaths per thousand between the years 1967 and 1968, only one year after the project was launched. General fertility had declined considerably by 1970.

In the absence of data upon previous trends, or of a control group, it seems probable that other causes pre-existed in the Etimesgut area before the project was launched, which, enhanced by the project, were responsible for both fertility and mortality declines. Etimesgut, a mountainous area eastwards of Ankara but close to it, has easy access to modernization factors and health facilities besides those of this particular project. It seems likely that 1967 was a peak year for infant mortality and that infant mortality would have declined the same way in a control group as in the study area between 1967 and 1968 because a decline from 142 to 121 deaths per thousand is too much for any intervention project to accomplish in one year. The fertility decline took place too soon to be principally due to the project – the lag time is too short.

7) The Narangwal Experiment in Health and Family Planning, Punjab State, India

Unfortunately, this project which began in 1965 and continued to 1974 has been terminated. More details of its design and of its preliminary analysis are needed, because its design seems to make it important for purposes of this seminar. A participant thought he recalled that the project employed two control groups of which one received family planning services but no direct child health services while the other was a "blank" control group which received neither direct family planning nor direct health services.

If a decline in infant mortality is assumed to decrease the costs of having a child, remarked a participant, in the absence of countervailing factors rate of population growth would tend to increase. Therefore mortality reduction programs should attempt to increase the quality and quantity of health care given their children by mothers, by providing education and instruction to these mothers. Other participants agreed with this latter view and one suggested it would amount to encouragement of trade-offs between numbers and well-being of children, or in economic terms, between quantity and quality of children. That is, decreased costs per child caused by declining mortality would be balanced by increased costs per fewer children in care and educational opportunities provided for them. One participant observed that for a time the Narangwal experiment tried to provide such instruction for mothers, but abandoned this after some time because the expense was large. Another participant followed up this point, noting that costs of replicating this feature of educating mothers to better child care should not be considered excessive, if analysis should show it to be over a period of years a more efficient way of reducing population growth and fertility, to teach mothers child care than to omit this instruction because of costs, and because of this omission to have less success in reducing growth of population and fertility.

8) The Sri Lanka Malaria Eradication and Health Programs

No one program was referred to but a complex of programs to reduce mortality with emphasis on control of malaria. It was remarked that these programs furnish one of the better documented natural experiments which in general supports the basic hypothesis that a decline in infant and child mortality induces a decline in fertility. Attention was again called to the increase in fertility that sometimes initially accompanies a decline in infant and child mortality before level of fertility begins to fall. Figures 4, 5, and 6 of the background paper make these phenomena evident.

Much of the early decline in fertility was due to increasing age at marriage, according to the authors of the background paper. This points up the problems of employing crude birth rates as an index of fertility.

One participant contended that the mechanism by which infant and child mortality works upon level of fertility was not through an increase in age at marriage but rather through a decline in the relative number of marriages. A decline in infant and child mortality means a decline in number of men relative to women (decreasing sex ratio). A larger proportion of women remain unmarried, which causes the crude birth rate to decline (a) because their chances of bearing a child while unmarried are less and (b) because their chances of entering the labor force and thus tending to reduce their fertility are greater.

Another participant thought that short term effects of infant and child mortality upon marriage were counteracted by the marriages of older men with younger women. A third participant however denied the likelihood of this second opinion. Repeating an argument used previously, he noted that in Europe and possibly in Sri Lanka a woman can increase her dowry and thus her attractiveness for marriage by working, while young wives would have less time for work to increase their dowry. Since younger wives will have a longer reproductive period, contraceptive costs will be higher. So older men may prefer to marry older women when infant and child mortality rates are low.

Too "purist" a position in the evaluation of projects is not very practical in view of the expensiveness of field experiments, remarked a participant. He recommended obtaining all information possible from the Sri Lanka "natural experiment" and similar programs or sets of programs. He called attention to a report of the Mauritius Island experience just written by Brass. Mortality led by infant and child mortality fell with exceptional rapidity between 1945 and 1955, after which infant and child mortality continued to decline but more slowly. Between 1966 and 1973 level of fertility fell 55 per cent, a decline in seven years unmatched in speed by any other place in the world. This decline took place about 18 years after the fall in infant and child mortality, and like the decline in infant and child mortality, it took place with great rapidity.

One can say the fertility decline had little to do with structural changes in the population because it took place far too rapidly. Nor can the decline be attributed to the personal experience of improved mortality by and within individual families. Those who reduced their fertility were mostly young women without experience of infant or child mortality in their families.

Would such a remarkably fast decline in fertility have occurred without a previous decline in infant and child mortality ? This point is difficult to answer in a rigorous way from the data of such natural experiments but one can make a reasonably substantial case for a negative answer on the basis of these findings.

9) Conclusions

The discussions based upon the data of this background paper concluded that the studies cited provide no firm evidence that mortality reduction projects automatically change child-bearing attitudes or levels of fertility. If this is so, should not such projects, as has been previously said, incorporate vigorous attempts by educational efforts to increase care of and provision for children and to substitute for larger numbers in the family the concept of fewer but more healthy and more well educated children ?

Finally, it may be said that strong and convincing answers to the main seminar questions might be provided by special mortality reduction programs designed to test hypotheses about resulting voluntary effects on level of fertility. This fruitful area of study is likely to be of considerable importance for developing countries. The area however is one where experts from many disciplines must put their heads together because it is not easy to handle the problems of separating the effects of physiological, demographic, economic, social, and cultural factors, and thus to reach firm conclusions. Research experiments must be longitudinal since fertility decline may be expected to lag some years behind falling levels of mortality. This indicates that such research would be expensive and ways should therefore be examined in the present straitened economic circumstances to remove deficiencies from existing data so that these can shed meaningful light upon the relationship of infant and child mortality to decline in fertility.

RAPPORT FINAL
(Résumé des discussions)*

par Francis C. MADIGAN (S.J.), directeur
Mindanao Center for Population Studies, Cagayan de Oro City (Philippines)

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Conceptualisation

Dans ce Séminaire, on a défini la mortalité infantile dans son sens habituel, c'est-à-dire comme le rapport du nombre des décès d'enfants avant un an à celui des naissances vivantes survenues au cours de la même période. Cependant, afin d'analyser de manière plus exacte les effets volitifs de la mortalité infantile et juvénile sur la fécondité, la mortalité des enfants a été définie non seulement au sens habituel, c'est-à-dire la mortalité des enfants de 0 à 4 ans, mais aussi dans des contextes différents comme celle des enfants de 0 à 9 ans, 1 à 9 ans, 0 à 14 ans ou 1 à 14 ans. Dans ce qui suit on a essayé de préciser le sens utilisé par les participants en différentes occasions. Mais cela n'a pas toujours été possible. Il faut donc faire preuve de prudence lorsqu'on interprète les suggestions, les approches et les conclusions qui se rapportent à la mortalité des enfants, à moins que le sens de cette expression ne soit précisé par le contexte.

Un des participants a remarqué, à juste titre, qu'on décèle beaucoup mieux les différences de mortalité si on distingue les décès survenus avant un mois plutôt que ceux survenus avant un an. C'est pourquoi on a

(*) Seules sont résumées ici les questions soulevées par les participants au cours des séances. A moins d'avoir été longuement discuté lors du Séminaire, le contenu des documents de base ne figure pas dans ce rapport, le lecteur en ayant déjà pris vraisemblablement connaissance.

recommandé d'abandonner la division traditionnelle entre la mortalité infantile (de 0 à 1 an) et celle des enfants (de 1 à 4 ans) pour la remplacer par une division entre la mortalité de 0 à 1 mois et de 1 mois à 3 ou 4 ans.

Il est vrai que la distinction traditionnelle entre 0 à 1 an et 1 à 4 ans présente des inconvénients et que la distinction suggérée aurait de grands avantages d'un point de vue théorique. Cependant, comme l'ont fait remarquer d'autres participants, la mortalité néonatale est probablement la mesure la moins sûre de la mortalité dans les pays où les données sont de mauvaise qualité. De plus, la distinction traditionnelle est celle adoptée dans les données qui se réfèrent au passé et de nombreux pays présentent de nos jours leurs données d'une manière qui ne permet que de faire cette distinction traditionnelle. En outre, alors que le recul de la mortalité des enfants de 1 à 3 ans peut être trop faible pour exercer une forte influence sur l'évolution de la fécondité (ainsi qu'il a été remarqué), on a observé cependant que les effets cumulés de la mortalité des enfants de 1 à 9 ans peuvent être importants et un indice de mortalité qui porte sur les âges de 0 à 4 ans ou 0 à 9 ans permet d'examiner plus facilement la conscience qu'ont les parents de la perte d'un enfant et leur tendance à remplacer cette perte. Il a été reconnu, cependant, qu'un indice portant sur les âges de 0 à 9 ans nécessite des vérifications très rigoureuses afin d'empêcher les effets de la concentration des naissances sur la mortalité des enfants de gêner la mesure des effets de la mortalité des enfants sur la limitation volontaire de la fécondité.

On a bien spécifié que dans le séminaire, il s'agissait d'examiner les effets volontaires de la mortalité infantile (de 0 à 1 an) et de la mortalité des enfants (de 1 à 9 ans) sur la fécondité.

La distinction assez courante entre données globales et données individuelles est importante pour le sujet étudié ici. Cette distinction entre l'analyse des données portant sur des unités importantes (population d'un département, d'une province ou d'un pays) et celle qui se fait au niveau de la famille ne font pas forcément intervenir la dimension de l'échantillon (bien que ceux utilisés dans les analyses globales sont presque toujours plus grands). La différence entre ces deux genres d'études tient plutôt au fait qu'on s'intéresse aux réactions des familles, considérées séparément, lorsqu'elles se trouvent dans une situation donnée ; dans le cas présent il s'agit de la perte d'un enfant. Les études globales parviennent à des résultats qui s'expriment sous forme de taux de natalité. Au contraire, les études sur les familles font intervenir des notions telles que la probabilité d'agrandissement des familles, c'est-à-dire la proportion des femmes qui après avoir eu un nombre donné d'enfants donnent naissance à un enfant vivant. Ces femmes peuvent être classées selon qu'elles n'ont pas eu de décès d'enfant ou qu'elles en ont eu un, deux, ou trois.

Quatre genres d'effets exercés par la mortalité infantile ou par celle des enfants (de 1 à 9 ans) ont été distingués lors du séminaire. Il s'agit des effets biologiques et psychologiques (influences involontaires qui agissent par l'intermédiaire de la réduction de la période d'allaitement et la cessation de l'aménorrhée après l'accouchement qui en résulte), des effets de remplacement (remplacement volontaire d'un enfant décédé) ; effets d'assurance (comportement volontaire pour remplacer les décès d'enfants) et effets sociaux (comportement volontaire provoqué par les normes de la société ou par la réorganisation de normes sociales anciennes qui reflète la réponse suscitée par le niveau de la mortalité infantile et de celle des enfants) qui forment le contexte socio-culturel de reproduction dans lequel vivent les couples.

Les trois derniers concepts peuvent aussi être considérés comme l'expérience personnelle lors de la perte d'un enfant (il s'agit ici de l'effet de remplacement), comme la crainte de cette perte sans en avoir l'expérience personnelle (il s'agit alors de l'effet d'assurance) et comme la perception qu'a la communauté du recul de la mortalité (il s'agit dans ce cas des effets sociaux). Les problèmes qui se posent pour mesurer et surtout pour graduer cette crainte et la perception de la communauté sont différents selon que les données proviennent de réponses à des questions directes ou à des questions indirectes.

On peut aussi distinguer un effet de la mortalité infantile et de celle des enfants qui risque d'égarer les recherches. Il s'agit d'un effet de la fécondité sur la mortalité qui, encore qu'il se fasse sentir dans la direction opposée à celle que l'on envisage dans le présent séminaire, peut être pris pour un effet volitif de la mortalité sur la fécondité. Cet effet peut tenir à la "concentration des naissances", c'est-à-dire à la naissance de deux enfants ou davantage dans un laps de temps si court qu'il risque de nuire à la santé de la mère. Il n'est pas encore possible de définir avec plus d'exactitude la concentration des naissances car la manière dont elle agit sur la mortalité reste mal connue. Mais il est hors de doute qu'elle augmente beaucoup les risques de décès chez les enfants qui y sont exposés.

Les intervalles entre naissances ont été définis comme le nombre de mois et de jours entre les accouchements.

Dans ce séminaire, on n'est parvenu à aucune définition satisfaisante de la résidence rurale pour la distinguer de la résidence urbaine et les participants ont invité les chercheurs à être prudents lorsqu'ils comparent des populations de ce point de vue. Il faut bien s'assurer que les contextes sociaux sont à peu près analogues. Par exemple, dans certaines régions d'Afrique de nombreuses femmes sont classées comme "urbaines" dans les recensements si leur mari travaille dans une petite ou dans une grande ville. Et, pourtant, elles habitent toujours dans la zone rurale d'où leur mari est parti.

Plusieurs concepts se sont révélés utiles pour discuter des études historiques ou de celles qui portent sur des populations modernes.

L'un d'eux, l'hypothèse du seuil s'efforce d'expliquer le décalage de temps que l'on observe entre la baisse de la mortalité infantile ou de celle des enfants et le déclin de la fécondité qui la suit. Il faut en effet que ce recul de la mortalité soit assez important pour que les populations prennent conscience du fait qu'il n'est plus nécessaire d'avoir tant d'enfants pour parvenir à la dimension de la famille qu'ils ont envisagée. Avant d'atteindre ce seuil, c'est-à-dire tant que le recul de la mortalité n'est pas réellement perçu, les changements de la fécondité peuvent rester peu importants ou même ne pas apparaître du tout.

Un second concept discuté dans ce séminaire et qui présente peut-être une valeur méthodologique et analytique est celui de la "négligence". Utilisée comme hypothèse nulle, elle viserait à expliquer à la fois une forte fécondité et une forte mortalité infantile comme résultat d'une troisième variable, la négligence. Les femmes dont les enfants meurent parce qu'on ne leur donne pas les soins nécessaires peuvent également se montrer négligentes dans la pratique de la contraception.

Une troisième distinction peut aussi s'avérer utile. Elle consiste à distinguer le recul de la mortalité dû à l'introduction de technologies venues de l'extérieur des pays où on les utilise, par exemple pour combattre les épidémies, du déclin de la mortalité qui tient principalement à l'amélioration des conditions culturelles et/ou socio-économiques qui se produisent au sein de cette société elle-même.

Enfin, le concept de "règles d'arrêt" peut présenter un intérêt dans la discussion. On entend par là un principe culturel qui indique, de manière plus ou moins contraignante, la dimension de la famille que la société considère comme maximale. Bien entendu, toutes les cultures n'ont pas des "règles d'arrêt" explicites.

Niveaux de l'étude

Il a été généralement reconnu au séminaire que l'analyse des données globales est moins appropriée pour l'étude des relations entre la fécondité et la mortalité infantile et celle des enfants que l'analyse au niveau des familles.

Les phénomènes étudiés sont sujets à des interactions réciproques. Une forte mortalité des enfants peut entraîner une forte fécondité et celle-ci peut provoquer une forte mortalité des enfants. Il est difficile de séparer ces effets dans des études transversales portant sur des données globales.

Peut-on déceler des relations entre la mortalité et la fécondité au moyen de données longitudinales portant sur un ensemble de populations? A en juger par les données provenant de la Corée, il semble que seules les données individuelles permettent des analyses de ce genre. Cependant les tendances longitudinales sur la mortalité des enfants et la fécondité demeurent de bons outils pour déceler les relations entre ces variables dans l'ensemble d'une société. Les changements de la mortalité infantile et de celle des enfants (de 1 à 9 ans) peuvent être rapportés à l'âge des femmes au premier mariage ou à d'autres variables qui exercent une influence. On peut donc retirer beaucoup d'enseignements des études portant sur des données d'ensemble. Dans la question qui nous intéresse ce genre d'analyse peut mettre en lumière certaines causes profondes des phénomènes et certaines sources d'erreurs systématiques.

Pour estimer l'importance des mécanismes sociaux, il faut analyser comment ils parviennent à maintenir la dimension de la famille achevée aux alentours d'une certaine norme. Il s'agit ici des "règles d'arrêt" dont il a été question plus haut.

La communication de Macura, au présent séminaire, sur l'estimation de la mortalité des enfants à partir de données rétrospectives, ainsi que des recherches analogues sur la fécondité à partir de données également rétrospectives présente un grand intérêt à cet égard car elle permet de tirer des mesures de la mortalité et de la fécondité au cours du temps à partir de données globales pourvu que celles-ci ne conduisent pas à de graves erreurs systématiques. L'un des participants nous a cependant mis en garde contre les dangers d'une trop grande dépendance à l'égard des modèles. Il a fait ressortir que les méthodes utilisées pour corriger la fécondité et la mortalité des enfants peuvent elles-mêmes être corrélées. Cependant les données rétrospectives recueillies dans certains pays, en particulier dans les pays africains sont dans une large mesure, déficientes. Un article de Brass apporte des précisions au sujet de la correction des erreurs commises au cours du temps dans les séries chronologiques qui proviennent des souvenirs que les femmes rapportent sur leur vie génésique. Des travaux de ce genre sont en cours à l'Université de Princeton.

En fait, les données globales conviennent fort bien à l'analyse des effets sociaux. Comme l'a remarqué un des participants, si les effets sociaux s'exercent au moyen des normes auxquelles se plient les populations vivant dans des zones culturellement homogènes, il peut même être préférable de grouper les données pour travailler sur de grandes unités plutôt que de les fragmenter en petites zones. On peut ainsi faire porter l'analyse sur une vaste zone culturelle qui peut s'étendre à une région entière ou même à un pays entier au lieu de se limiter à des provinces ou à des villes.

Toutefois, un autre participant a exprimé son désaccord complet quant au choix de vastes zones comme unités pour l'analyse des relations écologiques. Manifestement, les petites zones peuvent être regroupées pour parvenir à des résultats portant sur l'ensemble alors qu'on ne peut scinder les résultats si on opère sur un ensemble. A son avis, la seule justification qu'on puisse trouver si on ne choisit pas les plus petites unités possibles serait le coût qu'entraîne cette manière de procéder. En effet, plus la population étudiée est hétérogène, plus l'analyse risque de s'avérer inutile.

En bref, donc, l'approche la plus recommandée pour étudier les effets volitifs de la mortalité infantile et de celle des enfants sur la fécondité est l'étude des familles, c'est-à-dire celle faite au niveau du couple individuel. Les études prospectives ou quasi prospectives ont été reconnues comme plus probantes du fait des possibilités de contrôle, surtout lorsqu'il s'agit d'échantillons importants, mais on prévoit que les études rétrospectives sur les familles seront plus nombreuses car portant sur des échantillons relativement petits, elles sont peu coûteuses.

Ainsi que l'a exprimé l'un des participants, ce sont les études relativement de peu d'envergure orientées dans la même direction, même si elles portent sur des populations de cultures très diverses, qui pourront apporter les réponses aux questions posées dans le présent séminaire.

Biais dans les études rétrospectives

Quels sont les biais et les erreurs d'interprétation qu'on peut craindre dans les études qui font appel aux souvenirs des personnes interrogées ? Pour répondre à cette question, il faut dire que les mesures utilisées dans chaque étude doivent être examinées d'un oeil très critique afin d'estimer si elles risquent d'être affectées par des biais stochastiques, par l'infécondité qui suit l'accouchement, par les effets de la fécondité ("concentration des naissances" et son influence sur la nutrition du premier enfant, manque de soins qui en résulte pour lui, etc.) sur la mortalité ou par d'autres causes d'erreur systématique. Les résultats des modèles par simulation nous ont surpris en montrant toute l'importance de ces effets perturbateurs et, si on n'y prend garde, ces biais peuvent affaiblir les conclusions des études sur les familles ou même leur ôter toute valeur. En général, les biais ou les facteurs perturbateurs qui posent des difficultés dans la simulation par ordinateur sont encore plus redoutables lorsqu'on travaille sur des données empiriques. D'autre part, ainsi qu'il a déjà été observé, de nombreuses études de famille orientées vers une hypothèse qu'il s'agit de vérifier seraient d'une grande valeur surtout si elles sont faites dans des régions très diverses où les conditions de vie sont très différentes.

Plusieurs participants pensent que les erreurs de mémoire, tout en étant inévitables, peuvent être réduites au minimum si on prend certaines précautions. Par exemple l'enquête coordonnée de l'OMS qui a été menée séparément dans neuf pays a analysé les dernières grossesses c'est-à-dire celles pour lesquelles les erreurs de mémoire sont minimes. En Inde, s'est déroulée une enquête longitudinale qui a duré deux ans (en relation avec l'enquête coordonnée de l'OMS dont il a été question) et pour laquelle des questions ont été posées de six semaines en six semaines pour corriger ce genre d'erreurs.

En outre, la mémoire des femmes quant aux naissances et aux décès a été étudiée pour les Philippines méridionales par l'Institut de Recherche pour la culture de Mindanao (RIMCU) de l'Université Xavier. Les résultats indiquent que, dans la population urbaine, les erreurs, 18 mois après l'événement, sont de beaucoup plus importantes qu'après 12 mois mais l'écoulement du temps de 6 à 12 mois ne change pas grand-chose. Il en va de même dans la population rurale. Il ressort de cette étude que les femmes n'oublient pas un décès au bout de 12 ou de 18 mois mais qu'elles le situent mal par rapport au présent événement, étant d'ailleurs tout aussi souvent éloigné que rapproché dans leurs souvenirs.

Un participant a fait ressortir assez vigoureusement que les études rétrospectives organisées par l'Enquête sur la fécondité dans le monde (WFS) sur les relations entre la mortalité infantile ou la mortalité des enfants et la fécondité coûtent bien cher par rapport aux résultats qu'elles peuvent apporter car, portant sur des échantillons trop petits (quelques milliers d'observations), elles ne permettent pas de disposer d'un nombre suffisant d'observations pour croiser les données dans l'analyse de certaines relations.

D'autres ne partageaient pas cette opinion et pensaient que les enquêtes sur la fécondité mondiale pouvaient apporter des résultats importants sur les relations entre la mortalité des enfants et la fécondité, surtout si, malgré les différences de pays et de culture, ces résultats concordaient entre eux. Les directives et la dimension des échantillons, a-t-on fait remarquer, peuvent être modifiées dans certains pays. Tous étaient d'accord, cependant, sur le fait qu'il serait souhaitable que les données de ces enquêtes (qui commenceront à être divulguées l'année prochaine ou à peu près) soient traitées selon des méthodes appropriées pour établir clairement quel effet les changements de mortalité ont sur le comportement reproducteur.

Selon un participant nous sommes près de disposer d'une nouvelle méthode susceptible d'améliorer l'efficacité des études rétrospectives, il s'agit de l'approche de Cho Grabill sur les enfants qu'on a eus. Si le recensement d'un pays comportait quelques questions exigées pour la méthodologie, si on disposait des

données convenables sur la mortalité et si les âges indiqués étaient relativement exacts, on disposerait d'échantillons de très grande dimension qui permettraient de tenir compte de nombreuses variables socio-culturelles et économiques même si on devait procéder à une analyse très détaillée.

Mesures, techniques et observations méthodologiques

De l'avis d'un des participants, il y a lieu de souhaiter que toutes les hypothèses de recherche soient soigneusement explicitées dans les études inspirées par le CICRED sur le sujet dont il est question au Séminaire. Cela pourrait inclure des hypothèses relatives au choix du sujet de recherche.

Les indices utilisés pour mesurer la mortalité infantile et celle des enfants sont multiples. Parmi eux, il y a les taux de mortalité infantile et de mortalité des enfants strictement définis, les taux de mortalité au-dessous de 5 ans (de type table centrale et table de mortalité, c'est-à-dire 5/Mo et 5 Qo) les taux de mortalité jusqu'à 10 ans et même jusqu'à 15 ans, le nombre de décès d'enfants selon le rang de naissance, les proportions normalisées des enfants décédés selon le rang de naissance et le nombre d'enfants en bas âge et d'enfants qui sont décédés rapporté à l'intervalle médian entre leur naissance et la naissance suivante.

Un des participants a affirmé que pour étudier les effets biologiques et les effets de remplacement, le décès avant 5 ans est un meilleur indice que le décès avant 10 ans. Un autre participant, cependant, tout en se déclarant d'accord sur le fait que le risque présenté par les biais tenant aux effets de la fécondité sur la mortalité infantile et celle des enfants, était plus fort lorsqu'il s'agissait des enfants presque parvenus à l'adolescence, estimait qu'on peut éliminer ces biais et que, dans ce cas, la mortalité jusqu'à 10 ou 15 ans permettait de mesurer plus exactement l'effet de la mortalité infantile et de celle des enfants sur la fécondité.

Parmi les indices utilisés pour mesurer la fécondité on peut citer le taux brut de natalité, les taux de fécondité par âge, la probabilité d'agrandissement des familles, l'intervalle médian entre naissances selon le rang de naissance, le nombre moyen de grossesses par femme et le nombre total de grossesses pour les femmes du groupe d'âges 40 à 44 ans.

Pour calculer la durée moyenne des intervalles entre naissances, a-t-on observé, la moyenne arithmétique ne semble pas convenir du fait des variations d'espacement. La moyenne harmonique en fait, semble mieux appropriée.

Quelques-unes des techniques utilisées pour comparer la mortalité infantile et celle des enfants à la fécondité ont été la corrélation totale, partielle et multiple, la régression linéaire de degré zéro ou de degré plus élevé, la régression curvilinéaire, les probabilités d'agrandissement selon qu'il y a 0 enfant, de 1 enfant à 3 ou 4 enfants décédés et les intervalles médians entre les naissances selon le rang de naissance et l'âge de la mère.

En ce qui concerne la mesure des effets volontaires de la perte d'un bébé ou d'un enfant sur la fécondité, de nombreuses mises en garde ont été formulées. En premier lieu, il faut signaler les difficultés que présente l'utilisation de la théorie des populations stables et/ou les tables-types de mortalité en relation avec les estimations de la fécondité puis la corrélation entre les indices de naissances et de décès. Comme l'estimation de la population stable et les tables-types de mortalité se fondent sur des hypothèses sur la mortalité, les corrélations entre les estimations de la fécondité et de la mortalité en seront affectées. De plus, les tables-types peuvent conduire les chercheurs mal informés qui s'en servent à admettre qu'il y a un recul de 0 à 1 an et de 1 à 4 ans alors qu'il n'en va pas ainsi dans la population étudiée (du fait d'extrapolations hasardeuses).

En second lieu, il importe d'étudier de près la méthodologie utilisée pour mesurer l'influence de la mortalité infantile ou de celle des enfants sur l'intervalle entre naissances et sur les naissances postérieures. Si on choisit la mortalité de 0 à 9 ans pour représenter la mortalité des enfants et si un enfant meurt à 8 ans, il semble peu probable que sa mort affectera la durée des intervalles entre sa naissance et la naissance suivante encore qu'elle puisse raccourcir l'intervalle entre la dernière naissance avant sa mort et celle qui suit cette dernière.

En ce qui concerne les études faites sur des données pour lesquelles l'enregistrement des décès des nouveau-nés et des enfants est mauvais, on a fait remarquer de nouveau que si, par exemple la complétude de l'enregistrement est de 70 % environ, on ne peut estimer le biais qui en résulte par des procédés négatifs même si on n'est pas sûr que les 30 % soient atypiques, mais seulement par des procédés positifs (si on sait que ces 30 % de décès manquants sont typiques ou si on sait dans quelle mesure ils s'écartent du reste).

Enfin la cohérence des différences des effets de la mortalité des enfants sur la fécondité au cours du temps peut sembler beaucoup plus forte qu'elle ne l'est en réalité si les mesures sont refaites pour la même femme. La cohérence, dans ce cas, tient bien entendu, en partie à la répétition de la même expérience alors que pour être valable il faudrait qu'elle provienne d'expériences indépendantes.

Observations méthodologiques

A diverses reprises, dans ce séminaire, des observations intéressantes ont été faites sur la méthodologie. Ces remarques tendent à être disparates mais elles ont été regroupées pour plus de facilité dans le présent paragraphe et dans les suivants. Plusieurs participants ont fait ressortir que l'élément utile de la pente (en relation avec l'analyse par corrélation et par régression) ne devrait pas être perdu de vue en relation avec le sujet du séminaire. En supposant – ce qui est contraire à la réalité – que le remplacement des enfants décédés soit complet, si on considère la pente attendue, il est évident que l'influence de la mortalité sur la fécondité sera probablement masquée par d'autres influences au niveau des données globales. Par exemple, étant donné une mortalité infantile allant de 100 à 200 pour 1000 naissances vivantes, le remplacement complet des enfants pourrait impliquer un taux brut de natalité de 36 p. 1000 et non de 33 p. 1000 (sans remplacement) si on maintient les mêmes proportions pour la mortalité et la fécondité pour 1000. Ceci revient à dire que les différences importantes de la mortalité infantile seraient associées à des différences minimes de la fécondité même pour un remplacement maximal au niveau de la famille. C'est probablement pourquoi on parvient à des résultats si différents lorsqu'on étudie les corrélations au niveau global. La relation attendue est faible et la pente est aisément masquée par d'autres caractéristiques. Cependant cela ne signifie pas qu'il n'existe pas une influence réelle. De plus, si nous obtenons une pente plus marquée, il s'ensuit que les effets au niveau social se font sentir.

Les données provenant du recensement français de 1906 ont été examinées pour y déceler la relation entre le niveau de la mortalité infantile et la dimension de la famille complète. Il en résulte que – et d'autres études confirment ce point, en particulier celles sur les Mormons – la mortalité des enfants présente de plus fortes corrélations avec la dimension finale de la famille qu'avec le rang de naissance. En 1906, la contraception était très répandue en France ce qui confirme l'importance des aspects volontaires sur la dimension de la famille complète.

Certains résultats montrent des probabilités d'agrandissement plus faibles dans les familles dont un des enfants est mort que dans les autres couples (données de Rutstein et Medica pour la Colombie et le Pérou). Mais ils sont sujets à caution. L'explication qui a été fournie relativement à des problèmes sanitaires qui auraient provoqué à la fois les décès d'enfants et une plus basse fertilité chez la mère ne sont pas d'un grand secours. Elle n'aide pas à comprendre pourquoi ces effets se font sentir dans un pays et pas dans l'autre. Une explication possible est que certaines maladies font baisser la fertilité tout en augmentant la mortalité des enfants. C'est le cas pour la syphilis congénitale et le paludisme. En Inde, dans les régions où le paludisme était à l'état endémique, on a remarqué que la fécondité augmentait légèrement lorsque le paludisme disparaissait.

Selon un des participants, pour l'étude des effets de remplacement, il faudrait que la probabilité d'agrandissement des familles ayant eu (n) enfants et qui n'ont perdu aucun nouveau né et aucun enfant, soit comparée à la probabilité d'agrandissement des familles ayant eu (n) enfants et qui avaient eu ($n + 1$) enfants mais qui avaient perdu cet enfant supplémentaire. Selon lui, la comparaison des familles ayant ($n + 1$) enfants sans en avoir perdu un seul avec les familles ayant (n) enfants du fait du décès d'un enfant était sujette à caution. Si on suppose que (n) enfants donnent aux parents une certaine quantité de satisfaction (y) alors que le $n + 1$e enfant fournit aux parents une quantité différente et peut-être inférieure de satisfaction (z), alors la probabilité de remplacement (P_z) est différente de la probabilité de remplacement (P_y) et lui est souvent inférieure. Cependant, deux participants ne partageaient pas ce point de vue.

On peut opposer dans l'analyse la survie ou le décès de l'enfant précédent et associer chacune de ces alternatives avec la fécondité postérieure en l'exprimant par l'intervalle moyen qui sépare la naissance précédente de la suivante. Cette mesure a été utilisée avec succès pour résoudre le problème posé par la concentration des naissances (associée à une forte mortalité) qui risque de masquer les effets volontaires de la mortalité sur la fécondité. Un autre système de mesure est fourni par le nombre de décès selon le rang de naissance jusqu'à la parité 3 ou 4.

Une manière de mesurer la "fécondité excédentaire" c'est-à-dire les effets volontaires de la mortalité infantile ou de celle des enfants sur la fécondité a été indiquée dans le tableau II de la communication Lery-Vallin. Il s'agit de :

$$\frac{\text{Colonne 1} - \text{Colonne 2}}{\text{Colonne 2}}$$

Un participant a suggéré qu'une autre mesure du même genre, révèle mieux dans quelle mesure les familles remplacent vraiment un décès d'enfant car cette mesure éliminerait l'"effet de plafond" produit par l'impossibilité de dépasser l'unité. Il a utilisé cette mesure pour montrer (voir tableau III de sa communication) que chez les agriculteurs on notait des effets de remplacement plus importants que parmi les membres des professions libérales. Cet indicateur est le suivant :

$$\frac{\text{Colonne 1} - \text{Colonne 2}}{1 - \text{Colonne 2}}$$

Cependant, tout le monde (y compris les auteurs) ne s'est pas déclaré d'accord sur la supériorité de ce nouvel indicateur par rapport à celui qui est recommandé dans la communication.

Un biais peut changer de direction si on utilise des moyens de contrôle et on a fait remarquer qu'il est bon de s'en souvenir lorsqu'il s'agit d'interpréter les résultats. Il s'agit là, bien entendu, d'un phénomène général qui ne se limite pas à la question discutée ici. Les facteurs qu'il convient de contrôler dans les sciences humaines ne peuvent que rarement l'être complètement. Il faut donc employer des contrôles partiels au moyen d'indicateurs plutôt que de se servir des variables exactes qu'on se propose en définitive de contrôler. Il en résulte que l'élément qui n'exerce pas d'influence sur la caractéristique qu'on veut contrôler tend à varier de manière aléatoire. L'effet stochastique produit tend à renverser la direction du biais par rapport à celle de la variable non contrôlée.

Lorsqu'il y a sous-enregistrement des décès d'enfants, l'importance de l'effet de remplacement est artificiellement réduite, selon un des participants, et non pas artificiellement gonflée comme l'avait admis un autre participant. Une femme qui a en fait perdu un enfant sans que le décès soit enregistré est placée dans la catégorie des "sans décès d'enfants". Si elle remplace l'enfant décédé la fécondité postérieure moyenne du groupe "sans décès d'enfants" se trouve gonflée artificiellement et les effets de remplacement en sont diminués d'autant.

On a fait observer qu'en reportant sur graphique la mortalité des enfants selon l'âge de la mère au premier mariage, on obtient une courbe en forme de U. Un participant a donc été conduit à faire remarquer que cette courbe ne convenait pas à l'étude de la mortalité des enfants en fonction de l'âge de la mère à la naissance d'un enfant. Cependant, un autre participant a fait ressortir qu'on pouvait quand même faire une analyse appropriée en classant les observations selon l'âge de la mère (de 15 à 30 ans d'une part et 30 ans et au dessus, de l'autre) et en analysant séparément les deux sous-échantillons.

On a également observé que l'effet de la mortalité intra-utérine sur la fécondité ultérieure semble avoir tendance à se distribuer selon une courbe en forme de U. Les probabilités d'agrandissement tendent à être basses lorsqu'il n'y a pas de décès intra-utérins ou lorsqu'il y en a beaucoup.

Selon un des participants, l'analyse discriminante pourrait être utilisée pour analyser les facteurs qui déterminent la fécondité . La division des unités d'études en groupes classés selon les caractéristiques de fécondité ou de mortalité ou selon leurs relations permettrait de chercher des mesures pour faire des distinctions entre ces groupes et pour définir par conséquent les conditions dans lesquelles se produit l'effet de remplacement volontaire de la mortalité des enfants (ou l'effet "d'assurance"). L'analyse discriminante ou par régression multiple devrait cependant être utilisée prudemment, comme l'a fait remarquer un autre participant. La régression multiple peut indiquer que la mortalité explique la plus grande partie de la variance de la fécondité et elle permet aussi d'interpréter les mêmes données pour signifier que les changements de la fécondité peuvent expliquer la plus grande partie de la variance de la mortalité des enfants. Le problème est de déterminer si le cheminement de l'interaction va de la mortalité à la fécondité ou si c'est l'inverse qui se produit. Un mécanisme peut exister par lequel une forte fertilité peut être biologiquement en corrélation avec une forte mortalité des enfants, s'il en est ainsi, l'analyse ne peut distinguer ces effets biologiques sur le remplacement des effets volitifs, sauf peut-être si on recourt aux études de répartition de second ordre dont il est question dans la communication de Brass. Si on pose des effets surtout volontaires, la forme de la répartition du nombre de décès d'enfants selon l'âge et la parité de la mère devrait être influencée de manière différente de celles que l'on observerait si les effets avaient été surtout non volitifs. Par exemple, cette approche pourrait être utilisée pour séparer les effets dus à la "négligence" de certaines femmes des effets dus à un "remplacement" délibéré ou à l'"assurance". Cependant il se peut qu'il soit possible de séparer plus facilement ces effets en recueillant des données supplémentaires.

Les résultats de l'analyse par corrélation au niveau global (en particulier la corrélation de degré zéro) ont été observés de très près dans les nombreux résultats des études par un des participants. C'est surtout parce que ces études s'appuyaient sur des moyens de mesure assez frustes, tels que le taux brut de natalité qu'il a conclu que l'analyse par corrélation des influences de la mortalité sur la fécondité ne saurait fournir des résultats fiables en particulier s'il y a un décalage entre le déclin de la fécondité et celui de la mortalité infantile et si la méthodologie utilisée pour tenir compte de ce décalage n'est pas soigneusement mise au point.

Un autre participant a complété cette conclusion en remarquant que, bien que les techniques de corrélation et de régression aient souvent été mentionnées au cours du séminaire et qu'elles aient été utilisées dans de nombreuses études, elles restent insuffisantes pour analyser les relations subtiles et complexes dont il est question ici. Cela est si évident qu'il conviendrait de mettre au point et d'adopter des approches statistiques mieux appropriées.

A cet égard, un des participants a suggéré que les coefficients de régression partielle et de corrélation devraient être normalisés. Selon lui, il conviendrait de diviser le coefficient partiel par l'écart-type de la variable dépendante ou de la variable indépendante, selon les cas.

Les techniques d'analyse multivariate sont de plus en plus recommandées dans les études de ce genre.

Elles sont préférées aux approches conventionnelles de classification et de normalisation. Les techniques à stages multiples et les techniques de régression par la méthode des moindres carrés ont été employées dans quelques modèles de relations entre la fécondité et la mortalité des enfants, mais depuis quelque temps c'est l'analyse par classification multiple qui tient le devant de la scène. Elle peut s'avérer être la meilleure méthode pour traiter le genre de données dont il est question ici. Elle présente de grands avantages sur les autres techniques qui sont en concurrence avec elle, et en particulier sur celles qui sont le plus anciennement employées. Elle utilise des variables fictives et ne nécessite aucune hypothèse de linéarité, (ce qui n'est pas le cas pour la régression multiple c'est-à-dire linéaire). Elle est en outre extrêmement flexible. L'analyse par cheminement peut également s'avérer utile pour étudier la relation entre mortalité et fécondité.

L'une des difficultés auxquelles on se heurte pour l'utilisation de l'analyse par classification multiple est la limitation imposée par les programmes d'ordinateur qui ne peuvent traiter que des effets additifs. Cependant, un des collègues du professeur Brass, le professeur Osborne, vient de mettre au point un programme de classification par multiplication multiple. Cette méthode répartit les données en sous-groupes dans de nombreux cas. Le programme jusqu'ici a été appliqué pour étudier les effets de l'âge de la mère, la parité et les intervalles entre naissances sur les mort-nés et sur les composantes de la mortalité des enfants.

Contrôle sur les variables qui entrent en jeu

Si on ne parvient pas à contrôler les variables socio-culturelles et économiques telles que l'âge de la mère, l'instruction, la profession du chef de famille et le statut socio-économique de la famille, on peut aboutir à des résultats qu'il est impossible de comparer et qu'on ne peut grouper. Les termes urbain et rural devraient être définis de manière uniforme pour permettre les comparaisons entre unités analogues d'une culture à l'autre.

On a recommandé les études portant sur des cultures et des pays divers lorsque les données le permettent mais il faut être très prudent lorsqu'il s'agit du concept de famille. La famille souche en Europe, la famille non nucléaire en Inde, la famille patriarcale de la Chine avant la Révolution et la famille étendue des Philippines, par exemple ne doivent pas être traitées en bloc car elles représentent des types de famille de structures très différentes. On peut s'attendre à ce que ces divers types de famille étendue exercent des influences différentes sur le comportement social en particulier pour l'âge au premier mariage, les coutumes conjugales et la valeur donnée aux enfants. Pour ces raisons et pour d'autres tout aussi pertinentes, on a souvent insisté sur l'importance, non seulement des considérations statistiques et démographiques, mais aussi sur la nécessité de contrôler les variables socio-culturelles et économiques importantes. C'est probablement le point qui a été le plus souvent mis en lumière au cours du séminaire.

Plusieurs participants ont recommandé une utilisation plus prudente de la méthodologie sociologique pour étudier les effets volitifs de la mortalité des enfants sur la fécondité. Les entrevues en profondeur et une meilleure conceptualisation des variables socio-culturelles et économiques ont été considérées comme faisant partie de la stratégie pour attaquer le problème. Comme l'a remarqué un des participants, les études historiques en Europe ne prouvent guère que le déclin de la mortalité des enfants suffit à déclencher directement une baisse de la fécondité, si d'autres facteurs n'interviennent pas. Le recul de la mortalité infantile peut cependant appartenir à un complexe de causes qui y contribuent, surtout si on garde présente à l'esprit l'hypothèse du seuil.

Parmi les valeurs et les attitudes socio-culturelles, on a insisté à cet égard sur l'importance des normes relatives à la dimension de la famille et sur les buts qu'on se fixait en relation avec l'effet de "remplacement" ou "d'assurance". Parmi les éléments socio-culturels et économiques on accordait en général la première place au degré d'instruction de la mère. En ce qui concerne les questions portant sur la dimension idéale, désirée ou attendue de la famille, on a insisté sur le fait que dans certaines cultures, la composition par sexe des enfants survivants peut avoir une influence considérable sur les décisions qui affectent la fécondité ultérieure. On a également fait ressortir qu'il convient de distinguer entre les populations où une proportion importante de couples mariés pratiquent la contraception des populations où il en va autrement soit parce que la connaissance de la contraception n'existe pas ou que, pour quelque raison, elle ne pouvait être pratiquée à l'époque de l'étude. L'âge au mariage a été mentionné comme un mécanisme social qui limite la dimension de la famille (c'est-à-dire que l'âge au mariage s'élève si la mortalité des enfants baisse et réciproquement). Mais il est bien entendu que les pressions sociales sur la nuptialité et la fécondité ne sauraient changer rapidement et que, par conséquent, les décisions relatives à la famille moyenne ne peuvent s'en trouver affectées à court terme.

Pour étudier l'existence des effets volontaires de la mortalité des enfants sur la fécondité, est-il nécessaire de trouver des populations dans lesquelles la pratique de la contraception est importante ? Si le pourcentage maximal des couples qui ont pratiqué la contraception est inférieur à, disons 35 %, une manière pour étudier les effets volontaires dans ces populations serait de diviser l'échantillon en deux parties : ceux qui pratiquent la contraception et ceux qui ne la pratiquent pas. Cependant, la contraception n'est pas le seul moyen par

lequel s'exercent les pressions sociales propres à réduire le nombre des grossesses. Outre le mariage différé, on a remarqué que, dans certaines cultures, les grossesses ou tout au moins les accouchements sont évités par la pratique traditionnelle de l'abstinence, par le fait que l'épouse vit chez ses parents pendant une longue période après l'accouchement et par l'avortement. La coutume d'allaiter les enfants tend également à allonger la période d'aménorrhée après l'accouchement.

On a reconnu que la lactation et la période d'aménorrhée qui en dépend constituent un facteur biologique et physiologique important qu'il convient de contrôler pour essayer d'étudier les effets volontaires de la mortalité infantile et de celle des enfants sur la fécondité, en particulier parce que les aspects socio-culturels et économiques sont si étroitement liés à la durée et aux effets de la lactation (femmes sous-alimentées). Les études faites au Nigeria, par exemple, ont révélé une variation de la durée de l'allaitement allant de 6 mois à 3 ans et demi et même parfois la lactation n'est pas pratiquée du tout.

Selon un des participants, cependant, les ouvrages et les articles de démographie ont attribué une influence de l'allaitement sur les intervalles entre naissances plus forte qu'il n'apparaît d'après les études cliniques. Il estime que l'intervalle entre naissances n'a été allongé de manière significative que lorsque c'était des femmes sous-alimentées qui pratiquaient la lactation.

On a indiqué en outre, que l'effet de la lactation sur l'aménorrhée après accouchement n'est pas constant dans toutes les populations. Des recherches sur cette question seraient utiles.

Des intervalles courts entre naissances, a-t-on remarqué, qui à première vue tiendraient à la mortalité infantile peuvent très bien, en réalité, être dus à la fécondité plutôt qu'à la mortalité. En effet, une grossesse qui survient lorsque le dernier né est encore très jeune peut faire négliger celui-ci et cette négligence peut lui être fatale. Il semble possible qu'une femme qui n'a pas pratiqué soigneusement la contraception peut se montrer négligente de la santé de ses enfants. S'il en était ainsi, la mortalité infantile et la fécondité dépendraient très étroitement l'une de l'autre.

En ce qui concerne "l'hypothèse de la négligence", une analyse par classification multiple des éléments qui déterminent la mortalité des enfants (de 0 à 5 ans) a été faite dans l'étude de Heer-Wu sur Formose. La variable la plus importante portait sur le décès des frères et soeurs. Ceci est en accord avec l'hypothèse selon laquelle la négligence et l'incompétence de la mère peuvent être un facteur commun du décès des enfants et de l'augmentation de la fécondité.

Un des participants a fait ressortir qu'il y a un risque pour que les effets inverses soient interprétés comme une relation positive de la mortalité des enfants et de la fécondité du fait des effets volitifs si la concentration des naissances est forte et si l'intervalle attendu entre naissances varie. Cela affecterait la mesure des naissances dues au remplacement consécutif au décès d'un enfant en faisant intervenir des naissances qui, en fait, ne sont pas des naissances de remplacement. Certes ces effets inverses peuvent être faibles (car une naissance précède un décès et ne le suit pas) mais les différences provoquées par les effets de remplacement, surtout dans les études historiques, peuvent être également très faibles. Si on essaie d'éviter ces effets inverses par des contrôles, on peut perdre toute sensitivité.

C'est alors qu'il a été remarqué combien il est important de distinguer soigneusement trois sources d'expérience : l'expérience personnelle directe, l'expérience personnelle indirecte et l'expérience et les pressions sociales. Elles sont analytiquement séparables mais elles ne sont pas distinctes dans l'expérience réelle des couples et sont indépendantes les unes des autres.

Un des participants a fait ressortir que si on essaie d'étudier et de contrôler les variables qui entrent en jeu, on est certes dans la bonne voie et que cette approche convient particulièrement bien à l'Afrique tropicale où les effets de la mortalité des enfants sur la fécondité s'exercent surtout par les améliorations socio-culturelles et économiques. Dans les zones rurales de ces régions, les enfants supplémentaires n'augmentent pas beaucoup les dépenses et ne nécessitent pas une attention particulière du fait de la structure de la société et de la famille. La famille matrilinéaire et patrilinéaire et les systèmes de parenté sont différents des modèles européens et asiatiques. Les structures sociales et les normes varient selon les groupes sociaux. Dans bien des sociétés, même si le père ou la mère meurt, son frère ou sa soeur assument la responsabilité des enfants et peuvent même continuer à propager la lignée du défunt.

Le déclin de la mortalité infantile dans les pays actuellement en voie de développement, a-t-on dit peut être attribué en grande partie à des programmes médicaux épidémiologiques et sanitaires dirigés par les gouvernements. Au contraire, en Europe, le recul de la mortalité était lié à l'ensemble des transformations sociales et économiques de la société. Cela signifie que les pays actuellement en voie de développement fournissent une occasion unique pour étudier les effets que peuvent avoir sur la mortalité des enfants les instructions relatives à la nutrition des enfants, les pratiques des sages-femmes, la plus grande utilisation des hôpitaux et la santé de la mère. Des études de ce genre faites sur de petites unités avec des échantillons de faible dimension peuvent révéler la dynamique et les mécanismes par lesquels la mortalité infantile et celle des enfants influent sur le déclin de la fécondité. Le projet démographique de l'Inde organisé par la Banque Mondiale dans deux provinces indiennes a établi le plan d'études des relations qui existent entre la fécondité

et la mortalité. Le travail d'enquête dans les zones rurales de l'Inde du Nord a montré une relation positive entre la mortalité des enfants au début de la vie conjugale et la fécondité ultérieure. Des études longitudinales faites par enquêtes à passages répétés peuvent fournir les données nécessaires pour mener à bien ce genre d'études.

Cependant, un autre participant a suggéré que les possibilités de déclin de la mortalité infantile provoquées de l'extérieur peuvent être très exagérées. Selon lui, il faut que des changements fondamentaux se produisent dans la société avant qu'apparaissent ces déclins.

Ces considérations ont conduit à remarquer qu'il existe plus d'un genre de transitions démographiques parmi lesquels le sujet du présent séminaire nous conduit à distinguer : a) la transition classique, b) la transition accélérée et c) la transition retardée.

Une autre variable qui intervient et sur laquelle l'attention a été attirée est la nutrition. Par exemple chez les Papous de la Nouvelle Guinée, parmi les peuplades mal nourries des montagnes, l'apparition des règles peut se produire à un âge aussi élevé que 18,7 ans et l'âge moyen à la ménopause dans les montagnes survient 4 ans plus tôt que dans la plaine où les habitants sont mieux nourris. Dans l'ensemble, la différence totale pour la durée de la vie féconde est de 6 à 7 ans entre ces deux populations.

Cependant, il y a des variables dont l'action se situe entre la nutrition et la fécondité et il convient d'examiner la question avec soin. On pourrait prévoir un autre séminaire pour étudier les effets de la nutrition et peut-être d'autres variables socio-économiques sur la fécondité. Ce sujet pourrait faire l'objet de recherches concertées. De plus, la mortalité infantile est souvent considérée comme un indicateur du niveau de vie. En fait il en est bien ainsi et cela implique que la distinction des effets du niveau de vie sur la fécondité des effets de la mortalité infantile et de celle des enfants peut être difficile à faire.

Selon un des participants certaines causes particulières de décès peuvent inciter les parents à ne pas remplacer les enfants décédés. Cependant, sauf si ces causes de décès sont courantes et si on peut véritablement montrer qu'elles exercent une forte influence sur les parents, on ne saurait considérer ce contrôle comme étant d'importance primordiale dans les présentes recherches sur la question.

L'attention a été attirée sur les relations entre la mortalité infantile et l'âge au mariage car la précocité du mariage provoque souvent une forte mortalité infantile. Un autre participant a fait remarquer, cependant, que l'incidence et le niveau de la mortalité infantile selon l'âge de la mère se répartissent selon une courbe en U. Il semble donc douteux que l'âge au mariage produise des différences sur les niveaux de la mortalité infantile. D'une manière générale, cependant, il convient de toujours considérer que les effets de la fécondité sur la nuptialité produisent des différences de mortalité.

On a aussi attiré l'attention sur l'effet de la mortalité infantile et de celle des enfants sur l'équilibre entre les sexes et les chances de se marier. La mortalité infantile et celle des enfants de 1 à 15 ans varient selon le sexe d'un pays à un autre. Les changements de la mortalité infantile pourraient provoquer un effet structurel sur la population et produire un déséquilibre sur le marché matrimonial. Si les hommes sont en général plus âgés que les femmes qu'ils prennent pour épouses et si la mortalité des enfants a baissé rapidement dans le passé, il peut en résulter un surplus de femmes qui ne peuvent trouver facilement un mari. Un des participants s'est efforcé de montrer alors qu'une réduction de la mortalité des enfants peut avoir un effet immédiat sur l'âge au mariage, de la manière qui suit : si un homme veut se marier, il peut décider d'épouser une femme plus vieille ou plus jeune que lui. Si la mortalité des enfants est élevée, cet homme peut décider de se marier à une femme relativement jeune qui peut avoir de nombreux enfants. Si la mortalité des enfants est basse, il peut décider de se marier à une femme relativement âgée pour éviter les frais qu'entraîne la limitation des naissances. A Formose, par exemple, l'âge au mariage, pour les femmes, s'est beaucoup élevé et il est devenu d'usage que les jeunes filles travaillent avant de se marier afin de se constituer une dot.

Ces effets du changement de la mortalité des enfants sur la nuptialité et sur la fécondité légitime nécessitent des études plus poussées. Il s'agit surtout du déclin de la mortalité, provoqué (a) par l'extension de la modernisation (b) par d'autres facteurs en l'absence de modernisation. En particulier pour le second type de déclin, les changements peuvent conduire à un conflit aigu entre la fécondité désirée ou la structure démographique et les institutions et normes traditionnelles de la société. L'acuité de ce conflit au niveau social avant que chacun des couples soit influencé à choisir les solutions contraceptives, c'est-à-dire avant le passage du niveau individuel au niveau global,peut être précisée grâce à la recherche. Celle-ci devrait se concentrer en premier lieu sur les sociétés dont les conditions de vie agricoles et sociales sont très différentes. Ces recherches devraient ensuite être soigneusement précisées pour permettre des analyses expérimentales.

Il faut prendre bien soin de définir la société ou la communauté, pour le calcul d'un taux de mortalité si on admet que celui-ci exerce une influence sur le comportement génésique de chacun des couples. Si la société ou la communauté prise pour calculer le taux n'est pas celle qui sert de groupe de référence pour le couple concerné, l'effet présumé de la mortalité sociétale ou de la communauté sera mal mesuré. Il convient d'orienter les recherches de manière à découvrir comment le recul de la mortalité des enfants provoque la pratique de la contraception. On a suggéré qu'il existait une dépendance entre ces deux phénomènes mais lorsqu'on l'examine

correctement, c'est-à-dire longitudinalement et non transversalement, on s'aperçoit que l'augmentation en elle-même (par exemple 16 % ou moins) n'est d'ordinaire pas assez importante pour être très décisive. Si on se fixe un but à propos de la dimension de la famille, par exemple si on veut qu'il y ait au moins un fils qui parvienne à l'âge que son père avait lors de la naissance de ce fils, il faut supposer que certains critères sont remplis qui sont propres à convaincre la famille qu'elle peut atteindre ce but, tout en réduisant sa fécondité. Cependant, pour comprendre comment se prend la décision d'éviter d'autres naissances, il faut considérer d'autres critères, tels que la répugnance à diviser le patrimoine foncier de la famille, ce qui est le cas lorsque deux fils survivent. Deux buts entrent alors en conflit et la famille doit peser les avantages et les inconvénients pour se décider à n'avoir qu'un fils et à pratiquer la limitation des naissances afin d'éviter d'en avoir deux. Comme les parents ne peuvent remettre leur décision jusqu'à l'époque où le premier fils est parvenu à l'âge adulte ou peut-être à l'adolescence, il faut avoir des indicateurs permettant de savoir si le premier fils survivra et un modèle d'étude de cette décision doit utiliser les mêmes indicateurs, par exemple a) si le premier fils a atteint l'âge de 10 ans ou b) si le deuxième fils naît alors que le premier vit encore. Les familles cessent de se reproduire quand elles ont atteint ce niveau indicateur. Le taux de croissance est-il plus élevé quand il n'existe aucune "règle d'arrêt" de ce genre que quand il y en a ? Quel est l'effet qu'a sur la croissance de la population une "règle d'arrêt" ? Des recherches dans ce domaine devraient être poursuivies.

Diverses zones utiles de recherches de ce genre ont été indiquées, en particulier la stérilité et la sous-fertilité ainsi que leurs conséquences et celles de la concentration des naissances pour les effets de remplacement.

L'hypothèse selon laquelle, dans certaines conditions lors des premières étapes de l'industrialisation et de la modernisation, l'augmentation du revenu entraîne celle du désir d'avoir plus d'enfants a souvent été confirmée (voir la communication de Retherford) par l'expérience des pays en voie de développement où la fécondité des agriculteurs, dit-on, est en fonction directe de leur revenu. S'il en est ainsi, peut-on expliquer pourquoi dans tous les pays ce sont les pauvres qui ont le plus d'enfants ? Ces contradictions apparentes s'expliquent si on essaie d'analyser les données des sociétés rurales modernes qui présentent une relation en forme de U. Par exemple, les enquêtes nationales sur la Turquie indiquent que la fécondité est élevée parmi les familles rurales dont le revenu est peu élevé, beaucoup plus basse parmi les agriculteurs dont le revenu est moyen et très élevée parmi les agriculteurs les plus riches qui ne forment qu'une petite minorité. Ainsi donc on peut s'attendre à ce qu'une répartition plus équitable des terres fasse baisser la fécondité.

Modèles économiques

Quelle est l'utilité des modèles microstatiques sur l'offre et la demande pour étudier les décisions des parents quant au remplacement d'un enfant ou au fait qu'ils s'assurent par une naissance contre la perte possible d'un enfant ? La décision de quelqu'un qui s'abandonne au hasard peut être très différente de celui qui s'appuie sur les probabilités objectives des risques auxquels il est confronté. Elle peut être beaucoup déterminée par les circonstances concrètes et particulières du moment. C'est pourquoi, un des participants estime que le modèle économique objectif n'est pas suffisamment susceptible de prendre en compte les facteurs réels qui entrent dans les décisions lorsqu'il s'agit d'avoir ou de ne pas avoir un enfant pour des motifs de remplacement ou d'assurance. En effet, ce modèle change trop selon les motifs qui poussent à prendre la décision. Les bébés ne sont pas comparables aux objets de consommation durables. Quel avantage net y a-t-il donc à les faire figurer dans cette rubrique ? Des normes sociales et économiques qui ont très peu en commun avec la relation purement économique d'offre et de demande influencent beaucoup la fécondité. De plus, la relation d'offre et de demande est statistique alors que la relation entre la mortalité des enfants et la fécondité volitive est dynamique. Cependant, un modèle de ce genre peut permettre de s'approcher des résultats de la relation réelle et cette possibilité devrait être exploitée dans les études d'observation. Cependant, selon un des participants, les recherches devraient être poursuivies de manière à tenir compte des désirs plutôt que de l'opposition entre offre et demande dans le présent séminaire. C'est en effet le désir qui détermine la fécondité et non la demande, bien que la demande puisse fixer un nombre minimal d'enfants au delà duquel le désir et les coûts peuvent plus ou moins s'équilibrer. Parmi les coûts qu'il convient de considérer figure le malaise psychologique qu'entraîne le fait de ne pas se plier aux normes traditionnelles et la perte du prestige (pour l'homme et pour la femme) qui, dans certaines sociétés, est associé à la possession d'une famille nombreuse. D'un autre côté, les coûts qu'entraîne le fait d'avoir plus d'enfants (nourriture, logement, soins et éducation) doivent entrer en ligne de compte.

Un autre participant, cependant, a soutenu qu'un modèle économique statique peut s'avérer utile si l'élément du choix est retenu. C'est seulement de manière empirique qu'on peut déterminer si les résultats obtenus se rapprochent des résultats réels. La question de savoir si le désir est plus important que la demande dans l'étude de la relation de la mortalité des enfants aux effets de remplacement volitif et d'assurance reste largement ouverte. La question du remplacement est une question de décision à laquelle doit répondre la famille et c'est pourquoi le cadre économique semble être celui qu'il convient d'adopter. Diverses dimensions sociales pourraient, bien entendu, y être ajoutées mais elles rendraient l'analyse beaucoup plus complexe.

Un troisième participant a fait ressortir qu'il pourrait être utile d'envisager une approche par les modèles économiques qui fasse intervenir les coûts d'utilité marginale.

Relations entre mortalité et fécondité : études historiques

Les résultats de l'analyse des données historiques des pays européens au cours de leur période de transition démographique sur lesquels porte le projet sur la fécondité européenne de Princeton n'aboutissent pas, pour le moment, à des résultats certains sur la relation entre la mortalité infantile et celle des enfants (de 0 à 14 ans) et la fécondité. Ils montrent cependant qu'un recul de la mortalité infantile (de 0 à 1 an) n'est pas une condition nécessaire à un déclin de la fécondité. Dans une province allemande sur deux à peu près, le déclin de la fécondité s'est produit environ 9 ans avant celui de la mortalité. En Belgique, la limitation des naissances s'est répandue, de manière significative, au moins 25 ans avant qu'apparaisse le recul de la mortalité infantile. En Suède, enfin, la mortalité infantile est tombée de 200 p. 1000 naissances vivantes avant 1800 à 130 p. 1000 en 1871-1880 sans qu'il y ait de baisse de la fécondité. L'expérience européenne ne présente donc qu'un assez maigre intérêt pour éclairer la relation entre la mortalité infantile (au sens strict de ce terme) et la fécondité dans les pays aujourd'hui en développement.

Cependant, toute différente semble la relation entre la mortalité des enfants (de 0 à 9 ans, de 1 à 9 ans, ou même de 0 à 14 ans) et la fécondité. Un des participants a exposé qu'il ne connaissait pas de pays européens où s'était produite une baisse importante de la fécondité qui n'ait pas été précédée d'un recul substantiel de la mortalité des enfants (de 0 à 9 ans ou de 0 à 14 ans). Ce résultat ne semble avoir été contredit par aucun participant bien qu'on ait fait ressortir que, dans certains pays, on observait un décalage entre la baisse de la fécondité et celle de la mortalité des enfants et qu'il fallait envisager l'utilisation d'autres variables qui entrent en jeu pour expliquer cette relation.

Un des participants a fait remarquer que la baisse de la fécondité qui a précédé celle de la mortalité infantile dans à peu près la moitié des provinces allemandes a précédé probablement un recul de la mortalité des enfants (de 1 à 4 ans ou de 1 à 9 ans) encore que les données qui permettront de le démontrer n'aient pas encore été exploitées électroniquement. R. Lesthaeghe a montré que lorsque la mortalité des enfants de plus d'un an est substituée à la mortalité infantile, le déclin de la fécondité qui dans presque toutes les provinces belges avait précédé le recul de la mortalité, apparaît alors postérieur à ce recul dans la moitié des provinces. E.A. Wrigley a montré qu'en Angleterre, le recul de la mortalité infantile est resté en retard sur celui de la mortalité des enfants et des adultes. Selon un autre participant, cependant, la conclusion qui se dégage des études historiques européennes est qu'on manque de preuves pour affirmer que c'est le déclin de la mortalité des enfants qui a déclenché la baisse de la fécondité sans que d'autres facteurs interviennent. Il a admis, cependant, que la baisse de la mortalité des enfants fait partie de tout un complexe de causes ; il se peut que ce participant ait voulu parler de la mortalité infantile (de 0 à 1 an) dans ces remarques bien qu'il ait utilisé l'expression, mortalité des enfants.

Le décalage entre la baisse de la fécondité et celle de la mortalité, a-t-on pensé, mérite des études approfondies. Un "effet de seuil" dont il a été question plus haut, peut présenter une grande importance pour expliquer ce décalage. Dans quelques pays européens, mais pas dans tous, ainsi qu'il vient d'être dit, la baisse de la mortalité infantile (de 0 à 1 an) a de beaucoup précédé celle de la fécondité, alors que dans d'autres diverses relations ont été trouvées. En Suède pour les années 1850-1890 la fécondité est plus élevée en zone urbaine qu'en zone rurale.

Ces différences, selon un participant peuvent tenir à des biais qui, dans les données, affectent les âges et la structure matrimoniale. Ce ne seraient pas dans ce cas, de véritables différences. Des analyses transversales et longitudinales des effets de la baisse de la mortalité infantile sur l'âge moyen au premier mariage devraient être faites.

Les données de Princeton sur les transitions démographiques en Europe, si on les analyse pour examiner cette relation, pourraient fournir des résultats intéressants et ouvrir des perspectives. Une étude de ce genre faite par le démographe soviétique Novoseliskij dans les années 20 comportait une analyse transversale des provinces de l'Empire russe vers 1900. Elle révéla une importante corrélation négative entre la mortalité infantile et l'âge moyen au mariage. Le coefficient décrit était un coefficient total plutôt que partiel. Un autre participant, cependant, estime que la différence observée en Suède entre zones urbaines et zones rurales pouvait être réelle et tenir à l'accroissement de la "demande" (au sens économique du terme) pour les enfants dans les villes dans la première phase de la Révolution industrielle. Cette interprétation a été contestée. Un des participants a pensé que les parents qui avaient perdu des enfants du fait des mauvaises conditions de vie au début de la Révolution industrielle avaient bien pu perdre le désir de les remplacer dans de telles conditions. Un autre a observé qu'une augmentation de ce genre peut bien avoir été provoquée par une légère augmentation de la fertilité au cours des premières années de la transition démographique mais qu'une augmentation de la fécondité a très bien pu se produire sous l'influence de la modernisation qui, avant que les

couples aient su pratiquer la contraception, brisa les traditions culturelles qui auparavant jouaient un rôle modérateur sur la fécondité. Par exemple, il se peut que les mères, contraintes de travailler, aient cessé de séjourner longtemps chez leur mère après l'accouchement. Les coutumes d'abstinence se perdirent peut-être ainsi que celle d'allaiter les enfants. Enfin les avortements provoqués purent faire diminuer les intervalles entre naissances. Comme les églises en Europe avant l'industrialisation et au début de celle-ci réprouvaient sévèrement l'avortement, ces avortements n'étaient pas mentionnés dans les registres paroissiaux. C'est pourquoi les intervalles entre naissances qu'on calcule à partir de ceux-ci sont sujets à caution.

La recherche de Knodel, fondée il est vrai, sur des régions très restreintes, montre que dans la Bavière du 19e siècle, dans les districts où l'allaitement n'était pas pratiqué, il existait une corrélation très étroite, au niveau global entre la mortalité infantile et la fécondité légitime. Comme l'allaitement n'était pas pratiqué, cette corrélation ne peut tenir à l'aménorrhée consécutive à l'accouchement, variable qui n'entre pas en jeu dans ce cas. Comme cette recherche ne révèle qu'une faible relation pour les mêmes régions au niveau individuel entre la mortalité infantile et la fécondité, il en résulte qu'il existait un effet indépendant important au niveau de la société.

On analyse actuellement les statistiques de l'état civil au Royaume-Uni pour jeter quelque lumière sur la relation entre la mortalité des enfants et la fécondité. Ce pays a été divisé en 12 régions présentant chacune une certaine homogénéité et les séries chronologiques s'étendent sur 130 ans, de 1840 à 1970. L'analyse a examiné l'évolution de la baisse de la mortalité et de la fécondité.

Les résultats sont les suivants : (1) les corrélations sont fortement positives (allant jusqu'à environ 0,70) pour la période du déclin rapide de la fécondité. Elles sont au maximum lorsqu'il n'y a pas de décalage (c'est-à-dire lorsque la baisse de la mortalité et celle de la fécondité surviennent en même temps) ; (2) sur une période de 20 ans, la mortalité infantile a augmenté mais les corrélations sont restées constantes du fait de l'intervention de données portant sur les régions où l'augmentation est la plus faible et où le déclin de la mortalité est le plus fort ; (3) malgré de fortes variations de la mortalité des enfants, la baisse initiale de la fécondité s'est produite presque simultanément dans chaque région.

Ces résultats indiquent que les effets directs de la baisse de la mortalité des enfants ont été faibles et que les changements socio-culturels et économiques affectaient à la fois la mortalité des enfants et le niveau des mesures de la fécondité. L'évolution au Royaume-Uni (voir paragraphe 3) indique qu'un long décalage entre le déclin de la mortalité des enfants et celui de la fécondité semble moins probable aujourd'hui.

Les changements simultanés de la mortalité infantile et de celle des enfants et de la fécondité en Angleterre entre 1840 et 1900 peuvent tenir à des facteurs qui affectent les deux variables. Mais ce résultat peut s'être produit parce qu'un seuil dans la perte des enfants avait été atteint.

Comme le déclin de la fécondité et celui de la mortalité furent brusques au début et survinrent à peu près en même temps dans les différentes régions de l'Angleterre et du pays de Galles, malgré de fortes différences dans les conditions sociales et sanitaires, on est enclin à penser que les causes déterminantes étaient les mêmes dans l'ensemble du pays.

L'étude du changement de la fécondité en Europe permet d'aboutir à des conclusions sur la manière dont il convient d'agir dans les pays en voie de développement. Le niveau de mortalité infantile auquel correspond le début de baisse de la fécondité varie beaucoup. Les différences atteignent 20 % dans certaines parties du Royaume-Uni par rapport à l'ensemble. La plupart des pays en voie de développement se trouvent à présent à des niveaux de mortalité beaucoup plus bas que ceux qui prévalaient dans certaines régions d'Europe lorsque la fécondité commença à baisser.

Deux composantes du changement de la mortalité infantile, a-t-on suggéré, peuvent affecter le niveau de la fécondité. Ce sont a) les changements réels des taux et b) le changement des concepts qu'ont les gens sur l'évolution de la mortalité des enfants. Cette dernière composante ne peut être déduite ni des données historiques ni des données d'ensemble du mouvement de la population.

Les données australiennes, actuellement étudiées à l'Université Nationale Australienne, révèlent un décalage de 20 à 30 ans entre le début du recul de la mortalité infantile et de celle des enfants au 19e siècle et un déclin éventuel de la fécondité. Avec un décalage de cette importance, a observé un des participants, il est difficile d'imaginer une relation causale entre les deux facteurs. Il est plus probable que ces deux composantes dépendaient d'un facteur sous-jacent à savoir l'évolution sociale.

Les discussions sur la communication de Retherford ont fait ressortir l'importance des migrations dans leurs relations avec la fécondité (surtout migrations des campagnes vers la ville). On ne sait trop si les migrations ont été prises en considération dans l'analyse des données historiques du projet de Princeton sur la fécondité en Europe. Il serait intéressant d'être renseigné sur ce point.

Pour ce que se propose le présent séminaire (c'est-à-dire d'analyser séparément les effets volontaires de la mortalité infantile et de celle des enfants sur la fécondité) la distinction des effets de la contraception sur la fécondité de ceux de l'avortement et de l'abstinence ne présente pas une grande importance dans les études

historiques. Ce qui importe, cependant, c'est de distinguer les effets volontaires des effets purement physiologiques. Les difficultés auxquelles on se heurte pour faire cette distinction lorsque les données ne sont pas recueillies précisément à cette fin sont évidentes. Ce problème s'étend bien entendu non seulement aux données historiques mais aussi à toutes les données recueillies à d'autres fins que celles du séminaire ou pour des sujets qui y sont étroitement liés. Une autre difficulté est qu'en démographie on travaille, en général, sur de petits échantillons dont il est hasardeux de tirer des conclusions générales.

Un participant a exprimé l'idée que les données historiques contiennent très probablement divers biais fort difficiles à mesurer du fait des visites peu fréquentes des autorités religieuses (prêtres ou pasteurs) dans les hameaux les plus écartés, de l'enregistrement tardif (baptêmes et enterrements), des erreurs sur les âges et surtout des migrations hors paroisse. Alors que, dans les études contemporaines, on peut faire des vérifications pour éliminer ces sources d'erreur, il n'en va pas de même pour les données historiques. Cependant on a rétorqué que des méthodes ont été mises au point pour juger de la qualité des registres. Il est d'ailleurs probable que le plus souvent ces registres étaient mieux tenus jadis qu'à présent. Les registres allemands et canadiens étaient très exacts et très précis. En Angleterre l'utilisation des registres est possible bien qu'elle pose des difficultés. La technique de la reconstitution des familles a-t-on observé fournit des renseignements sur l'histoire génésique d'un couple tout au long de sa période féconde et ne laisse place à aucun doute. Il n'en va pas de même pour les données provenant d'enquêtes sur les femmes de moins de 45 ans. Ces biographies s'appuient sur des événements qui ont été enregistrés au fur et à mesure qu'ils se produisaient. Il n'y a donc aucune possibilité d'erreur de mémoire comme c'est le cas pour les données provenant d'enquêtes rétrospectives.

On a demandé au CICRED de faire tout son possible pour faire établir une banque de données sur ordinateur sur les statistiques par paroisses du potentiel démographique. Cela permettrait aux chercheurs en démographie historique d'analyser ces registres d'une manière plus complète.

Relations entre la mortalité et la fécondité : Etudes modernes par zones

On a déjà beaucoup parlé de cette question dans ce qui précède. On évitera ici les répétitions. Les données provenant d'études faites dans diverses régions du monde ont été discutées et comparées.

Un des participants a trouvé frappantes les similarités qui apparaissent dans les résultats de l'étude sur le Bangladesh et sur le Pakistan et ceux présentés par les études de démographie historique sur l'Europe. Il a aussi souligné que, comme l'étude de Lery-Vallin montre que les effets de remplacement augmentent dans les populations où la fécondité est basse et la limitation des naissances répandue, les recherches, dans l'avenir, devraient se concentrer sur la période de la transition démographique où ce mécanisme commence à s'exercer.

L'étude sur le Pakistan et le Bangladesh dont il est question dans la communication de base est, en fait, surtout un essai pour étudier les effets volitifs de la mortalité infantile sur l'espacement des naissances plutôt qu'une étude sur la limitation des naissances et le remplacement des enfants. En général, comme l'a remarqué un des participants, il conviendrait de se montrer très prudent lorsqu'il s'agit des données sur l'âge au Pakistan car les familles ne se rappellent pas correctement l'âge des enfants en années révolues et beaucoup moins encore en mois. Les intervalles médians sont donc fort sujets à caution du fait de ces biais.

On a fait observer qu'une étude longitudinale dans laquelle on maintiendrait constantes les variables socioculturelles et économiques pourrait donner des résultats qui sembleraient confirmer l'hypothèse des effets volontaires en Afrique Tropicale. Cependant la proportion des décès d'enfants omis en Afrique Tropicale est plus forte que celle des enfants qui survivent d'où une forte sous-estimation de la mortalité infantile et de celle des enfants. Les omissions, les erreurs, les réponses erronées brouillent les résultats. Les variations de la fécondité peuvent aussi tenir à des différences culturelles et sociales. En outre, la polygamie peut expliquer le niveau peu élevé de la fécondité et de la mortalité des enfants. La résidence rurale ou urbaine, la migration et autres variables socioculturelles et économiques peuvent l'emporter sur les effets du remplacement des enfants.

En Afrique, comme on l'a déjà noté, on peut se demander si la distinction entre population urbaine et population rurale est bien valable. En bref, les données ne se prêtent pas à des recherches sur les effets volontaires de la mortalité des enfants sur la fécondité. Elles peuvent cependant s'avérer utiles pour des raisons subsidiaires.

Un participant a fait remarquer que la forte fertilité en interaction avec la disparition des tabous traditionnels sur le sexe peut être un élément déterminant de la fécondité en Afrique. La résidence urbaine, si elle tend à empêcher les mères de rendre visite à leur propre mère et de séjourner chez elle "afin de reprendre des forces" et jusqu'à ce que leur enfant soit "assez fort" peut provoquer une augmentation de la fécondité en ville plutôt qu'une baisse du fait d'une disparition des tabous sur le sexe.

Un autre participant a fait remarquer que les nouvelles données dont on dispose permettent et rendent souhaitable une révision des comparaisons qui ont été faites entre les diverses régions de l'Afrique tropicale.

Les effets physiologiques semblent particulièrement importants dans certains pays de l'Afrique tropicale. Cependant, la fécondité est si forte au Nigeria que même si l'allaitement atteint ou dépasse 36 mois, une diminution de cet intervalle du fait de décès d'enfants ou de bébés ne semble pas faire augmenter la fécondité de manière appréciable.

La transition de la mortalité en Inde et dans la plupart des pays asiatiques s'est produite dans la première moitié du 20e siècle avant que la modernisation ait battu son plein, principalement du fait de mesures prises pour améliorer la santé et pour combattre les épidémies. D'un côté, là où la fécondité a baissé, ça n'a pas été avant les années 60 (à quelques exceptions près). Le décalage a souvent été de 30 à 50 ans. L'élévation de l'âge au mariage, le progrès très répandu de l'instruction et la modernisation sont les raisons que l'on donne le plus souvent pour expliquer cette baisse.

Les comparaisons transversales des niveaux de la fécondité et de la mortalité considérés ensemble dans la plupart des pays d'Asie ne s'avéreront peut-être pas très utiles, a-t-on remarqué parce qu'on sait peu de chose des différences entre ville et campagne en Asie. Il convient de se montrer très prudent si on utilise les taux bruts de natalité et de mortalité du fait des effets de la structure par âges sur les taux de natalité.

Les données sur l'âge sont entachées d'erreur dans de nombreuses sociétés asiatiques et l'enregistrement des décès des nouveau-nés et des enfants est très mauvais du fait d'erreurs de mémoire, de la motivation psychologique et des attitudes socio-culturelles.

Des données sur le déclin de la fécondité et de la mortalité à Singapour et à Hong Kong ont été présentées par un des participants. Ces déclins sont importants à Singapour où ils vont de 45 naissances p.1000 vers 1955 à 22 p. 1000 en 1970 et de 75 décès avant un an pour 1000 naissances vivantes à 20 p. 1000 au cours des deux dernières décennies. Il en va de même à Hong Kong (de 47 naissances p. 1000 en 1950 à 37,4 en 1958 puis 20 en 1971 et de 100 décès avant un an pour 1000 naissances en 1950 à environ 20 p. 1000 ces dernières années). Certes, la structure par âges explique une bonne partie des changements de la natalité dans les deux villes mais l'analyse des données pour y déceler l'effet de la mortalité des enfants sur la fécondité serait du plus haut intérêt.

Les mécanismes qui s'exercent dans de nombreux pays d'Afrique sont différents de ceux de l'Asie, de l'Amérique latine, de l'Europe et souvent même des autres pays d'Afrique. Les données doivent donc être examinées soigneusement avant de choisir une méthode pour y appliquer des techniques d'analyse scondaire.

Une opinion sur la politique de population est exprimée dans la communication de Medica-Rutstein. Selon ces auteurs, une baisse de la mortalité infantile et de celle des enfants provoque une augmentation du taux de croissance démographique à moins que l'expérience personnelle indirecte et les pressions sociales fournissent une influence suffisamment forte dans le sens de la restreinte. Cette conclusion ne semble guère présenter une grande importance car il est peu probable que la mortalité infantile et celle des enfants tombent beaucoup au-dessous de leur niveau actuel dans de nombreux pays d'Amérique latine s'il ne s'y produit pas de changement du niveau de vie. Si ces changements se produisent, on estime en général qu'il s'ensuivra un déclin de la fécondité.

Les deux études d'ensemble sur Porto-Rico et la troisième sur les données sur les enfants portent sur moins de 5 % de la population latino-américaine. L'analyse en profondeur nommée PECFAL-RURAL porte sur un tiers de la population de l'Amérique latine mais elle se limite aux zones rurales ou semi-rurales. Cependant près de 60 % de la population de l'Amérique latine est urbaine. Par exemple, 25 % de la population brésilienne vit dans 9 zones métropolitaines et cette proportion est encore plus forte pour l'Argentine, le Chili, la Colombie, le Mexique, l'Uruguay, le Venezuela et d'autres pays d'Amérique latine.

Il est donc plus important de faire des recherches sur le comportement des populations urbaines de l'Amérique latine, ainsi que l'a fait CELADE il y a dix ans (voir "la fécondité dans les villes de l'Amérique latine").

Une étude sur 1328 femmes mariées du Comté de Sao Leopoldo, presque complètement urbain, faite par CEDOPE (USINOS, Sao Leopoldo) et portant entre autres sur la relation sur la mortalité infantile et celle des enfants a montré que 67 % des femmes de 15 à 44 ans pratiquaient la contraception. Elle révèle également une forte cohérence entre le nombre désiré d'enfants, le nombre connu de grossesses et celui des naissances vivantes, respectivement, 3,79, 3,93 et 3,27 par femme. La fécondité totale au Brésil, selon le recensement de 1970, était de 4,97 naissances par femme de 15 à 49 ans.

Une étude longitudinale sur diverses populations à propos de la mortalité infantile et de celle des enfants dans plusieurs régions de l'Amérique latine de Mai 1968 à Juin 1970 faite par l'Organisation panaméricaine de la santé (voir "schéma de la mortalité dans l'enfance" sous la direction de Puffer et Serrano) est probablement de nature à apporter des renseignements intéressants sur le sujet du séminaire.

Relations entre la mortalité et la fécondité : Projets de réduction de la mortalité

Ce sujet s'est surtout limité à une discussion de la communication de base qui s'y rapportait et aux projets qui y étaient présentés.

1) Introduction, analyse transversale

Il a d'abord été souligné que l'analyse transversale des données de 74 pays en voie de développement n'avait pas grand-chose à voir avec le sujet principal de cette communication, à savoir les effets des projets portant spécifiquement sur la fécondité. En second lieu, comme l'analyse initiale a employé la corrélation totale et la régression de degré zéro comme techniques de mesure, les coefficients qui en résultent présentent tous les défauts habituels dans ce genre d'approche.

1) La corrélation mesure l'association et non la causalité. Une variation d'une des variables peut "s'expliquer" par l'autre variable. Même la corrélation partielle et multiple et la régression de plus haut degré ne sont guère à conseiller pour rechercher les effets volontaires du déclin de la mortalité sur la fécondité pour l'analyse secondaire des données portant sur des populations appartenant à des cultures diverses.

2) Les données consistent surtout en estimations qui s'appuient sur la théorie des populations stables ou sur des tables-types de mortalité. L'utilisation des tables-types de mortalité implique l'existence de hauts niveaux de corrélations. Ces estimations, par conséquent supposent des corrélations entre les variables étudiées, ainsi qu'il a déjà été mentionné au cours de ce séminaire. Les corrélations entre ces estimations et les tests de signification sur ces corrélations ne sont donc pas d'une grande valeur.

3) La simulation des interactions longitudinales et des séries chronologiques au moyen de données transversales n'est guère à recommander.

4) Alors que la corrélation et la régression peuvent être utilisées pour des données portant sur diverses populations (pourvu que les estimations ne se fondent pas, comme dans cette communication sur la population stable ou sur l'analyse des tables-types), il faut être très prudent dans l'utilisation de l'analyse secondaire et des comparaisons des données internationales. Autrement des biais importants peuvent se glisser dans les données du fait de la variation des contextes socio-culturels et économiques, des définitions différentes des termes employées et de la variété des buts de recherche.

5) Les variables qu'il s'agit de corréler doivent être choisies de manière à réduire au minimum le risque que présentent les effets produits par les variables qui entrent en jeu ou bien ces variables intermédiaires doivent être contrôlées, par exemple pour la corrélation entre la vente des journaux (pour servir d'indice de modernisation), la mortalité infantile et celle des enfants et les taux de natalité.

En ce qui concerne toutes les autres études dont il est question ci-dessous, les participants ont insisté sur la possibilité d'un décalage important du déclin de la fécondité. Celui-ci ne se ferait guère sentir, sauf à très long terme, à la suite d'un programme de réduction de la mortalité. On a également fait ressortir qu'il fallait distinguer entre les effets sur la fécondité d'un déclin de la mortalité infantile (de 0 à 1 an) (1) et d'un déclin de la mortalité des enfants (de 0 à 4 ans, 0 à 9 ans ou même 0 à 14 ans). On a aussi attiré l'attention sur la nécessité de distinguer les effets de "remplacement" des effets "d'assurance" et des effets "sociaux". On a rappelé aux participants qu'il n'était pas nécessaire que les jeunes femmes ou les jeunes couples perdent personnellement un enfant pour que la mortalité de leur communauté ait une influence sur leur comportement génésique.

2) Laboratoire de recherche sur le choléra, Dacca, Bangladesh

Les données de cette étude présentées dans cette communication ne sont pas complètes. De plus, il n'y avait plus lieu, semble-t-il, d'inclure le projet sur le Bangladesh dans la communication de base car ni la mortalité infantile ni la fécondité n'y ont baissé au cours de 7 années. Ce projet vise surtout à réduire la mortalité au-dessus d'un an et il n'y est guère question de la réduction de la mortalité infantile (de 0 à 1 an).

En second lieu, le niveau et les tendances de la mortalité infantile et de celle des enfants au début du programme doivent être déterminés et ne pas être perdus de vue. On pourra ainsi savoir si le déclin de la fécondité pendant la période de réduction de la mortalité suit les tendances observées auparavant ou s'il s'en écarte.

En troisième lieu, il y a un faible biais qui conduit à une corrélation positive car la mortalité exerce une influence sur la composition par âges. En effet, plus la mortalité infantile et celle des enfants est basse plus la population est jeune. Une moindre proportion des gens sont alors en âge de se reproduire ce qui fait baisser le taux de natalité. Il serait intéressant de faire des recherches pour déterminer l'importance de ce biais. En même temps il convient de se montrer prudent dans l'interprétation des corrélations, en particulier lorsque les

(1) C'est-à-dire au-dessous d'un an. L'âge d'un an ici (comme ailleurs dans ce résumé) est utilisé comme une limite supérieure qui n'est pas complètement atteinte.

différences dans la mortalité infantile et dans celle des enfants à diverses époques sont fortes alors que les taux bruts de natalité aux mêmes époques sont faibles.

3) Le projet global Danfa sur le planning familial et la santé en zone rurale, Danfa, Ghana.

Ce projet n'était pas destiné à examiner la valeur des hypothèses relatives à la relation entre la fécondité et la mortalité infantile et celle des enfants. Il vise plutôt à faire bénéficier la population rurale de cette région de services sanitaires pour les enfants et pour les mères. Cependant les données rassemblées pour ce projet peuvent jeter quelque lumière sur le sujet du séminaire car la mortalité infantile a baissé dans cette région.

4) L'étude de Khanna, District de Ludhiana, Etat de Punjab en Inde

Cette étude a commencé très tôt dans le cadre du programme pour la population indienne. Elle porte sur des localités où la pression démographique se faisait relativement peu sentir. Mais d'après tous les articles publiés à ce sujet, il ne semble pas que ces données s'insèrent dans le sujet traîté dans l'article de base présenté ici. Ce programme n'a fait changer ni la fécondité, ni la mortalité. C'est ce qui se dégage du tableau 3 de cet article. Après un clocher au cours des années 1957-1959, tant dans la région testée que dans celle qui servait de contrôle, le taux brut de mortalité, le taux de mortalité infantile et le taux brut de natalité des deux zones étudiées apparaissent analogues. Le tableau 4 est le seul qui apporte quelque élément pour le sujet du séminaire. Il semble bien qu'à mesure que la survie augmente, la fécondité diminue. Cependant cette étude s'est limitée aux 6 premières naissances. Cette manière de procéder masque une grande partie de l'interaction et il y a trop peu de femmes dans les groupes où ne survit qu'un enfant ou pas d'enfant du tout.

5) Les projets Taylor-Berelson

On a besoin de plus de détails sur ces projets qui se déroulent en Indonésie, aux Philippines et en Turquie. Le projet des Philippines consiste en un programme de planning familial qui est mené au moyen de services sanitaires pour les enfants et pour les mères. Il devrait donc en résulter un effet sur la mortalité infantile et celle des enfants ainsi que sur la fécondité. Ce projet ne semble pas, cependant, avoir été organisé de manière à analyser l'influence d'un déclin de la mortalité infantile et de celle des enfants sur le déclin de la fécondité obtenu par la limitation des naissances. Cependant les données rassemblées peuvent jeter quelque lumière sur cette relation.

6) Le projet Etimesgut, District d'Etimesgut, Turquie

Il se dégage de la figure 3 et du tableau 2 que la mortalité infantile est passée de 142 à 121 pour mille entre 1967 et 1968, une année seulement après le début du projet. La fécondité globale avait beaucoup baissé dès 1970.

En l'absence de données sur les tendances antérieures ou pour un groupe de contrôle, il semble probable que d'autres causes préexistaient dans la zone d'Etimesgut avant le projet et qu'elles ont été renforcées par celui-ci, d'où une baisse de la fécondité en même temps que de la mortalité. Etimesgut, région montagneuse à l'est d'Ankara mais assez proche de cette ville est aisément accessible à la modernisation et à l'amélioration des conditions sanitaires même sans l'influence du projet en question. Il semble bien que l'année 1967 ait été marquée par une mortalité infantile anormalement élevée et que la mortalité infantile ait baissé de manière tout aussi spectaculaire dans un groupe contrôlé que dans la zone étudiée entre 1967 et 1968, car une baisse de 142 à 121 pour mille est trop importante pour provenir de l'influence du projet en un an. La baisse de la fécondité se place trop tôt pour en être l'effet et le décalage est trop court.

7) L'expérience de Narangwal sur le planning familial et la santé, Etat de Punjab, Inde

Malheureusement ce projet qui a commencé en 1965 et s'est prolongé jusqu'en 1974 est à présent terminé. On a besoin de plus de détails sur la manière dont il a été mené et sur une analyse approfondie de sa première phase car ces aspects semblent fort importants pour les questions qui intéressent le séminaire. Un participant se rappelait que ce projet employait deux groupes de contrôle dont l'un bénéficiait de services pour le planning familial mais non pour la santé des enfants plus ou moins directement. L'autre groupe ne recevait ni les uns ni les autres.

Si on admet qu'une baisse de la mortalité infantile fait baisser le coût de la naissance d'un enfant, a fait remarquer l'un des participants, si aucun autre facteur n'intervient en contrepartie, le taux d'accroissement de la population tendrait à augmenter. Les programmes de réduction de la mortalité devraient donc viser à accroître la qualité et la quantité des soins sanitaires que les mères donnent à leurs enfants, en fournissant à ces mères une meilleure éducation et plus d'instruction. D'autres participants se sont déclarés d'accord avec ce point de vue. Selon eux cela revient à encourager à remplacer le nombre par le bien-être des enfants ou en termes économiques, leur quantité par leur qualité. Ceci revient à dire que la baisse du coût de l'ensemble des enfants provoquée par celle de la mortalité serait compensée par l'augmentation du coût pour chaque enfant auquel plus de soins et d'occasions de s'instruire seraient consacrés.

Un des participants a fait observer que pendant quelque temps l'expérience de Narangwal s'était efforcée de fournir ce genre d'éducation aux mères mais qu'il a bientôt fallu y renoncer du fait des grandes dépenses que cela entraînait. Un autre participant a poursuivi dans la même direction. Il a remarqué que le coût qu'entraîne l'éducation des mères pour fournir de meilleurs soins à leurs enfants ne devrait pas être considéré comme excessif si l'analyse révèle qu'à long terme on parvient mieux ainsi à réduire la fécondité et la croissance démographique mondiale.

8) La campagne d'éradication du paludisme à Sri Lanka et les programmes sanitaires

On n'a pas fait état d'un seul programme mais de toute une série de programmes pour réduire la mortalité en mettant l'accent sur le contrôle du paludisme. Il a été remarqué que ces programmes constituent une des expériences naturelles les mieux documentées qui, en général, confirme l'hypothèse de base selon laquelle une baisse de la mortalité infantile et de celle des enfants provoque une baisse de la fécondité. On a de nouveau attiré l'attention sur l'augmentation de la fécondité qui accompagne parfois, au début, la baisse de la mortalité infantile et de celle des enfants avant que le niveau de la fécondité commence à tomber. Les tableaux 4, 5 et 6 de la communication de base rendent ces phénomènes évidents.

La plus grande partie du déclin initial de la fécondité tenait à l'élévation de l'âge au mariage d'après les auteurs de la communication de base. C'est pourquoi il est hasardeux d'employer des taux bruts de natalité comme indicateur de la fécondité.

Un participant a soutenu que le mécanisme par lequel la mortalité infantile et celle des enfants agit sur le niveau de la fécondité ne consiste pas en une élévation de l'âge au mariage mais plutôt en une baisse de la nuptialité. Une baisse de la mortalité infantile et de celle des enfants implique une baisse du nombre d'hommes par rapport à celui des femmes (rapport de masculinité en diminution). Plus de femmes restent célibataires ce qui provoque une baisse du taux brut de natalité a) parce que leur probabilité d'avoir des enfants hors mariage est moindre b) parce que leurs chances de travailler augmente ce qui tend à diminuer leur fécondité.

Selon un autre participant les effets à court terme de la mortalité infantile et de celle des enfants sur la nuptialité sont contrebalancés par la plus grande fréquence des mariages d'hommes relativement âgés avec des femmes relativement jeunes. Un troisième participant a cependant dit qu'il ne saurait en être ainsi. Reprenant un argument déjà utilisé, il a fait observer qu'en Europe et peut-être au Sri Lanka, une femme peut augmenter sa dot et donc son attrait pour le mariage en travaillant, alors que les femmes plus jeunes ont moins de temps pour travailler et pour se constituer une dot. Comme les épouses jeunes ont devant elles une période de reproduction plus longue, le coût de la contraception sera plus élevé. C'est pourquoi les hommes relativement âgés préfèrent épouser des femmes d'un certain âge lorsque la mortalité infantile et celle des enfants sont basses.

Une position aussi "puriste" pour évaluer les projets s'écarte des réalités du fait du coût très élevé des expériences sur le terrain, a remarqué un des participants. Il a recommandé qu'on rassemble tous les renseignements possibles sur "l'expérience naturelle" de Sri Lanka et sur les programmes ou séries de programmes analogues. Il a attiré l'attention sur un rapport relatif à l'expérience sur l'Ile Maurice que vient d'écrire Brass. La mortalité et en premier lieu la mortalité infantile et celle des enfants ont baissé avec une rapidité exceptionnelle de 1945 à 1955, après quoi elles ont continué à diminuer mais plus lentement. De 1966 à 1973, la fécondité a baissé de 55 % ce qui constitue un record sur une période de 7 ans. Cette baisse s'est produite 18 ans environ après celle de la mortalité infantile et de la mortalité des enfants et tout comme pour elle, ce changement a été très rapide.

On peut dire que le déclin de la fécondité n'avait pas grand'chose à voir avec les changements de structure de la population car il s'est produit beaucoup trop rapidement. On ne peut attribuer ce déclin à la prise de conscience du recul de la mortalité dans la société en général et dans chaque famille en particulier. Les femmes qui ont réduit leur fécondité étaient pour la plupart, jeunes et n'avaient guère eu le temps de constater que moins d'enfants mouraient en bas âge.

Une baisse aussi rapide de la fécondité se serait-elle produite sans un recul préalable de la mortalité infantile et de celle des enfants ? Il est difficile de répondre à cette question de manière rigoureuse à partir des données provenant de ces expériences naturelles mais l'analyse raisonnable des résultats nous conduit plutôt à répondre par la négative.

9) Conclusion

Les discussions qui s'appuient sur les données fournies par cette communication de base ont permis de conclure qu'il n'y a pas de preuve solide pour affirmer que les projets de réduction de la mortalité changent automatiquement les attitudes envers la procréation et la fécondité qui en découle. S'il en est ainsi, comme on l'a dit plus haut, ne conviendrait-il pas de faire figurer dans ces programmes des dispositions destinées à améliorer l'instruction pour que les enfants soient mieux soignés ? On substituerait de la sorte un nouvel

idéal. Au lieu d'avoir beaucoup d'enfants on voudrait en avoir moins mais on se préoccuperait davantage de leur éducation et de leur santé.

Enfin, on peut dire que des réponses pertinentes et convaincantes qui ont été données aux principales questions du séminaire pourraient être fournies par des programmes destinés spécialement à faire baisser la mortalité afin de tester les hypothèses relatives aux effets volontaires sur la fécondité. Ce domaine de recherches, qui s'avère très prometteur, présentera probablement une grande importance pour les pays en voie de développement. Il s'agit cependant d'un domaine qui nécessite une approche multidisciplinaire car il est difficile de distinguer les effets des facteurs physiologiques, démographiques, économiques,sociaux et culturels pour aboutir à des conclusions solides. Les recherches doivent être longitudinales car la baisse de la fécondité se produira avec un certain décalage par rapport au recul de la mortalité. Les recherches dans ce domaine étant coûteuses, il convient donc de trouver comment, dans les circonstances actuelles, peu propices à l'augmentation des crédits de recherches, on pourra éliminer les défauts des données dont on dispose. C'est ainsi qu'il sera possible de mieux comprendre comment la mortalité infantile et celle des enfants influent sur la baisse de la fécondité.

INFORME FINAL
(Resumen de las discussiones)*

por Francis C. MADIGAN (S.J.), Director
Mindanao Center for Population Studies, Cagayan de Oro City (Philippines)

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Conceptualización

Para los propósitos de este Seminario, la mortalidad infantil fue definida en su sentido habitual, es decir, como la razón entre las defunciones de menores de un año y el número de nacidos vivos en el período respectivo. Sin embargo, para analizar más adecuadamente los efectos volitivos de la mortalidad infantil y del niño sobre la fecundidad, la mortalidad del niño no fue definida solamente en su sentido habitual, referido a las muertes de los niños de 1 a 4 años, sino que también y en diferentes contextos, como la mortalidad referida a los niños de 0-4, 0-9, 1-9, 0-14, o 1-14 años de edad. En este documento se ha hecho un esfuerzo para especificar el sentido utilizado por los participantes en diferentes ocasiones. Sin embargo, no siempre fue posible aclarar este significado, por lo tanto es necesario prestar atención a las sugerencias, referencias y conclusiones relativas a la "mortalidad del niño", a menos que el sentido sea aclarado en el contexto.

Un participante sostuvo con convicción, que las diferencias en la mortalidad son mejor captadas cuando se divide en menores de un mes que cuando se divide en menores de un año. Por lo que se solicitó que fuera abolida la división tradicional de la mortalidad de los niños en mortalidad infantil (0-1) y mortalidad de la niñez (1-4) y sustituída por una clasificación en mortalidad de 0-1 mes y de 1 mes a 3 o 4 años de edad.

(*) En este resumen sólo se incluyen los temas discutidos por los participantes en las sesiones plenarias. No se incluyen materias de los documentos básicos, que se suponen conocidos por los lectores, a menos que hubieran sido discutidas con algún detenimiento en las sesiones plenarias.

En realidad la clasificación tradicional de la mortalidad en menores de 1 año y de 1-4 años de edad, presenta diversas dificultades y la distinción sugerida tiene varias ventajas desde un punto de vista ideal. Sin embargo, otros participantes hicieron notar que la mortalidad neo-natal es probablemente la medida de la natalidad menos confiable en los países con datos de mala calidad. Además la clasificación tradicional es la utilizada en las estadísticas del pasado e incluso muchos países utilizan actualmente esta única distinción. Más aún, tal como ya fue establecido, la disminución de la mortalidad de la niñez entre los 1-3 años de edad puede no ser suficientemente fuerte como para ejercer una influencia notable sobre los niveles de la fecundidad. Por el contrario, se ha observado que los efectos acumulativos de la mortalidad de la niñez de 1 a 9 años pueden ser substanciales y los índices que consideran una clasificación de la mortalidad entre 0-4 y 0-9 años ofrecen mayores posibilidades para detectar como perciben los padres la pérdida de sus hijos, y sus esfuerzos consecuentes para reemplazar tales pérdidas. Se reconoció, sin embargo, que un índice que abarque las edades de 0-9 años requiere controles cuidadosos para evitar que los efectos de la concentración de los nacimientos sobre la mortalidad de los niños, contamine la medición de los efectos de la mortalidad de la niñez sobre la limitación voluntaria de los nacimientos.

En este Seminario la atención se centró en el efecto de la mortalidad infantil (0-1) y de la niñez (de 1-9) sobre los niveles de la fecundidad.

En este caso es muy importante hacer la diferencia entre datos globales y datos individuales. Esta distinción se refiere al tamaño de las unidades básicas de observación. Son globales cuando se toma como unidad la población de un distrito, de una provincia o de un país y son individuales cuando se toma como unidad la familia. La distinción no se refiere tanto al tamaño de la muestra (a pesar de que en los estudios globales las muestras tienden a ser casi siempre mayores), sino que a las reacciones de la familia frente a situaciones específicas, en este caso la pérdida de un hijo. Los resultados de los estudios globales pueden expresarse en tasas de natalidad, mientras que los resultados de los estudios de familias individuales pueden expresarse en probabilidades de agrandamiento de la familia, es decir, la proporción de mujeres que han tenido un cierto número de hijos y que esperan tener un nacido vivo más. Además las mujeres que han tenido un cierto número de hijos pueden ser clasificadas en aquellas que no han tenido ningún hijo muerto y aquellas que han tenido uno, dos o tres niños que han fallecido.

En el Seminario se distinguieron cuatro tipos diferentes de efectos de la mortalidad infantil y de la niñez (1-9 años de edad) sobre el nivel de la fecundidad. Estos tipos fueron : efectos biológicos y fisiológicos (influencias involuntarias que operan principalmente a través de la disminución del período de lactancia materna y de la consecuente cesación de la amenorrea post-partum) ; – efectos de reemplazo (reemplazo voluntario de un niño muerto) ; – efectos de seguridad (conducta voluntaria tendiente a prevenir la muerte de los niños), y – efectos sociales que enmarcan el contexto sociocultural de la reproducción, en el que viven las parejas (conducta voluntaria inducida por las normas sociales en respuesta a los niveles de mortalidad infantil y de la niñez ; puede tratarse también de adaptaciones de normas existentes en el pasado).

Los tres últimos conceptos pueden también ser considerados como : reacción frente a la experiencia personal de la pérdida de un hijo (efecto de reemplazo), miedo de tal pérdida sin haber tenido la experiencia personal (efecto de seguridad) y conciencia de la comunidad frente a los cambios de los niveles de mortalidad (efectos sociales). Los problemas que se presentan para medir y sobre todo para graduar los temores de perder un hijo y la percepción de la comunidad de tales pérdidas, son diferentes según se trate de datos provenientes de respuestas a preguntas directas o indirectas.

También se puede distinguir un falso efecto de la mortalidad infantil y de la niñez sobre la fecundidad. Se trata del efecto de la fecundidad sobre la mortalidad, en este caso aunque se trata de un efecto que actúa en una dirección claramente opuesta a la estudiada en este Seminario, puede ser mal interpretada como un efecto volitivo de la mortalidad sobre la fecundidad. Este efecto puede ser debido a la "concentración de los nacimientos", que puede ser descrita como el nacimiento de dos o más niños en un período más corto que el aconsejable por razones de salud. Aunque no es posible definir la concentración de los nacimientos de una manera más precisa, debido a que la forma en que afecta a la mortalidad no está todavía claramente determinada, sin embargo es ampliamente conocido el aumento del riesgo de morir de los niños provenientes de nacimientos concentrados.

Los intervales entre nacimientos fueron definidos como el número de meses y/o de días entre los nacimientos.

En el Seminario no se llegó a una definición satisfactoria de residencia rural en oposición a residencia urbana y los participantes invitan a los investigadores a ser prudentes cuando se trata de efectuar comparaciones desde este punto de vista. Deben asegurarse que los contextos sociales a que se refieren estos términos sean aproximadamente similares. Por ejemplo, existen regiones en Africa en las cuales muchas mujeres son clasificadas en los censos como "urbanas" si sus maridos trabajan en pequeñas o grandes ciudades, en circunstancias que ellas continúan viviendo en las zonas rurales desde las cuales provienen sus maridos.

Varios conceptos demostraron ser útiles tanto en los estudios históricos como en las poblaciones modernas.

Uno de estos conceptos es el de hipótesis "umbral", que intenta explicar el desfase temporal que existe entre la reducción de la mortalidad infantil y de la niñez y la subsecuente baja de la fecundidad. En efecto, es necesario que la disminución de la mortalidad sea lo suficientemente importante como para que la población se de cuenta de que bastan menos nacimientos para lograr el tamaño deseado de la familia. Antes de alcanzar este umbral, es decir, antes de que sea percibida la reducción de la mortalidad, los cambios de la fecundidad pueden ser insignificantes o nulos.

Otro concepto discutido en este Seminario y que puede tener un probable valor tanto metodológico como analítico,es la hipótesis de "falta de cuidado". Utilizada como una hipótesis nula, intenta explicar tanto la alta fecundidad como la alta mortalidad de los niños como el efecto de una tercera variable, la "negligencia". Las mujeres cuyos niños mueren por falta de atención adecuada, pueden mostrar la misma falta de cuidado en practicar la planificación familiar.

Una tercera distinción realizada en el Seminario, puede ser también de utilidad. Se trata de la reducción de la mortalidad debido a la introducción de técnicas médicas importadas desde el exterior (tales como campañas epidemiológicas) y la reducción de la mortalidad debido al mejoramiento interno de las condiciones socio-culturales y económicas de la comunidad.

Finalmente, el concepto de "reglas de contención" puede ser útil en la presente discusión. Por una regla de contención se quiere significar un principio cultural que indica de una manera más o menos compulsiva el tamaño de la familia que la sociedad considera como "suficiente". No todas las culturas tienen, por lo demás, reglas de contención.

Niveles de estudio

Fue evidente en el curso del Seminario que, para el estudio de las relaciones entre la mortalidad infantil y de la niñez, es más útil el análisis al nivel de la familia individual que al nivel de la sociedad global.

Los fenómenos estudiados pueden interactuar en dos direcciones. Una alta mortalidad de la niñez puede estimular una alta fecundidad y la fecundidad elevada puede ocasionar una alta mortalidad de la niñez. Estos efectos no pueden ser separados con facilidad en los estudios transversales con datos de la sociedad global.

¿ Es posible estudiar las inter-relaciones simultáneas entre la mortalidad y la fecundidad, mediante el uso de técnicas longitudinales y con datos de la sociedad global ? El documento presentado con datos de Corea trata de probar que un estudio de este tipo sólo puede realizarse con datos a nivel de la familia individual. Sin embargo, las tendencias longitudinales tanto de la mortalidad de la niñez como de la fecundidad constituyen todavía instrumentos muy útiles para estudiar las asociaciones entre estas variables a nivel de la sociedad global. Los cambios de la mortalidad infantil y de la niñez (1-9 años) pueden ser asociados con la edad de las mujeres al primer matrimonio y con otras variables. En el nivel actual de nuestros conocimientos, se pueden aprovechar los estudios con datos globales para aclarar muchos aspectos dudosos e incluso muchas posibles fuentes de error.

Los mecanismos sociales interesan, sobre todo, para intentar aclarar la forma en que ellos contribuyen a mantener un tamaño promedio de la familia completa, aproximadamente igual al tamaño medio socialmente aceptable según la "regla de contención" ya mencionada.

El documento presentado por Macura a este Seminario es muy importante en relación al tema que estamos tratando. La estimación de series cronológicas, de tasas de mortalidad de la niñez y de fecundidad, sobre la base de métodos retrospectivos, permite obtener estas tasas a nivel global, con la ventaja de que los datos no están sujetos a errores groseros. (Uno de los participantes llamó la atención sobre la excesiva dependencia en "modelos". Agregó además, que los métodos utilizados para corregir la fecundidad y la mortalidad de la niñez, deben también correlacionarse entre sí). Sin embargo, los datos obtenidos mediante técnicas retrospectivas en algunos países, especialmente en algunas regiones de Africa, son en su mayor parte defectuosos. Brass presentó un documento sobre el tema de la corrección de los errores de las series cronológicas obtenidas de las historias obstétricas de las madres. En la Universidad de Princeton se está trabajando actualmente sobre el mismo tema.

Los datos globales constituyen el material adecuado para el estudio de los efectos sociales. Un participante hizo notar que si los efectos sociales operan a través de normas compartidas por las poblaciones de áreas culturalmente homogéneas, es más recomendable reunir los datos en grandes unidades de estudio y no dividirlos en muchas áreas pequeñas. De esta manera las unidades globales deben abarcar más bien grandes áreas culturales incluyendo regiones o países completos, antes que provincias o ciudades.

Sin embargo, otro asistente expresó su total desacuerdo en la elección de grandes áreas como unidades para el estudio de relaciones ecológicas. No cabe duda que las pequeñas áreas pueden ser re-agrupadas ; pero las unidades constituídas por grandes áreas no pueden ser subdivididas. Según su opinión, la única razón que podría justificar la no elección de pequeñas áreas, sería económica. En efecto, mientras mayor sea la

heterogeneidad de una población, parece tornarse menos útil el análisis.

Resumiendo, entonces, la forma más recomendable para estudiar los efectos volitivos de la mortalidad infantil y del niño sobre la fecundidad es la de nivel familiar. Esto es, a través de estudios individuales de fecundidad y de mortalidad de la niñez. Los estudios prospectivos o semi-prospectivos fueron calificados como más convenientes por sus posibilidades de control, principalmente cuando se realizan mediante muestras grandes ; pero se previó que los estudios retrospectivos a nivel de la familia y sobre la base de muestras pequeñas se realizarán con más frecuencia por su bajo costo.

Se afirmó que los resultados de muchos estudios realizados con muestras pequeñas, con una misma dirección general pero en zonas culturales totalmente distintas, serán valiosos para responder a los interrogantes planteados en el Seminario.

Errores de los estudios retrospectivos

¿ En qué medida están afectados los estudios retrospectivos por las fallas de la memoria o por otros errores de interpretación ? A modo de respuesta puede decirse que las distintas medidas utilizadas en cada estudio deben ser cuidadosamente analizadas para intentar evaluar el grado en que pueden estar afectadas por distintas imperfecciones : errores estadísticos, esterilidad post-partum, efectos de la fecundidad sobre la mortalidad (en el caso de la "concentración de los nacimientos", el efecto del embarazo sobre la alimentación, cuidado y atención del niño ya tenido) y otras fuentes de errores. Los modelos de simulación han puesto en evidencia la magnitud de tales "efectos perturbadores", que si no son atendidos pueden dañar e incluso invalidar las conclusiones de algunos estudios de familia. En general los errores o los efectos perturbadores que se presentan en los modelos de simulación realizados mediante computadoras, son aún mayores cuando se trabaja con datos empíricos. Por otra parte, tal como ha sido observado, la repetición de muchos estudios de familia es muy útil. Principalmente cuando estos estudios se hacen sobre la base de hipótesis similares y en contextos culturales y épocas distintas pueden reunir valiosos antecedentes en apoyo de tales hipótesis.

Muchos participantes piensan que aunque algunos errores de memoria son inevitables, debe hacerse lo posible por minimizarlos. Por ejemplo, en la encuesta comparativa que la Organización Mundial de la Salud está realizando en nueve países separadamente, se ha analizado el último embarazo, en el cual los errores de memoria son mínimos. En la India, en un estudio longitudinal de los años de duración, relacionado con la misma encuesta comparativa, se realizaban controles periódicos casa seis semanas, para corregir los errores de memoria en los estudios retrospectivos.

Más aún, los errores de memoria de las mujeres, al declarar los nacimientos y las defunciones de sus hijos, han sido estudiados por el Instituto de Investigaciones de la Cultura de Mindanao (RIMCU), Universidad de Xavier, en el Sur de Filipinas. Los resultados indican que los errores de memoria, en las zonas urbanas, son mayores a los 18 meses que a los 12 meses ; pero que en esas mismas zonas los errores a los 6 son parecidos a los errores de los 12 meses. Lo mismo ocurre con las diferencias en áreas rurales a los 12 y 18 meses. El estudio sugiere que más que olvidar a los niños que han muerto hace 12 o 18 meses, las mujeres entrevistadas sitúan esas muertes de una manera equivocada con respecto a un acontecimiento actual, es decir, se producen cambios de ubicación en el tiempo en ambos sentidos, dentro de los límites considerados.

Un participante expresó con bastante vigor su opinión en relación a los estudios retrospectivos de là Encuesta Mundial de Fecundidad. Sostuvo que no se justificaba el costo de esta encuesta y que difícilmente se podrían establecer relaciones entre la mortalidad infantil y de la niñez debido al tamaño de la muestra, unos pocos miles de casos. Agregó que este era un número demasiado pequeño para establecer tabulaciones cruzadas entre las diversas variables.

Otros asistentes no compartieron las apreciaciones mencionadas y sostuvieron que las encuestas sobre la fecundidad mundial podrían aportar bastante claridad sobre las inter-relaciones entre la mortalidad de la niñez y la fecundidad, principalmente si sus resultados son concordantes a pesar de las diferencias de países y culturas. Se dijo, también, que los cuestionarios de la Encuesta Mundial de Fecundidad pueden ser adaptados en algunos países. Hubo acuerdo unánime, sin embargo, en que sería sumamente conveniente que los datos de la Encuesta Mundial de Fecundidad, que van a empezar a ser divulgados dentro de un año aproximadamente, pudieran ser analizados de manera que se estableciera claramente el efecto que tienen los cambios de la mortalidad de la niñez en la fecundidad.

Un participante afirmó que es posible utilizar un nuevo método para mejorar la utilidad de los estudios retrospectivos. Se trata del método denominado de Cho-Grabill sobre los niños tenidos. Si el censo de un país puede incluir varias preguntas sobre este aspecto y si se cuenta con buenas estadísticas de mortalidad, sobre todo si las declaraciones de edad son satisfactorias, se contará con una muestra lo suficientemente grande como para efectuar las tabulaciones cruzadas necesarias, controlando al mismo tiempo las variables socioculturales y económicas.

Medidas, Técnicas y Observaciones Metodológicas

Se expresó la conveniencia de que en los estudios patrocinados por el CICRED, sobre el tema objeto del Seminario, las hipótesis de las investigaciones sean cuidadosamente descritas. Esta sugerencia podría extenderse a las hipótesis relativas a la elección del tema de la investigación.

Se han utilizado diversos índices para medir la mortalidad infantil y de la niñez. Entre ellos los siguientes : las tasas de mortalidad infantil y de la niñez de acuerdo con la definición tradicional ; las tasas de mortalidad de los menores de 5 años (por ejemplo, los ${}_5M_0$ y ${}_5Q_0$ de las tablas de vida) ; tasas de mortalidad de los menores de 10 años y aún de los menores de 15 años ; número de niñoz muertos según el rango de nacimientos ; proporciones tipificadas de niños muertos según rango de nacimiento ; y número de niños muertos según el intervalo medio transcurrido entre su propio nacimiento y el nacimiento siguiente.

Un participante sostuvo que para estudiar los efectos biológicos y de reemplazo son más adecuados los índices basados en las defunciones de menores de 5 años que en las de menores de 10 años. Otro asistente al Seminario, junto con expresar su acuerdo en el sentido de que los riesgos de error derivados del efecto de la fecundidad sobre la mortalidad infantil y de la niñez aumentaban al tomar grupos de niños de mayor edad ; agregó que este tipo de errores podía evitarse y en este caso las defunciones de menos de 10 y de menos de 15 años, eran más adecuadas para estudiar el efecto de la mortalidad infantil y de la niñez sobre la fecundidad.

Entre los índices utilizados para medir la fecundidad pueden mencionarse los siguientes : tasas crudas de natalidad, tasas de fecundidad según edad de la madre, la probabilidad de agrandamiento de la familia, tamaño completo de la familia, intervalo medio entre nacimientos según rango de nacimiento, número medio de embarazos por mujer y número total de embarazos de las mujeres de 40-44 años de edad.

En el cálculo de los intervalos medios entre nacimientos se ha observado que la media aritmética no es muy adecuada, debido a las variaciones de los espaciamientos. En este caso es más útil la media armónica.

Algunas de las técnicas utilizadas para relacionar la mortalidad infantil y de la niñez con la fecundidad han sido las siguientes : correlación parcial, total y múltiple ; regresión líneal de orden cero o de más alto grado ; regresión curvilínea ; probabilidades de agrandamiento de la familia según número de hijos muertos, e intervalos medios entre nacimientos según rango de nacimiento y edad de la madre.

En relación a la medición de los efectos voluntarios de la muerte de un niño sobre la fecundidad, se formularon diversas advertencias. En primer lugar se mencionó la dificultad de usar la teoría de las poblaciones estables y/o las tablas de vida modelos para estimar la fecundidad y correlacionar enseguida los índices de natalidad y mortalidad. El hecho de que tanto las poblaciones estables como las tablas modelos incluyen supuestos sobre la mortalidad, pueden afectar la correlación entre la fecundidad y la mortalidad. Además, las graduaciones de las tablas modelos pueden conducir al usuario no precavido, a suponer reducciones de la mortalidad de 0-1 y de 1-4 años, que no existen actualmente en las poblaciones estudiadas.

En segundo término, es muy importante estudiar cuidadosamente la metodología que se va a usar para medir la influencia de la muerte de un niño en los intervalos entre nacimientos y en los nacimientos siguientes. Supongamos que se ha elegido la mortalidad de 0-9 años como índice de mortalidad de la niñez y que un niño muera a los 8 años. En este caso es muy poco probable que la defunción de este niño pueda afectar el intervalo entre su nacimiento y el nacimiento siguiente. Pero sí puede acortar el intervalo entre el último nacimiento anterior a la fecha de su defunción y el siguiente posterior a esa fecha.

Es relación a los estudios en que la integridad del registro de las defunciones infantiles y de la niñez es bajo, se señaló lo siguiente. Si, por ejemplo, se sabe que la cobertura es de un 70 %, los sesgos no pueden estimarse sobre la base de conocimientos negativos (no se sabe si el 30 % restante es irregular), sino que sólo mediante conocimientos positivos (se sabe que el 30 % restante tiene características semejantes o el grado de irregularidad es conocido).

Finalmente, la coherencia de las diferencias de los efectos temporales de la mortalidad infantil y del niño sobre la fecundidad puede aparecer mucho más impresionante que la realmente existente, si las medidas se repiten sobre las mismas mujeres. La coherencia en este caso responde más, parcialmente al menos, a la repetición de la misma experiencia que a mediciones independientes.

Observaciones metodológicas

En el curso del Seminario se hicieron varias observaciones en relación a la metodología. Aunque estas observaciones se refieren a temas bien diferentes, pareció conveniente reunirlas en este y en los párrafos siguientes. Algunos participantes señalaron que la inclinación de la curva (en los análisis de correlación y regresión) debería tenerse presente en relación con el tema del Seminario. En el supuesto (irreal) de que el reemplazo de los niños muertos sea completo, si se considera la inclinación de la curva, puede ocurrir que la inferencia de la mortalidad sobre la fecundidad sea obnubilada por otras influencias en el nivel global. Por ejemplo, si se supone una mortalidad infantil que fluctúe entre 100 a 200 defunciones infantiles por 1000 nacidos vivos, la tasa cruda de natalidad en condiciones de reemplazo completo sería de 36, en lugar de 33

por 1000 sin tal reemplazo, si se mantienen las mismas proporciones de mortalidad y fecundidad en tanto por mil. Es decir, grandes diferencias en la mortalidad infantil estarían asociadas a diferencias menores en la fecundidad, incluso en condiciones de un reemplazo total en el nivel de la familia. Esta sea probablemente la explicación de los resultados tan diferentes que se obtienen cuando se establecen correlaciones a nivel global. La relación esperada es débil y la pendiente de la curva puede ser fácilmente opacada por otras características. Sin embargo esto no significa que no exista una influencia real. Más aún, si se obtiene una pendiente de la curva mayor que esta, se puede deducir que existe una influencia de los factores sociales.

La relación entre el nivel de la mortalidad infantil y el tamaño completo de la familia fue estudiado sobre la base de datos del censo de Francia de 1906. Los resultados de este estudio, así como el de otros sobre el mismo tema, – por ejemplo el estudio sobre los mormones – requieren que el nivel de la mortalidad infantil presente una asociación más estrecha con el tamaño final de la familia que con el orden de los nacimientos. Mientras mayor sea la mortalidad infantil, mayor es el tamaño final de la familia. La contracepción estaba muy extendida en Francia en 1906, hecho que pone de relieve los aspectos voluntarios en la determinación del tamaño de la familia en esa época.

Algunos resultados, que muestran una probabilidad de agrandamiento de la familia menor para las familias en las cuales ha muerto un niño, en comparación con aquellas en las que no ha muerto ninguno (como por ejemplo los datos presentados por Rutstein-Medica para Perú y Colombia), deben ser tomados con precaución. – Tampoco es de gran utilidad la explicación que sostiene que los problemas de salud son causantes a la vez de la mortalidad de los niños y de la baja fecundidad de las mujeres. No explica el hecho de que se encuentre tal efecto en un país pero no en otro. Una posible respuesta podría ser que existen enfermedades que disminuyen la fecundidad y al mismo tiempo provocan un aumento de la mortalidad de los niños. Tal es el caso de la sífilis congénita y de la malaria. Se ha encontrado en algunas regiones de la India, en las cuales la malaria tenía carácter endémico, que la fecundidad aumentó levemente despues que la malaria fue erradicada.

Se sostuvo que el efecto de reemplazo podría ser estudiado en la siguiente forma. Podría compararse la posibilidad de agrandamiento de la familia en el caso de familias que tengan (n) niños en las cuales no haya muerto ningún niño, con familias que hayan tenido (n+1) niños, pero que por la pérdida de uno de ellos tengan solamente (n). La comparación de familias con (n+1) niños, en las cuales no ha fallecido ninguno, con familias con (n) pero que han perdido uno, pareció menos válida.

Si se supone que (n) niños proporcionan a sus padres un cierto grado de satisfacción (y), mientras que (n+1) proporcionan a sus padres respectivos un grado distinto de satisfacción, talvez menor, (z), entonces la probabilidad de reemplazo (P_z) es diferente y a menudo menor que la probabilidad de reemplazo (P_y). Sin embargo dos asistentes manifestaron su desacuerdo con esta proposición.

Una medida que se ha utilizado de una manera ventajosa, para resolver el problema de como diferenciar los efectos de la concentración de los nacimientos (asociados con una alta mortalidad) de la medida de la influencia de los efectos voluntarios de la mortalidad sobre la fecundidad, ha sido la siguiente. Se clasifica la experiencia de los niños previos según hayan sobrevivido o que hayan muerto y se asocia cada experiencia con la fecundidad posterior, en términos de intervalo medio entre esa experiencia y el nacimiento siguiente.

Una forma de medir el "exceso de fecundidad", es decir los efectos voluntarios de la mortalidad infantil y del niño sobre la fecundidad, fue sugerido en la tabla II del documento Lery-Vallin, mediante la relación :

$$\frac{\text{Columna 1} - \text{Columna 2}}{\text{Columna 2}}$$

Se sugirió que una medida alternativa a esta relación era :

$$\frac{\text{Columna 1} - \text{Columna 2}}{1 - \text{Columna 2}}$$

Se dijo que esta última medida era más explicativa del grado en que las familias reemplazan en la actualidad un niño muerto y que podría eliminar el "efecto tope" producido por la imposibilidad de sobrepasar 1 (la unidad). Se utilizó la medida alternativa para demostrar, con datos de la Tabla III del documento, que entre los agricultores se observan efectos de reemplazo superiores que entre los miembros de las profesiones liberales. Sin embargo, no todos los asistantes – incluso los autores – estuvieron de acuerdo en que la medida alternativa era mejor que la propuesta en el documento.

Si se utilizan controles, el sentido de los sesgos puede cambiar de dirección, y esto es necesario tenerlo presente cuando se trata de interpretar los resultados. Por lo demás este es un fenómeno general que no se limita a los temas que se discuten en este caso. En las ciencias humanas es muy difícil controlar los factores en juego y muchas veces hay que utilizar controles parciales mediante indicadores, en vez de controles directos sobre las variables exactas. Como una consecuencia de esto, el factor que no es pertinente a la característica

que se desea controlar, tiende a variar de una manera aleatoria y el efecto estocástico producido tiende a invertir la dirección del sesgo en relación a la de la variable no controlada.

Un asistente al Seminario sostuvo que cuando existe sub-registro de las defunciones infantiles, se produce una disminución artificial del efecto reemplazo y no una inflación artificial del mismo, como sostuvo otro participante. Si una mujer ha perdido un niño y esta defución infantil no es registrada, en la clasificación es ubicada en la categoría de las que no han perdido niños. Si enseguida reemplaza al niño muerto, entonces la fecundidad promedio del grupo que no han tenido pérdidas infantiles es artificialmente aumentada mientras que el efecto reemplazo es disminuído.

Se observó que si se dibuja en un gráfico la mortalidad infantil, según la edad de la madre al casarse por primera vez, la curva que resulta tiene forma de U. Sin embargo un participante sostuvo que esta curva no era adecuada para el estudio de la mortalidad infantil como una función de la edad de la madre al nacimiento del niño. Otro asistente indicó que un análisis apropiado podría realizarse haciendo una dicotomía de las observaciones en dos grupos, según la edad de la madre al nacimiento del niño, por ejemplo un grupo de madres de 15-30 y otro de 30 y más años de edad. Enseguida se analizaría cada grupo separadamente.

También se observó que el efecto de la mortalidad fetal en la fecundidad subsiguiente, aparentemente tiene una tendencia a distribuírse según una curva en forma de U. Las probabilidades de agrandamiento de la familia tienden a ser bajas cuando no se ha producido ninguna defunción fetal o cuando se han producido muchas.

Otro participante sugirió que el análisis discriminante podría ser utilizado para estudiar los factores determinantes de la fecundidad. La división de las unidades de estudio en grupos clasificados según fecundidad, mortalidad o parentezco, facilitaría el hallazgo de medidas que permitirían hacer distinciones entre esos grupos y definir así las condiciones implícitas en la presencia de la mortalidad y el efecto voluntario de reemplazo o del efecto de seguridad. Otro asistente observó que tanto la regresión múltiple como el análisis discriminante deberían ser utilizados con prudencia. Mientras que la regresión múltiple podría indicar que la mortalidad infantil explica la mayor parte de la varianza de la fecundidad ; los mismos datos podrían interpretarse también como que los cambios de la fecundidad explican la mayor parte de la varianza de la mortalidad infantil. El problema consiste en determinar si el esquema de interacción conduce desde la mortalidad a la fecundidad o desde la fecundidad a la mortalidad. Talvez exista un mecanismo, a través del cual se produzca una interacción biológica entre la alta fecundidad y la mortalidad infantil también elevada. Si así fuera, el análisis no podría diferenciar los efectos biológicos del reemplazo de los efectos volitivos, exceptuando talvez los estudios de las distribuciones de segundo orden a que hace referencia Brass en su documento. La forma de la distribución de las defunciones infantiles según edad y orden del parto de las madres, estará sujeta a condicionamientos diferentes según si los efectos son principalmente volitivos o involuntarios. Un enfoque de este tipo puede servir, por ejemplo, para separar los efectos debidos a "falta de cariño", de los debidos a "reemplazo" deliberado o a "seguridad". Sin embargo, es posible que tales efectos puedan ser separados con mayor facilidad, si se reune información adicional.

Uno de los participantes observó atentamente los resultados de numerosos estudios, en que se utilizó el análisis de correlación en el nivel global (especialmente la correlación de orden cero). Llegó a la conclusión de que, entre otras cosas, la utilización de medidas poco finas de la fecundidad, como por ejemplo la tasa cruda de natalidad, dificulta la obtención de resultados satisfactorios al estudiar mediante análisis de correlación, la influencia de la mortalidad sobre la fecundidad. Esto es particularmente válido cuando no se estudian cuidadosamente los desfases de la disminución de la fecundidad, con posterioridad a la declinación de la mortalidad ; ni las metodologías para calcular los coeficientes de correlación de estos desfases.

Otro participante completó esta conclusión diciendo que a pesar de que en el curso del Seminario se habló con frecuencia de las técnicas de correlación y de regresión, las que fueron utilizadas en diversos estudios, las insuficiencias de estas técnicas para estudiar mecanismos de tal dinamismo y relaciones de tal complejidad, como los tratados en el Seminario, son tan obvias, que otros enfoques estadísticos deberían ser adoptados o elaborados.

A este respecto, otro participante sugirió que los coeficientes de correlación parcial y de regresión deberían ser tipificados. Agregó que una forma de hacerlo sería dividir el coeficiente parcial por la desviación típica de la variable independiente o de la variable dependiente (la que en el contexto aparezca más adecuada).

Las técnicas de análisis multivariato están siendo utilizadas de una manera creciente en los estudios de este tipo y están dejando atrás los enfoques tradicionales de clasificaciones cruzadas y tipificación. Las técniças de graduación múltiple y de regresión por el método de los mínimos cuadrados han sido empleadas en algunos modelos de relación entre el nivel de la mortalidad infantil y de la fecundidad. Pero el análisis de clasificación múltiple ha empezado a dominar la escena en los últimos años. Puede ser el medio más efectivo de tratar el tipo de datos comprendidos en las relaciones en discusión y ofrece muchas ventajas sobre las técnicas rivales, principalmente sobre las más antiguas. Utiliza variables simuladas, no hace supuestos acerca de la linealidad y es muy flexible. El análisis de modelos puede ser también útil para estudiar la influencia de la mortalidad sobre la fecundidad.

Uno de los problemas actuales en el uso del análisis de clasificación múltiple es la limitación impuesta por los programas de computación que sólo pueden tratar efectos aditivos. Sin embargo, un colega del profesor Brass, el profesor Osborne, desarrolló recientemente un programa de clasificación múltiple de efectos multiplicadores. En muchos casos este programa ajusta mejor los datos en los sub-grupos. Hasta ahora ha sido aplicado al estudio de los efectos de la edad de la madre, paridad y espaciamiento de los nacimientos, sobre los nacidos muertos y los componentes de la mortalidad infantil.

El Control de las Variables

La falta de control de variables socio-culturales y económicas tales como edad y educación de la madre, ocupación del sostén principal, y el status socio-económico de la familia puede dificultar la comparabilidad de los resultados. Las zonas urbanas y rurales deben ser definidas en una forma coherente para asegurar la comparación de unidades de tabulación cultural similares.

En las ocasiones en que se hagan comparaciones de datos familiares, deben presentarse las tabulaciones culturales nacionales y debe otorgarse gran importancia a la conceptualización de la familia. Por ejemplo, la familia europea, el sistema familiar de la India, la familia patriarcal de la China pre-revolucionaria y la familia extendida de las Filipinas, no deben englobarse en una unidad ya que representan familias tipos con diferencias estructurales. Los diversos tipos de familia pueden influenciar de una manera diversa la conducta demográfica y otros aspectos del comportamiento social de consecuencias demográficas, por ejemplo la edad al casarse por primera vez, costumbres matrimoniales y valoración de los hijos. Por esta y otras razones similares convincentes, el énfasis fue puesto una y otra vez sobre la importancia de controlar las variables socio-económicas y no sólo los antecedentes estadísticos y demográficos. Es probable que esta haya sido la recomendación más repetida en el Seminario.

Varios participantes señalaron que era necesario efectuar una utilización más cuidadosa de la metodología sociológica en el estudio de los efectos volitivos de la mortalidad de la niñez sobre la fecundidad. Para tal efecto se propuso que se hicieran entrevistas en profundidad y que se formulara una mejor conceptualización de las variables socio culturales y económicas. Un participante señaló que en los estudios históricos europeos no existía evidencia de que la reducción de la mortalidad de la niñez fuera suficiente por sí misma para desencadenar la caída de la fecundidad, sin la intervención de otros factores. Tal reducción de la mortalidad de la niñez puede ser, sin embargo, parte integrante de una constelación de causas, especialmente si se tiene presente la hipótesis umbral.

Las normas y expectativas acerca del tamaño de la familia adquieren toda su importancia a la luz de estas implicaciones, al igual que otros valores y actitudes relacionados con el efecto "reemplazo" o con el efecto "seguridad". Muchos pensaron que la educación de la madre jugaba un rol predominante entre tales consideraciones socio-culturales y económicas. En algunas culturas, la composición por sexo de los niños sobrevivientes puede haber tenido una gran importancia en relación a las decisiones acerca de la fecundidad ulterior y de las inquietudes que se plantean en torno al tamaño deseado, esperado y óptimo de la familia. Se solicitó también que se hiciera una clara distinción entre las poblaciones en las cuales una alta proporción de los matrimonios usuban métodos anticonceptivos y las poblaciones en las cuales el uso de anticonceptivos es mucho menor debido al desconocimiento de los métodos o a otros impedimentos que hacían impracticable su uso en la época del estudio. La edad al casarse fué mencionada como otro mecanismo social que regula el tamaño de la familia, por ejemplo,la edad al casarse aumenta si la mortalidad de la niñez aumenta y vice-versa. Aunque se concluyó que ni las presiones sociales sobre la nupcialidad y sobre la fecundidad cambian en apariencia rápidamente ; ni cambian, por lo mismo, las decisiones sobre el tamaño medio de la familia en períodos cortos.

En las poblaciones en las cuales se ha extendido el uso de los métodos anticonceptivos : necesitan que se estudie la existencia de efectos voluntarios de la mortalidad de la niñez sobre la fecundidad ? Un medio de estudiar estos efectos voluntarios en las poblaciones en que el porcentaje máximo de parejas que utilizan la anticoncepción no alcanza al 35 % es dividir la muestra en dos partes : los que usan y los que no usan anticonceptivos. Sin embargo el uso de anticonceptivos no es el único medio mediante el cual la presión social ejerce su influencia para disminuír el número de embarazos. Además de la postergación de los matrimonios, se observó que en algunas se evitan los embarazos o por lo menos los nacimientos de los niños a través de las prácticas tradicionales de la abstinencia, de la residencia de la esposa en la casa de sus padres por un largo período después del nacimiento del hijo y mediante los abortos. Las costumbres relativas al amamantamiento de los hijos provocan también variaciones en la amenorrea post-partum.

Se reconoció que en el estudio de los efectos voluntarios de la mortalidad infantil y de la niñez sobre la fecundidad era muy importante controlar la lactancia y la consiguiente amenorrea post-partum, como un importante factor biológico y fisiológico. Principalmente cuando los aspectos socio-culturales y económicos están muy estrechamente vinculados a la duración y efectos de la lactancia, por ejemplo en el caso de madres

desnutridas. En Nigeria se ha encontrado que la duración del amamantamiento ha variado desde seis meses o aún desde ninguno hasta tres años y medio.

Sin embargo un participante sostuvo que en la literatura demográfica se había atribuído mayor influencia que la esperada, de acuerdo a la evidencia clínica, a la lactancia sobre los intervalos entre nacimientos. Según su opinión, se había notado un aumento del intervalo medio entre nacimientos, sólo cuando la lactancia era practicada por madres desnutridas.

Se sugirió, además, que el efecto de la lactancia sobre la amenorrea post-partum no era idéntico en todas las poblaciones y que sería muy interesante que se hicieran estudios más detenidos sobre este aspecto.

Se observó que, a veces, se atribuía el acortamiento de los intervalos entre nacimientos a la mortalidad infantil, cuando en realidad puede atribuirse este hecho más a la fecundidad que a la mortalidad. Una madre que tenga un hijo de muy corta edad y queda de nuevo embarazada, debido a este embarazo puede descuidar la atención de su hijo pequeño hasta el punto que este muere por falta de atención. Parece que una mujer que no utilize cuidadosamente métodos anticonceptivos, tampoco se preocupará con mucha atención de la salud de sus hijos. Sí esto es así, existiría una relación muy estrecha entre mortalidad infantil y nivel de fecundidad.

Con respecto a esta "hipótesis de falta de cuidado", Heer-Wu realizó un estudio en Taiwan acerca de los determinantes de la mortalidad de la niñez (niños menores de cinco años) mediante el análisis de clasificación múltiple. La variable individual más importante era la muerte de un hermano. Esto es coherente con la hipótesis de que la falta de cuidado y la incompetencia de la madre puede ser un factor común tanto de la muerte de cada uno de los dos niños como del aumento de la fecundidad.

Un participante observó, que cuando existe una alta concentración de los nacimientos y los intervalos entre nacimientos esperados varían, existe el riesgo de tomar la relación inversa mencionada anteriormente, como una influencia positiva de la mortalidad de la niñez sobre la fecundidad a través de efectos volitivos. Esto podría afectar la medición de los nacimientos debidos al reemplazo subsiguiente a la muerte de un niño por la inclusión de nacimientos falsamente calificados de reemplazo. Mientras tales efectos inversos (nacimientos precedentes que no se han producido después de una defunción) podrían ser pequeños, aún las diferencias provocadas por el efecto reemplazo, especialmente en estudios históricos, podrían también ser muy pequeñas. Pero se pierde la sensibilidad de la medición si se trata de impedir mediante controles tales efectos inversos.

Se señaló aquí la importancia de mantener tres fuentes de experiencias distintas : experiencia personal directa, experiencia personal indirecta y experiencias y presiones sociales. Estas fuentes no son diferentes en la real experiencia de las parejas y no son mutuamente independiente, aunque son analíticamente separables.

Otro participante sostuvo que el esfuerzo de estudiar y controlar las variables en juego, puede ser de gran importancia en Africa tropical, donde los efectos de la mortalidad infantil sobre la fecundidad se hacen sentir principalmente a través de los mejoramientos de los niveles socio-culturales y económicos. Aquí en las areas rurales, debido a la estructura de la sociedad y a las formas de la familia, los niños adicionales no representan ni un mayor costo excesivo, ni un mayor problema de atención. Las formas de familia matrilineal y patrilineal así como los sistemas de parentezco son diferentes tanto en los modelos europeos como en los asiáticos. Las normas y estructuras sociales varían entre los diferentes grupos sociales. En muchos tipos, incluso si el padre o la madre mueren, el hermano o la hermana pueden hacerse cargo del cuidado de los niños, pueden incluso continuar procreando niños.

La baja en la mortalidad de la niñez en los países subdesarrollados del mundo de hoy, puede atribuírse en gran parte a los programas de atención médica, campañas epidermiológicas y otras medidas de salud, propiciadas por los gobiernos ; en contraste con lo ocurrido en los países europeos, donde la reducción de la mortalidad formó parte del conjunto de transformaciones sociales y económicas de la sociedad. Esto significa que los países en desarrollo ofrecen actualmente oportunidades únicas para el estudio de los efectos de las instrucciones en cuanto a la nutrición del niño, de las prácticas de las parteras, del aumento de la utilización de los hospitales y de la salud de la madre sobre el nivel de mortalidad del niño. Tales estudios, realizados en el micro-nivel, mediante muestras pequeñas pueden revelar la dinámica y los mecanismos mediante los cuales la mortalidad infantil y de la niñez ejercen su influencia sobre la disminución de la fecundidad. El Programa de Estudios de Población que ha conducido el Banco Mundial en dos provincias de la India ha emprendido tales estudios acerca de las inter-relaciones entre fecundidad y mortalidad. El trabajo de terreno en las areas rurales de la parte septentrional de la India ha mostrado una relación positiva entre mortalidad de la niñez en la temprana vida matrimonial y la fecundidad subsiguiente. Estudios longitudinales de seguimiento, de tamaño pequeño, podrían proporcionar los datos necesarios para profundizar el estudio de estas influencias.

Otro participante sugirió sin embargo, que las posibilidades de reducción de la mortalidad de la niñez mediante una inducción externa pueden haber sido extraordinariamente exageradas e insistió en que deben ocurrir cambios sociales fundamentales antes de que ocurran tales reducciones.

Estas consideraciones condujeron a la conclusión de que existen varios tipos de trancisión demográfica, entre los cuales el presente seminario distinguió tres : a) la transición clásica, b) la transición acelerada y c) la transición retardada.

Otra variable intermedia a la que se prestó atención fue la nutrición. Por ejemplo en Papua, Nueva Guinea, la edad media a la menarquia entre las mujeres montañesas pobres y mal alimentadas puede ser tan tardía como a la edad de 18,7 años y la edad media a la menopausia puede ser hasta cuatro años menos en las regiones altas que en las zonas mejor alimentadas de las planicies. En conjunto este hecho, totaliza una diferencia de 6-7 años en el período fecundo entre las tribus mal alimentadas de la montaña y las poblaciones que viven en las zonas más desarrolladas y mejor alimentadas.

Sin embargo, hay variables intermedias entre la nutrición y la fecundidad, y es necesario estudiarlas cuidadosamente. Podría organizarse otro seminario para estudiar los efectos de la nutrición y talvez de otras variables socio-culturales y económicas sobre la fecundidad. El efecto de la nutrición sobre la fecundidad y la mortalidad podría muy bien ser el objectivo de un programa de investigaciones. Puede agregarse que la mortalidad infantil es considerada frecuentemente como un indicador del nivel de vida. Si es así esto significa que la discriminación de los efectos sobre la fecundidad del nivel de vida de aquellos efectos provocados por la mortalidad infantil y de la niñez se hace mucho más difícil.

Un participante sostuvo que ciertas causas de muerte específicas inducían menos a los padres a reemplazar a sus hijos que mueren. Sin embargo en la presente fase de las investigaciones se consideró que este tipo de causas de muerte no era motivo de un control de primera prioridad a menos que tales causas de muerte fueran comunes.

Se sugirió que una relación entre la mortalidad infantil y la edad al casarse era posible, en el sentido en que el matrimonio temprano acarrea un mayor número de defunciones infantiles. Otro participante indicó, sin embargo, que la incidencia y nivel de la mortalidad infantil según la edad de la madre, al ser representadas gráficamente tenían una distribución en forma de U. No hay dudas entonces de que la edad al casarse provoca diferencias en los niveles de la mortalidad infantil. El aspecto general es bien conocido. Debe considerarse también la posibilidad de que los efectos de la fecundidad sobre las diferencias en la nupcialidad provoque diferencias en la mortalidad.

Se prestó también atención al efecto de la mortalidad infantil y de la niñez sobre el equilibrio entre los sexos y las probabilidades de casarse. La mortalidad infantil y la mortalidad de la niñez, de uno a quinze años de edad, varía según el sexo de país en país. Los cambios en la mortalidad de la niñez podrían producir un efecto estructural sobre la población y causar un desequilibrio en el "mercado del matrimonio". Si los hombres escogen sus esposas en generaciones de mujeres más jóvenes que la de ellos y si en el pasado se ha producido una rápida disminución de la mortalidad infantil, entonces podría ocurrir que un número excedente de mujeres tuviera dificultades en encontrar marido.

En este punto de la discusión un participante sostuvo que una reducción de la mortalidad podía tener un efecto inmediato sobre la edad al casarse, de la siguiente manera : si un hombre desea casarse, puede escoger para casarse tanto una mujer mas vieja como una mujer más joven. Si la mortalidad de la niñez es alta, este hombre puede escoger para casarse una mujer más joven capaz de tener un gran número de hijos. Si la mortalidad infantil es baja, puede escoger una mujer de más edad para evitar los costos del control de la natalidad. Sin embargo si una mujer es de mas edad al momento de casarse, puede haber tenido mas tiempo de ganarse una dote para sí misma. Por ejemplo, en Taiwan, la edad al casarse de las mujeres ha aumentado considerablemente y la nueva costumbre es que las niñas trabajen antes de casarse para reunir dinero para su dote.

Los efectos mencionados del cambio de la mortalidad de la niñez sobre la nupcialidad y sobre la fecundidad marital necesitan ser estudiados con más profundidad, especialmente las reducciones de la mortalidad producidas por : a) la extensión de la modernización o b) otros factores sin que se haya extendido la modernización. En el segundo conjunto de reducciones, especialmente, el cambio puede conducir a agudos conflictos entre la fecundidad deseada o los esquemas de población también deseados y las instituciones sociales y normas tradicionales. La investigación científica podría,talvez, precisar en que medida este conflicto puede existir en el nivel social antes de que las parejas individuales sean impulsadas a elegir soluciones de uso de anticonceptivos, esto es, antes de que sea activada la relación entre el micro y el macro nivel. Esta situación podría ser observada primero en diferentes condiciones sociales y agrícolas y enseguida podría elaborarse cuidadosamente un diseño experimental.

Deben tomarse precauciones para definir el ámbito social o comunitario, cuando se va a calcular una tasa de mortalidad a nivel de la sociedad o de la comunidad y se va a suponer después que esas medidas van a tener un impacto sobre la conducta en relación a la fecundidad de las parejas individuales. Si la sociedad o la comunidad tomada como base para calcular esas tasas no es la misma sociedad o comunidad que sirve de grupo de referencia a las parejas que se estudian, entonces estará mal medido el efecto social o comunitario de las tasas de mortalidad que se han calculado.

La investigación debería dirigirse también a averiguar la forma en que la reducción de la mortalidad de la niñez induce la práctica de la contracepción. Se ha afirmado que la carga de la población dependiente podría ser una de las causas, pero cuando la carga de la población dependiente es estudiada correctemente, es decir longitudinalmente y no en un corte transversal, entonces el aumento por sí mismo (un 16 % o menos) no es actualmente tan importante como para ser decisivo. Dada una meta específica de la familia, de que por lo menos un hijo alcance la edad del padre, cuando la mortalidad infantil y de la niñez disminuye, puede suponerse que el cumplimiento de ciertos requisitos puede llevar a la familia a la conclusión de que puede reducir la fertilidad y aún alcanzar tal meta. Si se quiere comprender la decisión de limitar los nacimientos adicionales, entonces deben considerarse otros criterios. Por ejemplo, cuando se desea no dividir la hacienda familiar, la que debería dividirse si sobreviven dos hijos. Dos metas aparecen entonces y la familia debe decidir si tiene un sólo hijo y entonces usar anticonceptivos para no tener más. Como los padres no pueden postergar la decisión hasta que el primer hijo haya alcanzado la edad adulta o incluso la adolescencia, entonces deben usar indicadores acerca de las probabilidades de sobreviviencia del primer hijo. Un estudio mediante un modelo de decisión debe usar los mismos indicadores, como por ejemplo : a) si el primer hijo ha llegado hasta los 10 años de edad o b) si ha nacido un segundo hijo cuando el primero está aún vivo. La familia cesa de tener más hijos cuando esos indicadores son satisfechos. Debe continuarse la investigación para averiguar : ¿ es mayor la tasa de crecimiento cuando no existen estos "topes" que cuando existen ? ¿ Cuál es el efecto sobre el crecimiento de la población de tales "topes" de tamaño de la familia ?

Se señalaron, además, varias otras areas útiles de investigación semejantes. Como por ejemplo, esterilidad y fecundidad reducida y las implicaciones de tales factores así como el de concentración de los nacimientos en los efectos de reemplazo.

Ha menudo se ha justificado la hipôtesis de que bajo ciertas condiciones, en las etapas de desarrollo temprano de la industrialización y/o de la modernización, a un aumento de los ingresos corresponde un aumento de la demanda del número de hijos. Por ejemplo en el documento de Retherford. Esta suposición se ha justificado principalmente por la experiencia de los países en desarrollo en los cuales se dice que la fecundidad de los hacendados varía en proporción directa a sus ingresos. ¿ Sí es así, como explicar el hecho de que por todas partes los pobres tengan un mayor número de hijos ? Se pensó que podría elaborarse una explicación de tal contradicción aparente a partir de los datos de las sociedades rurales modernas mediante una distribución de forma de U. Por ejemplo, la Encuestra Nacional de Turquía señala que la fecundidad es alta entre las familias de bajos ingresos de las areas rurales ; es considerablemente más baja entre los hacendados de situación media, pero es nuevamente muy alta entre las familias rurales de altos ingresos, que son sin embargo una minoría. Así podría lograrse una disminución de la fecundidad, mediante una distribución equitativa de la tierra.

Modelos económicos

¿ Qué utilidad puede prestar un modelo económico micro-estático, de oferta y demanda, para estudiar las decisiones de los padres sobre el reemplazo de un niño muerto o sobre la necesidad de asegurar mediante un hijo adicional la posible pérdida de uno de ellos ? Una decisión caprichosa puede ser completamente diferente, por ejemplo, que una decisión basada en probabilidades objetivas acerca de los riesgos involucrados y puede ser determinada en gran parte por las circunstancias del momento. Por esta razón, un participante sostuvo que un modelo económico objetivo no era suficientemente adecuado como para tomar en consideración los factores reales que intervienen en el acto de decisión acerca de tener o no otro hijo por razones de reemplazo o de seguridad. Además, el modelo cambia mucho las bases sobre las cuales es tomada la decisión. Los niños pequeños no son bienes de consumo durables. ¿ Cuáles son entonces las ventajas de considerarlos como tales ? Las normas e instituciones sociales, que tienen muy poco en común con las relaciones puramente económicas de la ofertas y la demanda, tienen por el contrario una gran influencia en la determinación de la fecundidad. Además, la relación oferta-demanda es estática, mientras que la relación entre la mortalidad de la niñez y la fecundidad volitiva es dinámica. Sin embargo, el modelo puede proporcionar resultados aproximados de las relaciones reales y esta posibilidad podría ser explorada en estudios experimentales. Sin embargo un participante sostuvo, que la investigación debería proceder en torno a lineas de deseo más bien que en torno a lineas de demanda en oposición a costos, en el objetivo actual del Seminario. Agregó que el deseo determina la fecundidad y no la demanda, aunque la demanda puede establecer un número mínimo de hijos más allá del cual los deseos y los costos deben ser cuidadosamente pesados antes de tomar una decisión. Entre los costos que deben ser considerados están las dificultades sicológicas de actuar contra las normas tradicionales y la posible disminución del status masculino (o femenino), el que en algunas sociedades aumenta según el número de hijos. Por otra parte, otros costos de los niños adicionales deben ser también considerados, como por ejemplo la alimentación adecuada, el alojamiento, el cuidado y la educación.

Sin embargo, otro participante sostuvo que un modelo económico estático puede ser útil si se conserva el elemento de elección. Solamente de una manera empírica puede determinarse si los resultados se aproximan o no a la realidad. Por lo demás es discutible, si el deseo es más importante que la demanda cuando el tema en estudio es la relación entre la mortalidad del niño y el reemplazo voluntario o el efecto de seguridad. El problema del reemplazo es una pregunta decisiva que debe encontrar una respuesta por parte de la familia y por esta razón el marco económico podría parecer ser correcto. Varias dimensiones sociales podrían, por lo demás, ser agregadas, lo que haría que el análisis fuera mucho más complejo. Un tercer participante sugirió que podría incluso ser útil considerar un esquema de modelo económico a través de los costos de utilidad marginal.

Relaciones entre mortalidad y niveles de fecundidad : estudios históricos

No se pueden aún concluír relaciones definitivas entre la mortalidad infantil y de la niñez (0-14 años), y la fecundidad a partir de los resultados del análisis de los datos históricos del Programa de Estudios de la Fecundidad Europea de la Universidad de Princeton. Estos datos se refieren al período de transición demográfica de los países incluídos en el programa. Sin embargo estos resultados indican que una disminución de la mortalidad infantil (0-1) no es un requisito previo para la declinación de la fecundidad. En la mitad de las provincias de Alemania, la disminución de la fecundidad ocurrió aproximadamente nueve años antes de la disminución de la mortalidad infantil. En Bélgica una substancial limitación de la natalidad precedió la disminución de la mortalidad infantil por lo menos en 25 años. Y en Suecia, la mortalidad infantil descendió desde aproximadamente 200 por 1000 nacidos vivos con anterioridad a 1800 hasta 130 defunciones infantiles por 1000 nacidos vivos en 1871-1880, sin ninguna declinación de la fecundidad. La experiencia europea puede ser, por otra parte, de valor limitado para comprender las relaciones actuales entre la mortalidad infantil y la fecundidad en países en desarrollo.

Completamente diferente parece ser la relación entre la mortalidad de la niñez (0-9, 1-9 e incluso 0-14) y el nivel de la fecundidad. Un participante sostuvo que no conocía ningún país no-europeo que hubiera experimentado una reducción significativa de la fecundidad sin haber experimentado con anterioridad una substancial reducción de la mortalidad de la niñez (0-9 o 0-14). Estos hallazgos parecen haber contado con el acuerdo mayoritario de los asistentes, aunque se agregó como una adaptación posible el retraso que se produce entre la reducción de la fecundidad después de la disminución de la mortalidad de la niñez, en algunos países, tanto como la posible intervención de otras variables intermedias.

Un participante indicó que probablemente la reducción de la fecundidad que precedió a la disminución de la mortalidad infantil en casi la mitad de las provincias de Alemania, pudo probablemente producirse a continuación de una declinación de la mortalidad de la niñez (1-4 o 1-9 años de edad), aunque los datos correspondientes para mostrar esta relación todavía no han sido tabulados. R. Lesthaeghe mostró que cuando la mortalidad de los niños de más de un año se substituye a la mortalidad infantil, entonces la declinación de la fecundidad que había precedido la declinación de la mortalidad en casi todas las provincias de Bélgica, aparece a continuación de ella en la mitad de las provincias. E.A. Wrigley ha señalado que en Inglaterra la declinación de la mortalidad infantil se retrasó con respecto a la disminución de la reducción de la mortalidad de los niños y de otras edades mayores. Otro participante declaró, sin embargo, que la conclusión más significativa de los estudios históricos europeos es "la falta de evidencia" de que la reducción de la mortalidad de la niñez sea suficiente por sí misma para acarrear directamente la baja de la fecundidad sin la intervención de otros factores, aunque reconoció que la baja de la mortalidad de la niñez puede ser una parte integrante de un conjunto complejo de factores causales. Posiblemente este participante quiso significar mortalidad infantil (0-1 años de edad) en su intervención, aunque usó el término mortalidad de la niñez.

El retraso de la declinación de la fecundidad detrás de la baja de la mortalidad merece un estudio cuidadoso. El efecto "umbral", al que ya se ha hecho mención, puede der de gran importancia en este desfase. Se ha establecido que en algunos, pero no en todos los países europeos, la baja de la mortalidad infantil (0–1 años de edad) precedió considerablemente a la baja de la fecundidad, mientras que diversas otras relaciones fueron encontradas en otros países. Los datos de Suecia para el período 1850-1890 muestran una mayor fecundidad urbana que rural.

Un participante sostuvo que estas diferencias entre la fecundidad urbana y rural que se encuentran en Suecia, podrían muy bien ser producto de sesgos en los datos referentes a la edad y a la estructura de los matrimonios más que diferencias reales.

Sería muy útil que se realizaran análisis transversales y longitudinales acerca de los efectos de la declinación de la mortalidad infantil sobre cambios en la edad media al casarse por primera vez. Los datos del Programa de Estudios de la Fecundidad Europea de la Universidad de Princeton, sobre la transición demográfica en Europa, podrían suministrar valiosos antecedentes y resultados, si se utilizan para examinar este tipo de relaciones. Un estudio de este tipo fue realizado por el demógrafo soviético Novoseliskij en la década de 1920 ; incluía un estudio transversal de las provincias del Imperio Ruso alrededor de 1900. Ese

estudio mostraba una correlación negativa substancial entre nivel de mortalidad infantil y edad media al casarse. El coeficiente descrito era más bien total que parcial. Sin embargo, otro participante sostuvo que talvez la diferencia urbano-rural encontrada en Suecia, podría ser real, y provocada por la creciente "demanda" (en el sentido económico) de niños en las areas urbanas en las primeras etapas de la revolución industrial. Esta interpretación fue rebatida por otros participantes. Uno de ellos sostuvo que en su opinión los padres que habían perdido hijos debido a las duras condiciones de la primera época de la revolución industrial podrían más bien haber perdido los deseos de reemplazar esos niños debido a esas condiciones. Otro agregó que tal aumento pudo haber sido parcialmente provocado por el ligero aumento de la fecundidad durante esos primeros años de la transición demográfica, pero que ese aumento bien pudo haber sido causado por la influencia de la modernización, ya que antes de que las parejas conocieran los métodos de limitar la familia, rompieron las tradiciones seculares que antiguamente habían moderado la fecundidad Por ejemplo, podría no haber sido posible para una madre obrera ir al hogar materno por un tiempo prolongado en la época del nacimiento, practicar períodos de abstinencia o amamantar a su hijo en la forma tradicional. Más aún, los abortos inducidos podrían haber reducido los intervalos entre nacimientos. Pero, debido a que la posición de las iglesias en la época pre-industrial y en las primeras épocas de la revolución industrial, era muy fuerte en contra del aborto, tales abortos ni eran registrados ni aparecen en los registros parroquiales. Así la calidad de los intervalos entre nacimientos calculados a partir de los registros parroquiales pudo haber sido afectada.

Sin embargo la investigación de Knodel, basada en pequeñas areas, muestra que en los distritos de Bavaria en el siglo XIX, donde no era practicado el amamantamiento de los hijos, existía una alta correlación a nivel global entre nivel de mortalidad infantil y nivel de fecundidad marital. Debido a que no era practicado el amamantamiento, esta correlación no pudo atribuírse a la variable intermedia de la amenorrea post-partum. Debido a que la misma investigación encuentra una relación muy pequeña para las mismas areas, pero a nivel individual, entre mortalidad infantil y fecundidad, el resultado sugiere que actuaba de una manera muy importante una variable independiente a nivel de la sociedad.

Las estadísticas del Reino Unido están siendo analizadas actualmente para buscar relaciones entre mortalidad de la niñez y fecundidad. El país has sido dividido en doce regiones manteniendo algún criterio de homogeneidad y se han calculado series cronológicas para un período de 130 años entre 1840 y 1970. El análisis se ha referido a la disminución de las tasas de mortalidad y de fecundidad.

Los resultados han sido los siguientes : (1) las correlaciones han sido altamente positivas (sobre 0,70) en el período de rápido descenso de la fecundidad y a un máximo en el cual no había retraso (por ejemplo, cuando los cambios en las tasas de mortalidad y de fecundidad eran simultáneos) ; (2) en un período de veinte años, la mortalidad de la niñez aumentó pero las correlaciones permanecieron constantes, debido a la interacción de los datos de regiones con la más pequeña y con la más alta disminución de la mortalidad ; (3) a pesar de las grandes variaciones de la mortalidad de la niñez, la disminución inicial de la fecundidad ocurrió casi simultaneamente en cada región.

Estos resultados sugieren que el efecto directo de la declinación de la mortalidad infantil fue pequeño y que los cambios socio-culturales y económicos estaban afectando tanto a la mortalidad de la niñez como a las medidas de los niveles de la fecundidad. La tercera conclusión de la experiencia del Reino Unido sugiere que actualmente es menos probable que se produzca un gran retraso entre la reducción de la mortalidad de la niñez y la disminución de la fecundidad.

Los cambios simultáneos en la mortalidad infantil y de la niñez y en la fecundidad en Inglaterra entre 1840 y 1900 pueden haber sido inducidos por factores que afectaron ambas variables. Pero el resultado puede haber sido también originado por el hecho de haber alcanzado un umbral en la pérdida de hijos.

Debido a que las declinaciones tanto de la fecundidad como de la mortalidad fueron agudos y se produjeron casi al mismo tiempo en las diferentes regiones de Inglaterra y Gales, a pesar de la gran variedad de condiciones, se puede sospechar de que los determinantes fueron comunes para todo el país.

El Estudio de la Fecundidad Europea puede permitir extraer conclusiones acerca de las acciones adecuadas que deben adoptar los países en desarrollo. El nivel de la mortalidad de la niñez a partir del cual la fecundidad empezó a descender fue muy variable, pues en alguna parte de Inglaterra era tan alto como veinte por ciento. Muchos países en desarrollo de la actualidad tienen niveles de la mortalidad de la niñez mucho más bajos que los niveles a los cuales la fecundidad empezó a bajar en varias regiones europeas.

Se sugirió que dos componentes del cambio de la mortalidad de la niñez pueden afectar el nivel de la fecundidad. Ellos son : a) el cambio actual en las tasas y b) el cambio en los conceptos de la población acerca de los cambios de la mortalidad de la niñez. El último componente no puede ser obtenido ni mediante los datos históricos ni, en general, de los datos a nivel global.

Los datos de Australia, obtenidos a través de los estudios de la Universidad Nacional de Australia, muestran un desfase de 20 a 30 años entre el momento en que empezó a declinar la mortalidad infantil y de la niñez en el siglo XIX y la eventual disminución de la fecundidad. Un participante sostuvo que con un retraso de tal magnitud era muy difícil afirmar que existía una relación causal entre estos dos factores. Es más

probable que el factor sub-yacente, común a ambos factores, sea el cambio social.

La discusión del documento Retherford destacó la importancia de las migraciones en sus relaciones con la fecundidad (principalmente la migración rural-urbana). No está claro si la migración fue tomada en cuenta en el Programa de Estudios de la Fecundidad Europea de Princeton y por lo menos sería útil tener informaciones al respecto.

En los estudios de carácter histórico, no es de gran importancia diferenciar los efectos voluntarios de la mortalidad infantil y de la niñez sobre la fecundidad, ni separar los efectos de la contracepción de aquellos del aborto y de la abstinencia, también sobre la fecundidad, para los efectos de este Seminario. Sin embargo lo que es realmente importante es la separación de los efectos voluntarios de aquellos exclusivamente fisiológicos. Son evidentes las dificultades que se encuentran al tratar de efectuar esta separación mediante datos que no fueron recogidos teniendo este propósito en consideración. Este problema se presenta no solamente en los datos históricos sino que también en cualquier otra colección de información recogida con fines agenos a los de este Seminario. También existe el problema de que en general las muestras con las cuales se trabaja en los estudios históricos son pequeñas y es bien difícil extraer conclusiones seguras con muestras pequeñas.

Un participante expresó que los datos de los estudios históricos pueden adolecer probablemente de diferentes sesgos cuya magnitud no es bien conocida. Estos errores pueden haber sido causados, por ejemplo, por las visitas irregulares de las autoridades religiosas (sacerdotes o ministros) a las partes más alejadas de sus territorios parroquiales, aplazamiento de la realización de algunos ritos (bautismos y ritos funerarios), mala declaración de las edades, y migraciones hacia o desde la población en estudio ; y que mientras en los estudios contemporáneos muchos de estos errores pueden corregirse mediante verificaciones en el terreno estas verificaciones no son posibles en el caso de los estudios históricos. Se le respondió, señalando que se habían elaborado pruebas para medir la calidad de los registros históricos y que en muchos casos los registros parroquiales del pasado eran mantenidos probablemente mejor que los registos parroquiales contemporáneos. Los registros parroquiales alemanes y canadiennes eran muy cuidadosos y precisos. Los registros parroquiales ingleses son utilizables, aunque con algunas dificultades. Las técnicas de reconstitución de las familias producen información acerca de las historias de las familias completas, lo que no deja lugar a conjeturas acerca de los hechos vitales ocurridos durante el período reproductivo de una pareja. Estas historias completas están basadas en hechos que se registraban a medida que ocurrían sin los problemas de memoria que caracteriza a las encuestas retrospectivas. Se urgió a CICRED para que estableciera o ayudara a formar un banco de datos de registros parroquiales, mediante el uso de computadoras y con el fin de ser utilizados en estudios demográficos. Esto permitiría hacer análisis más profundos de tales registros a los profesionales de la Demografía Histórica.

Relaciones entre Mortalidad y Niveles de Fecundidad : Estudios Actuales.

En esta sección no se va a repetir lo ya dicho en secciones anteriores sobre este tema.

Se discuten y comparan los datos correspondientes a varios estudios que se están realizando en diferentes regiones del mundo.

Un participante llamó la atención acerca de las similitudes de los resultados del estudio de Bangladesh y Pakistán con los resultados expuestos acerca del Programa Europeo de Estudios Históricos. Puntualizó también que el estudio de Lery-Vallin indicaba que el efecto reemplazo aumenta en poblaciones con baja fecundidad y con extensa difusión de control de la natalidad, por lo que en el futuro se deberían realizar investigaciones destinadas a encontrar el punto de la transición demográfica en que este mecanismo comienza a operar.

El estudio de Pakistán y Bangladesh descrito en el documento básico respectivo, es en efecto más un intento para estudiar los efectos volitivos de la mortalidad infantil sobre el espaciamiento de los nacimientos que un estudio de la limitación de la familia y reemplazo de los niños. Un participante observó que era necesario tomar con precaución los datos sobre la edad en el estudio de Pakistán, debido a que las familias en general no recuerdan correctamente la edad de sus hijos en años cumplidos, y mucho menos en meses cumplidos. Si no se toman tales precauciones los intervalos entre nacimientos pueden resultar con fuertes sesgos.

En Africa tropical se ha observado que un estudio longitudinal, manteniendo constantes las variables socio-culturales y económicas, puede obtener informaciones que parecen apoyar la hipótesis de los efectos voluntarios. Sin embargo, en los informes sobre Africa tropical se ha producido una mayor omisión de los niños que mueren que de los que sobreviven, lo que provoca una gran sub-estimación de la mortalidad infantil y de la niñez. Omisiones, errores y falsas respuestas alteran los resultados. Las variaciones de la fecundidad se deben también a la influencia de los valores culturales y sociales. Además, los matrimonios poliginios contribuyen a reducir los registros de los niveles de fecundidad y de mortalidad de la niñez. La residencia urbano-rural, la migración y otras variables socio-culturales y económicas pueden hacer preponderar los efectos del reemplazo del niño.

Pero es necesario saber si las distinciones entre area urbana y rural son adecuadas para este tipo de estudios en Africa. Resumiendo, parece ser que los datos disponibles no permiten investigar los efectos voluntarios de la mortalidad de la niñez sobre la fecundidad, aunque son útiles para muchos otros propósitos.

Un participante observó que la alta fecundidad combinada con los tradicionales tabues sobre el sexo pueden ser un factor importante en la evolución de la fecundidad en Africa. Como un resultado de esta quiebra de los tabues sobre el sexo, puede ocurrir en las zonas urbanas, que las tendencias de las mujeres a visitar menos a sus madres después de un parto para "recuperar fuerzas" hasta que el niño esté "suficientemente robusto", puede constribuír más bien a aumentar la fecundidad que a disminuírla.

Otro participante observó que los nuevos datos disponibles sobre Africa tropical hacían posible y deseable una revisión de las comparaciones.

En algunos países de Africa tropical parecen especialmente importantes los efectos fisiológicos. En todo caso el nivel de fecundidad en Nigeria, por ejemplo, es tan alto que aún cuando la lactancia dura hasta 36 meses o más, parece que una disminución de este período de amamantamiento debido a la muerte del niño no aumenta de una manera apreciable la fecundidad.

La transición de la mortalidad en la India y en la mayor parte de los países asiáticos ocurrió en la primera mitad del siglo XX, principalmente como respuesta a campañas epidemiológicas y otras medidas de salud, antes de que se produjera una modernización significativa. Por otra parte, en general la disminución de la fecundidad empezó en la década de 1960, es decir con un desfase de entre 30 a 50 años con respecto al comienzo de la reducción de la mortalidad. La disminución de la fecundidad se atribuye habitualmente a la elevación de la edad al casarse, a la extensión de logros educacionales y a la modernización.

Se observó que en muchos países asiáticos la comparación cruzada de los niveles de fecundidad y de mortalidad no ayuda mucho a comprender la escasa información acerca de las diferencias urbano-rural. Debido a los efectos de la composición por edades sobre las tasas crudas de mortalidad se recomendó utilizar con muchas precauciones estas tasas para estudiar las diferencias mencionadas anteriormente.

En muchas sociedades asiáticas los datos sobre la edad adolecen de una gran proporción de errores y la integridad del registro de defunciones infantiles y de la niñez es muy deficiente debido a errores de memoria, motivaciones sicológicas y perspectivas socio-culturales.

Se presentaron y discutieron los datos sobre la disminución de la fecundidad y la natalidad en Singapur y en Hong Kong. Estas reducciones fueron muy amplias tanto en Singapur (desde 45 nacidos vivos por mil a mediados de la década de 1950 hasta 22 por mil en 1970 y desde 75 hasta menos de 20 defunciones infantiles por mil nacidos vivos en las dos décadas recien pasadas) como en Hong Kong (desde 27 nacidos vivos por mil en 1950, 37,4 en 1958, y enseguida menos de 20 en 1971 y desde 100 defunciones infantiles por mil nacidos vivos en 1950 hasta cerca de 20 en años recientes). En ambas ciudades el cambio de estructuras por edades puede ser adjudicado en gran parte al cambio de la fecundidad y en ambas ciudades también puede ser válido el análisis del efecto volitivo de la mortalidad de la niñez sobre la fecundidad.

Los mecanismos que operan en muchos países de Africa son diferentes a los que operan en países de Asia, América Latina, Europa e incluso a otros países de la misma Africa. Los datos deben ser, por lo tanto, examinados cuidadosamente antes de elegir un método para aplicarles técnicas de análisis secundario.

En el documento de Rutstein-Medica se formula un planteamiento relativo a políticas de población en el sentido de que una disminución de la mortalidad infantil y de la niñez provocará un aumento en la tasa de crecimiento de la población a menos que la experiencia personal indirecta y las presiones de la sociedad juegen un rol más restrictivo. En el hecho esta recomendación parece ser de baja importancia relativa debido a que es muy poco probable que la mortalidad infantil y de la niñez disminuya sus actuales niveles en muchos países de América Latina, sin que cambien los niveles de vida. Pero si esto se produce, ocurrirá en general que se producirá a continuación una reducción del nivel de fecundidad.

Los dos macro-estudios sobre Puerto Rico ya mencionados y el tercero sobre datos de niños, cubren menos del cinco por ciento de la población latino-americana. El análisis de micro-nivel denominado PECFAL-RURAL cubre un tercio de la población latino-americana, pero está limitado a las areas rurales y semi-rurales. Sin embargo casi el 60 por ciento de la población de América Latina es urbana. El 25 por ciento de la población de Brasil vive en nueve areas metropolitana, y las cifras para Argentina, Chile, Colombia, Mexico, Uruguay, Venezuela y otros países latino-americanos son más altas.

Es por lo tanto más importante investigar la conducta de las poblaciones urbanas en América Latina, tal como lo hizo CELADE hace 10 años (vèr La Fecundidad en la América Latina Metropolitana).

Un estudio de 1328 mujeres casadas de casi la totalidad de la parte urbana de Sao Leopoldo County realizada por CEDOPE (USINOS, Sao Leopoldo), relativo a la relación de la mortalidad infantil y de la niñez, mostró que el 67 por ciento de las mujeres de 15 a 44 años de adad estaban usando métodos anticonceptivos y señaló que existía una coherencia entre el número deseado de niños, embarazos conocidos y nacidos vivos, a saber, 3,79 ; 3,93 y 3,27 por mujer. La fecundidad total en Brasil era de 4,97 nacimientos por mujer de 15-49 años de edad (ver el censo de 1970).

El estudio longitudinal, sobre la mortalidad infantil y de la niñez, realizado por la Organización Panamericana de la Salud en varias regiones de América Latina entre Mayo de 1968 y Junio de 1970 es probablemente pertinente a los temas del Seminario (Ver Patterns of Mortality in Childhood, editada por Puffer y Serrano).

Relaciones entre Mortalidad y Niveles de Fecundidad ; Programas de Redución de la Mortalidad

Este tema fue limitado a discutir exclusivamente los documentos básicos y proyectos mencionados en este documento :

1) El Análisis Cruzado

Primero, se señaló que el análisis cruzado de los datos correspondientes a 74 países en desarrollo, no combina bien con el tema principal del documento : efectos especiales de la mortalidad sobre la fecundidad. Segundo, debido a que en este análisis inicial se utilizan correlaciones totales y regresiones de orden cero, los coeficientes resultantes están tachados con los defectos habituales de este enfoque :

1) La correlación es una medida de asociación no de causalidad. Las variaciones de cada una de las variables pueden ser "explicadas" por las otras variables. Incluso la correlación parcial y múltiple y la correlación de un grado más alto, no son recomendables para estudiar los efectos voluntarios de la reducción de la mortalidad sobre niveles de fecundidad mediante el análisis secundario de datos culturales cruzados.

2) Los datos son, principalmente, estimaciones basadas en la teoría de las poblaciones estables y en tablas de vida modelos. El uso de tablas de vida modelos implica la existencia de altos grados de correlación, cuando en realidad en este caso son bajos. Tales estimaciones por lo demás suponen interrelaciones entre las variables en juego, tal como fue mencionado a comienzos del Seminario. Las correlaciones entre estas estimaciones y las pruebas de significación de estas correlaciones no son, por lo tanto, de gran valor.

3) No es recomentadable efectuar la simulación de las interacciones longitudinales y de las series cronológicas,mediantes datos transversales.

4) Cuando la correlación y la regresión se hayan calculado utilizando datos transversales (suponiendo que las estimaciones no estén basadas en los métodos de las poblaciones estables y de las tablas modelos como ocurre en este caso), deben tomarse grandes precauciones al realizar análisis secundarios y comparaciones con datos internacionales. De otra manera pueden introducirse serios sesgos en los datos debido a la variación del contexto socio-cultural y económico, diferentes definiciones de términos y diversos objetivos de la investigación.

5) Las variables que van a ser correlacionades deben seleccionarse de tal manera que eviten o minimicen los riesgos producidos por variables intermedias o estas variables deben ser controladas. Por ejemplo : la correlación entre la circulación de periódicos (como un índice de modernización) con las tasas de mortalidad infantil o de la niñez y/o de natalidad.

Con respecto a todos los demás estudios en general, los participantes puntualizaron una vez más lo siguiente : la posibilidad de que un desfase en la declinación de la fecundidad no aparezca en los resultados de un programa de reducción de la fecundidad que no se ha seguido en un periodo suficientemente prolongado ; la distinción entre los efectos de una declinación de la mortalidad infantil (0 – 1 años de edad) (1) y la declinación de la mortalidad de la niñez (0–4, 0–9, o aún 0–14 años de edad), sobre la fecundidad, y la distinción entre los efectos "reemplazo", de los de "seguridad" y "sociales". Se le hizo presente a los participantes, una vez más, que no es necesario que las mujeres recien casadas o las parejas jóvenes experimenten en sí mismas una defunción infantil o la pérdida de un niño, para que los altos o bajos niveles de tal mortalidad existentes en la comunidad a la cual pertenecen, afecten sus decisiones relatives a la fecundidad.

2) El Laboratorio de Investigaciones sobre el Cólera, Dacca, Bangladesh

Los datos sobre este estudio, presentados al Seminario, no estaban completos. Más aún, la inclusión de este proyecto de Bangladesh en los documentos básicos parece haber sido incierta ya que no disminuyeron durante siete años ni la mortalidad infantil ni la fecundidad. El proyecto está destinado fundamentalmente a reducir la mortalidad por encima de un año de edad, con pequeña incidencia en la mortalidad infantil (0–1).

En segundo término, deben tenerse presente los niveles y tendencias de la mortalidad infantil y de la niñez y de la fecundidad, existentes a la época de iniciarse el proyecto. Este antecedente permitirá juzgar si la

(1) Esto es, menores de 1 año de edad. Aquí la edad uno (al igual que en todo el Seminario) es utilizada como un verdadero límite superior que no es alcanzado completamente.

declinación de la fecundidad durante el período de reducción de la mortalidad significa un quiebre de las tendencias previas, o constituye una simple continuación de ellas.

Por último, un pequeño sesgo hacia una correlación positiva se produce debido a la influencia de la mortalidad sobre la estructura por edad.

Por ejemplo, una mortalidad infantil y de la niñez más baja, determinaran una estructura por edad más joven. Habrá, por tanto una menor proporción de población en las edades reproductivas lo que tenderá a disminuír la tasa cruda de natalidad. Una investigación muy útil sería determinar la magnitud de este sesgo. Entre tanto, es necesario prestar mucha atención a la interpretación de las correlaciones, principalmente cuando las diferencias en los niveles de la mortalidad infantil y de la niñez en diversas épocas son muy grandes, mientras que la diferencias de las tasas crudas de natalidad correspondiente a las mismas fechas son muy pequeñas.

3) El Proyecto de Salud y Planificación Familiar de Danfa, Ghana.

Este proyecto no fue diseñado para probar hipótesis acerca de la relación entre el nivel de la fecundidad y la mortalidad infantil y de la niñez. Su objetivo es, más bien, proporcionar servicios de atención materno-infantil a la población rural del area. Sin embargo, debido a que la mortalidad infantil se redujo en el area, sus resultados pueden ser útiles para los fines del Seminario.

4) El Estudio Khanna, Distrito Ludhiana, Estado de Punjab, India

Este estudio se inició cuando recien se ponía en marcha el Programa de Población de la India (1954) y en localidades en las cuales el problema de población era más bien pequeño. A pesar de la literatura referente a este proyecto, parece que no ajusta bien en el contexto de los documentos básicos que se están considerando. Tal como se aprecia en la tabla 3 del documento respectivo, no ha cambiado ni la fecundidad ni la mortalidad. Después de los años 1957-1959, que pueden considerarse como aquellos en que las tasas tenían los valores más altos, tanto en las areas de prueba como de control, las tasas crudas de mortalidad, las tasas de mortalidad infantil y las tasas crudas de natalidad, tanto en los grupos de prueba como de control, son prácticamente similares. La tabla 4 es la única que concierne al tema del Seminario. Se encuentra aquí una sugerencia en el sentido de que a medida que aumentan las probabilidades de sobrevivir, disminuye la fecundidad sub-siguiente. Sin embargo el estudio toma los primeros seis nacidos vivos como un punto de separación. Este hecho encubre demasiado la interacción y un número excesivamente pequeño de mujeres se encuentra en los grupos con ninguno o con un niño sobreviviente.

5) Los Proyectos Taylor-Berelson

Se necesita mayor información acerca de estos proyectos que están funcionando en Indonesia, en las Filipinas y en Turquía. El proyecto que se realiza en Filipinas es un programa de planificación familiar que funciona integrado a los servicios de atención de la salud materno-infantil y por lo tanto debería ejercer un impacto tanto en la mortalidad infantil y de la niñez como sobre el nivel de la fecundidad. Sin embargo parece que no fue establecido para medir el impacto sobre la fecundidad, de la disminución del nivel de la mortalidad infantil y de la niñez, a través del control de la natalidad, aunque sus datos puedan contribuír a aclarar estas inter-relaciones.

6) El Proyecto Etimesgut, Distrito Etimesgut, Turquia

Se desprende del gráfico 3 y de la tabla 2 que la mortalidad infantil disminuyó desde 142 a 121 defunciones de menores de 1 año por mil nacidos vivos, entre los años 1967 y 1968, es decir sólo un año después que el proyecto se puso en marcha. La disminución de la fecundidad general ha sido notable en 1970.

Debido a que no existen datos sobre las tendencias pasadas, ni tampoco un grupo control, parece probable que otras causas pre-existían en el area de Etimesgut antes de que el proyecto fuera lanzado, las que, reforzadas por el proyecto, fueron responsables tanto de la declinación de la fecundidad como de la mortalidad. Etimesgut, es una area montañosa ubicada hacia el oriente de Aukara, pero cerca de esta ciudad, tiene fácil acceso tanto a los factores de modernización como a las facilidades de salud, junto con aquellas proporcionadas por este proyecto especial. Parece probable que el año 1967 fue un año de mortalidad infantil maxima y que esta mortalidad podría haber descendido de la misma manera en un grupo control que en el area de estudio entre 1967 y 1968 ya que una disminución desde 142 a 121 defunciones por mil es demasiado como para que pueda ser lograda por cualquier proyecto en un año. La baja de la fecundidad se produjo de una manera muy pronta como para que haya sido ocasionada principalmente por el proyecto. El tiempo de desfase es demasiado corto.

7) El Experimento de Salud y Planificación Familiar de Narangwal. Estado de Punjab. India

Desgraciadamente, este proyecto que empezó en 1965 y continuó hasta 1974 ha sido terminado. Se

necesitan más detalles de su diseño y de sus análisis preliminares, ya que aparentemente su diseño parece ser interesante para los fines de este Seminario. Un participante dijo recordar que el proyecto empleaba dos grupos de control, uno de los cuales recibía servicios de planificación familiar pero no servicios directos de salud de la niñez, mientras que el otro era un grupo "blanco" que no recibía ni servicios directos de planificación familia, ni servicios directos de atención de salud.

Un participante observó que si disminuían los costos de tener un hijo, y no existen factores compensatorios, entonces la tasa de crecimiento de la población podría tender a aumentar. Sin embargo, los programas de reducción de la mortalidad podrían intentar mejorar la calidad y cantidad de atenciones de salud que las madres proporcionan a sus hijos, proporcionando educación e instrucción a esas madres. Otros participantes estuvieron de acuerdo en este último punto de vista y uno sugirió que ello podría estimular la inter-relación entre número y bienestar de los niños, es decir, en términos económicos, entre cantidad y calidad de los niños. Esto es, la disminución de los costos por niño provocada por la disminución de la mortalidad podría ser contrabalanceada por el aumento de los costos del cuidado y oportunidades educativas de unos pocos niños. Un participante informó que por un tiempo se trató de proporcionar tal instrución a las madres en el experimento Narangwal, pero que este intento fue abandonado después de algún tiempo debido a los altos gastos. Otro participante, refiriéndose al mismo punto, dijo que los costos de replicar este rasgo de educación de las madres para mejorar el cuidado de los niños no deberían considerarse excesivos ; si el análisis mostrara que en un período de años fuera un modo más eficiente de reducir el crecimiento de la población y la fecundidad, enseñar a las madres a cuidar a los niños antes que suprimir esta educación debido al costo, y si debido a esta omisión se fracasara en el intento de reducir el crecimiento de la población y la fecundidad, el costo final sería mucho mayor.

8) El Programa de Salud y de Erradicación de la Malaria de Sri Lanka

Este proyecto no estaba constituído por un sólo programa sino que por un conjunto de programas con énfasis en la erradicación de la malaria. Se remarcó que estos programas proporcionaron uno de los mejores experimentos naturales, que en general apoya la hipótesis básica de que la declinación de la mortalidad infantil y de la niñez induce una disminución de la fecundidad. Se llamó la atención, nuevamente, sobre el hecho de que a veces se produce un leve aumento de la fecundidad al disminuír la mortalidad infantil y de la niñez, antes de que el nivel de la fecundidad empiece a disminuir. Los gráficos 4, 5 y 6 del documento básico hace este fenómeno evidente.

Los autores de este documento sostienen que gran parte de la temprana disminución de la fecundidad se debe a la elevación de la edad al casarse. Este hecho plantea de nuevo el problema de utilizar tasas crudas de natalidad como un indicador de fecundidad.

Otro participante sostuvo que el mecanismo mediante el cual la mortalidad infantil y de la niñez actuaba sobre el nivel de fecundidad no era la elevación de la edad al casarse, sino que más bien la disminución del número relativo de matrimonios. Una disminución de la mortalidad infantil y de la niñez significa una declinación en el número relativo de hombres con respecto a mujeres (disminución del coeficiente de masculinidad). Una mayor cantidad de mujeres permanece sin casarse, lo que acarrea una declinación de la tasa cruda de natalidad :

a) porque sus probabilidades de tener un hijo no estando casadas son menores y

b) porque sus probabilidades de ingresar a la fuerza de trabajo y tender así a reducir su fecundidad son mayores.

Otro participante expresó que los efectos a corto plazo de la mortalidad infantil y de la niñez son contrabalanceados por los matrimonios de hombres de más edad con mujeres de menos edad. Un tercer participante negó la verosimilitud de esta segunda opinión. Repitiendo un argumento ya utilizado, sostuvo que en Europa y posiblemente también en Sri Lanka, una mujer puede aumentar su dote y así sus posibilidades de casarse mediante el trabajo, mientras que las casadas jóvenes tienen menos tiempo para trabajar y aumentar su dote. Más aún, debido a que las mujeres que se casan jóvenes tienen un período reproductivo mayor, los costos de la contracepción serán mas alto. Por lo tanto los hombres viejos prefieren mujeres viejas para casarse cuando las tasas de mortalidad infantil y de la niñez son bajas.

Un participante dijo que en virtud del excesivo costo de los experimentos de terreno, no era muy prático sostener una posición "purista" en la evaluación de los proyectos. Recomendó obtener toda la información posible acerca del "experimento natural" de Sri Lanka y de otros programas o conjuntos de programas similares. Se refirió también a un informe sobre la experiencia de la isla Mauritius descrita recientemente por Brass. La mortalidad infantil y de la niñez disminuyó con una rapidez excepcional entre 1945 y 1955, período después del cual la disminución se hizo más lenta. Entre 1966 y 1973 el nivel de la fecundidad disminuyó en un 55 por ciento, es decir alcanzó la más alta velocidad de disminución conocida. Esta declinación ocurrió 18 años después de la reducción de la mortalidad infantil y de la niñez y en ambos casos tuvo lugar con gran rapidez.

Se puede decir que la disminución de la fecundidad tiene poca relación con los cambios estructurales de la población debido a que se realizó con demasiada rapidez. La disminución no puede atribuírse a la experiencia personal de la mortalidad reducida por y dentro de las familias individuales. Aquellas que redujeron su fecundidad fueron en su mayoría mujeres jóvenes sin experiencias en cuanto a mortalidad infantil y de la niñez en sus familias.

Habría ocurrido una disminución tan rápida de la fecundidad sin una disminución previa de la mortalidad infantil y de la niñez ? Es difícil de responder este punto de una manera rigurosa a partir de los datos de tal experimento natural, pero puede adoptarse una razonable y substancial posición por una respuesta negativa a partir de estos hallazgos.

9) Conclusiones

Las discusiones basadas en los datos de este documento básico concluyeron en que los estudios citados no proporcionan una evidencia segura de que las reducciones de la mortalidad proyecten de una manera automática cambios en las actitudes acerca de los partos o los niveles de fecundidad. Si esto es así, no podrían tales proyectos, tal como ya fue previamente dicho, intentar mediante intensos esfuerzos educacionales aumentar el cuidado y alimentación de los niños y cambiar el concepto de la gran familia por el de una familia más pequeña, pero de mejor salud y con niños mejor educados ?

Finalmente debe decirse que es posible esperar respuestas seguras y convincentes a los principales interrogantes que se plantean en el seminario, mediante programas especiales de reducción de la mortalidad diseñados para probar las hipótesis acerca de los efectos volitivos sobre el nivel de la fecundidad. Esta fructífera area de investigación puede ser probablemente de gran importancia en los países en desarrollo. Este campo de investigación es uno de los más adecuados para que expertos de diversas disciplinas puedan colaborar juntos, ya que no es posible otbener conclusiones seguras si se separan los efectos de los factores fisiológicos, demográficos, económicos, sociales y culturales. Las investigaciones experimentales deben ser longitudinales ya que es necesario esperar algunos años, debido al retardo de la disminución de la fecundidad con posterioridad a la caída de la mortalidad. Como tales investigaciones podrían ser muy costosas, es necesario examinar desde ya, en las presentes condiciones de estrechez económica, las posibilidades de mejorar la calidad de los datos existentes de tal manera que se puedan aclarar las influencias de la mortalidad infantil y de la niñez en la reducción de la fecundidad.

SUGGESTED AREAS OF FUTURE RESEARCH

by Samuel H. PRESTON

Introduction

The Seminar concluded on the basis of evidence presented that fertility typically changes as a result of mortality change, but that the response is quantitatively weak and would rarely offset more than half of the growth increment associated with mortality decline *per se*. This conclusion is, of course, tentative because the appropriate data, methods and theory for estimating the effect are still evolving. Moreover, it is clear that the degree of responsiveness should be expected to vary among populations. Nevertheless, the conclusion was considered to be sufficiently well documented and of such policy import that it deserved rapid dissemination to policy makers for use in economic, social and health decision-making and planning.

The following are suggestions for needed research in the area. It is recognised that the choice of any particular area and project must be based on considerations of expected cost-effectiveness. In this respect, it was noted that much use can be made of existing data sets, often developed for other purposes. Moreover, existing studies can often be modified slightly to obtain the necessary basis for investigation. As one concrete example, it is suggested that countries involved in the World Fertility Survey utilize options available for generating data on lactation and community-level variables.

The suggestions are arranged into five areas corresponding to the principal modes of influence of mortality on fertility, although it is recognised that these areas are neither mutually exclusive nor exhaustive.

1. Involuntary or biological mechanisms

a) The role of nutritional level as a factor that conditions the ovulatory-suppressant effect of lactation is poorly understood. The relation between lactation, nutrition and ovulation may provide a key to understanding why the difference in birth intervals associated with a surviving child as opposed to a dying child varies so much from population to population.

b) Investigations should be made into other possible sources of shortened birth intervals following child death in natural fertility populations, besides extended amenorrhea. These might include differences in residential arrangements, sleeping customs, and intercourse frequency in general.

2. Replacement effects

a) Ideal data for study of the extent to which parents "replace" a dead child are not currently available for any population and attempts should be made to see that they are generated. The ideal data would be generated prospectively in order to minimize reporting error and would involve at least the following variables in order best to document heterogeneity and hence possibly to eliminate bias : fecundability, nutritional and health levels of women, child health practices in the family, urban-rural residence, social class, educational attainment, breastfeeding practices following each birth, history of contraceptive use, and family size preferences.

b) The most appropriate method of analysis of replacement effects is some form of multivariate analysis in which the dependent variable is cumulative total of births measured prospectively from a particular stage in a woman's reproductive career. Interactive effects should be examined in all cases, emphasizing the possibility of different responses by different groups in the same society.

c) Since the ideal data will not always be available, nor the most appropriate methods feasible, simulation of the likely biases to be encountered in typical studies should continue.

d) The size of the replacement effect should be estimated for populations arrayed over a wide range of socio-economic, cultural, familial and contraceptive technological circumstances. Investigations are needed to determine at what stage of the fertility transition a replacement effect starts to operate and how it changes as the transition proceeds. Historical European studies, as well as studies on countries currently at intermediate stages of the fertility decline, should prove especially illuminating. Estimation of replacement effects should be

informed by theoretical considerations that place child mortality-fertility relations in a broad socio-economic context.

3. Insurance effects

a) In order to predict the size of insurance effects, it is necessary to have some indication of how parents value differing numbers of children and not simply to obtain information on "the" desired family size. It is also desirable to have some indication of the age span of parents to which survival of children is most salient.

b) Empirically, estimation of the size of insurance effects requires information on parents' perceptions of child death-risks. Community level of mortality may serve as a proxy for these perceptions. If it is used in this fashion, the number of communities represented should be large and other relevant community-level variables controlled. Such studies also provide a good opportunity for study of other "contextual effects" on fertility.

4. Demand effects

a) It can be hypothesized that, when mortality declines, the number of surviving children demanded rises because the utility of additional children increases and their cost decreases. This hypothesis deserves investigation, presumably in an experimental setting.

5. Societal relations

a) Existing methodologies are inadequate for the study of responses of fertility to changing mortality or to mortality history at the aggregate level. Approaches are required that are sensitive to the many social options available for responding to population pressure, and that take account of social and cultural influences that affect the option adopted in any particular case. Particularly to be stressed in future research is the possible effect of mortality level on fertility through the intermediate variables of family system and age at marriage.

b) The hypothesis that high mortality contributes to an attitude of fatalism, which in turn discourages fertility control, is persuasive enough to deserve testing. Appropriate procedures would include social psychological testing of individuals exposed to different mortality regimes and anthropological studies of the same. Controlled experiments at the village level are another promising approach to the study of this and other linkages.

6. General considerations

a) The relation between the various mechanisms classified above needs attention. To the extent that parents are aware that extended lactation acts as a form of contraception, the biological mechanism has behavioural overtones. Replacement and insurance are closely related motivations whose combination is perhaps best achieved by computer simulation. Simulation studies should be continued in order to investigate the growth implications of mortality change when various "stopping rules" for family formation are in effect.

b) Emphasis in future research should be placed on the interrelations among levels of health and mortality, socio-economic development and contraceptive availability as determinants of fertility levels. The extent to which each factor can operate independently or must operate in concert with other factors has not been satisfactorily established.

c) Methodology, data and theory all need development if work on the subject is to advance much beyond the level reported at this Seminar. The continued development of indirect and relatively inexpensive measures of mortality and fertility is particularly to be encouraged.

SUGGESTIONS SUR L'ORIENTATION DES RECHERCHES DANS L'AVENIR

par Samuel H. PRESTON

Introduction

D'après les résultats présentés au séminaire, on peut conclure que l'évolution de la fécondité est liée à celle de la mortalité mais si on s'efforce d'estimer quantitativement cette réponse, on constate qu'elle est faible. L'influence de la mortalité sur la fécondité ne saurait réduire de plus de 50 % l'augmentation de l'accroissement démographique provoqué par la baisse de la mortalité. Il s'agit, bien entendu, d'une conclusion toute provisoire, car on manque de données satisfaisantes sur ces questions. En outre, les méthodes et les théories pour estimer cet effet sont encore en pleine évolution. Il est d'ailleurs évident qu'il existe à cet égard de grandes différences d'une population à une autre. Cependant, on peut considérer cette conclusion comme suffisamment fondée. L'importance qu'elle présente pour la politique démographique est si grande qu'il convient d'en informer rapidement les législateurs pour qu'ils en tiennent compte lorsqu'ils prennent des décisions dans le domaine économique, social et sanitaire.

Nous allons maintenant présenter quelques suggestions relatives à l'orientation des recherches dans ce domaine. Il est bien entendu que le choix d'un domaine ou d'un projet particulier doit tenir compte du coût et du rendement qu'on peut en attendre. A cet égard, on a fait remarquer qu'on peut utiliser bien des séries de données déjà rassemblées à d'autres fins. En outre, les études réalisées jusqu'ici peuvent souvent être légèrement modifiées de manière à en tirer les éléments de base nécessaires à la recherche. Pour prendre un exemple concret, on a fait remarquer que les pays qui participent à l'enquête mondiale sur la fécondité utilisent des questions dont on peut tirer des données sur la lactation et certaines variables au niveau de la communauté.

Nous avons classé les suggestions en 5 parties qui correspondent chacune à une des manières par lesquelles l'influence de la mortalité se fait sentir sur la fécondité. Il est bien entendu que ces différentes rubriques sont loin de s'exclure les unes les autres et qu'elles n'épuisent pas la question.

1. Mécanismes involontaires ou biologiques

a) Le rôle de l'alimentation en tant que facteur qui conditionne l'effet empêchant l'ovulation en période de lactation reste mal connu. La relation entre la lactation, l'alimentation et l'ovulation peut permettre de comprendre pourquoi les intervalles entre naissances lorsque l'enfant survit ou lorsqu'il meurt varient tellement selon les populations.

b) Des recherches devraient être faites pour trouver les causes autres qu'une aménorrhée prolongée qui réduisent l'intervalle entre naissances après un décès d'enfant dans les populations où la limitation des naissances n'est pas pratiquée. Ces causes peuvent tenir à l'habitat, au fait que les époux dorment ensemble ou, en général, à la fréquence des rapports sexuels.

2. Effets de remplacement

a) Les données idéales pour permettre d'étudier dans quelle mesure les parents "remplacent" un enfant décédé ne sont que rarement disponibles. Il faudrait essayer d'y remédier. Les données idéales devraient être recueillies en veillant à réduire au minimum les erreurs d'enregistrement et à procurer une documentation de haute qualité afin de diminuer le risque de commettre des erreurs de jugement sur les variables suivantes : fécondabilité, alimentation et santé des femmes, pratiques qui influencent la santé des enfants, résidence urbaine ou rurale, classe sociale, niveau d'instruction, allaitement après chaque naissance, pratique de la contraception et préférences quant à la dimension de la famille, tous ces renseignements étant recueillis en tenant compte de l'hétérogénéité des situations.

b) La méthode d'analyse qui convient le mieux pour étudier les effets de remplacement est l'analyse multi-variate (sous une forme ou sous une autre) dans laquelle la variable dépendante est le nombre cumulé des naissances mesuré, longitudinalement, à partir d'un certain point de la vie génésique d'une femme. Dans tous les cas, les interactions devront être examinées en tenant compte de la diversité des réactions qui peut exister dans différents groupes d'une même société.

c) Comme on ne disposera pas toujours de données idéales et que les méthodes les plus appropriées ne pourront pas toujours être employées, il conviendra de poursuivre les études par simulation pour éliminer les erreurs de jugement qu'on peut commettre à cet égard.

d) L'importance de l'effet de remplacement devrait être estimée pour des populations qui présentent une grande diversité du point de vue socio-économique, culturel, familial et par la pratique qu'elles font de la contraception. Des recherches sont nécessaires pour déterminer à quel stade de la transition démographique un effet de remplacement commence à se faire sentir et comment il évolue au cours de cette période de transition. Les études historiques sur l'Europe et celles sur des pays qui se trouvent actuellement en cette période de transition devraient être particulièrement intéressantes à cet égard. L'estimation des effets de remplacement devrait se fonder sur des considérations théoriques qui replacent les relations entre mortalité et fécondité dans leur contexte socio-économique, pris au sens large.

3. Effets d'assurance

a) Pour prédire l'importance des effets d'assurance, il faut avoir des renseignements sur la manière dont les parents apprécient divers nombres d'enfants et ne pas se contenter de rassembler des données sur la dimension désirée de la famille comme s'il s'agissait d'un concept sans ambiguité. Il est également souhaitable d'avoir quelque indication sur la période de la vie des parents où ils se soucient le plus de la survie des enfants.

b) Empiriquement, pour estimer l'importance des effets d'assurance, il faut disposer de renseignements sur la conscience qu'ont les parents des risques de décès de leurs enfants. Le niveau de la mortalité dans la localité où ils vivent peut servir d'indicateur à ce sujet. Si on l'utilise de cette façon, le nombre de localités représentées devrait être élevé et les autres variables au niveau de la localité devraient être contrôlées. Des études de ce genre fournissent aussi une bonne occasion d'analyser les autres "effets contextuels" sur la fécondité.

4. Effets de demande

On peut poser comme hypothèse que, lorsque la mortalité décline, le nombre des enfants survivants demandés s'élève parce que l'utilité des enfants supplémentaires augmente et que leur coût diminue. Cette hypothèse mérite qu'on y consacre des recherches, probablement dans un cadre expérimental.

5. Relations au niveau social

a) Les méthodologies existantes sont insuffisantes pour étudier la réponse de la fécondité au changement de la mortalité ou à l'évolution de la mortalité lorsqu'on utilise des données globales. Il convient d'utiliser des méthodes qui permettent de tenir compte des nombreuses options par lesquelles les sociétés peuvent réagir à la pression démographique ainsi que des influences sociales et culturelles qui affectent l'option adoptée, selon les cas. En particulier, dans les recherches futures, il faudra s'attacher à l'effet que peut exercer le niveau de la mortalité sur la fécondité par l'intermédiaire des variables du système familial et de l'âge au mariage.

b) L'hypothèse selon laquelle une forte mortalité conduit à une attitude fataliste qui, à son tour, empêche la limitation des naissances, mérite d'être examinée de près. Il faudrait pour cela utiliser des tests psychologiques auxquels on soumettrait des personnes appartenant à des sociétés dont les niveaux de mortalité sont différents. Les ethnologues pourraient apporter une aide précieuse à cet égard. Des expériences, contrôlées au niveau du village, peuvent constituer une approche fructueuse pour l'étude de ces problèmes.

6. Considérations générales

a) La relation entre les divers mécanismes classés ci-dessus mérite toute notre attention. Dans la mesure où les parents sont conscients que la lactation prolongée a des effets contraceptifs, le mécanisme biologique a des prolongements dans le domaine de l'étude des comportements. Le remplacement et l'assurance sont des motivations qui sont étroitement liées si bien que, pour les étudier ensemble, il faut probablement recourir à

la simulation par ordinateur. Ces études par simulation devraient être poursuivies de manière à examiner les conséquences qu'ont sur la croissance démographique les changements de la mortalité lorsque diverses "règles d'arrêt" se font sentir dans la formation de la famille.

b) Dans les recherches futures, il conviendrait d'insister sur les relations qui existent entre les conditions sanitaires d'une population et la mortalité, le développement socio-économique et l'accès aux méthodes de contraception car ce sont ces relations qui déterminent les niveaux de la fécondité. On n'a guère établi de manière satisfaisante dans quelle mesure chacun de ces facteurs peut s'exercer indépendamment des autres ou s'ils doivent tous s'exercer ensemble.

c) La méthodologie, les données et la théorie doivent progresser si on veut dépasser, dans ce genre d'études, le niveau auquel est parvenu le présent séminaire. Il convient particulièrement d'encourager la mise au point de méthodes indirectes et relativement peu coûteuses pour mesurer la mortalité et la fécondité.

AREAS DE INVESTIGACION SUGERIDAS PARA EL FUTURO

por Samuel H. PRESTON

Introducción

Sobre la base de las evidencias presentadas, el Seminario concluyó que la fecundidad cambia de una manera típica cuando cambia la mortalidad, pero que esta respuesta es cuantitativamente débil y que difícilmente podría compensar más de la mitad del aumento del crecimiento producido por la reducción de la mortalidad. Sin embargo, debido a que los datos adecuados, los métodos y la teoría necesarios para estimar el efecto, están todavía en desarrollo, esta conclusión debe considerarse provisoria. Mas aún, puede esperarse que el grado de respuesta sea variable según las poblaciones. Se consideró, sin embargo, que los fundamentos de la conclusión eran suficientemente serios y de una importancia tal. que merecía una rápida difusión, para que fuera utilizada por los planificadores y ejecutivos del sector económico, social y de salud.

A continuación se presentan algunas sugerencias acerca de las investigaciones que son necesarias en este campo. Hay que señalar en primer término, que la elección de un area de estudio y de un tema específico debe estar basada en consideraciones acerca del costo y de la efectividad esperados. Puede señalarse al respecto que existen muchos datos, obtenidos con otros propósitos, que a menudo pueden ser utilizados. Más aún, otros estudios en desarrollo pueden ser levemente modificados para adecuarlos a las investigaciones propuestas. Como un ejemplo concreto de esto último, puede sugerirse que los países que están participando en la Encuesta Mundial de Fecundidad, pueden aprovechar las posibilidades existentes para obtener y proporcionar información acerca de la lactancia y otras variables al nivel de la comunidad.

Las sugerencias se han clasificado en cinco areas, que correspondan a los principales modos de influencia de la mortalidad sobre la fecundidad, aunque es obvio que estas areas no son ni mutuamente excluyentes ni exhautivas.

1. Mecanismos involuntarios o biológicos

a) No está aclarado el papel que juega el nivel nutritivo como factor que condiciona el efecto inhibidor de la ovulación de la lactancia. La relación entre lactancia, nutrición y ovulación puede ser muy útil para comprender las variaciones que se observan en distintas poblaciones, en las diferencias entre los intervalos entre nacimientos asociados con un niño sobreviviente en oposición a los asociados con un niño muerto.

b) Las investigaciones sobre otras posibles fuentes de explicación del acortamiento de los intervalos entre nacimientos, que se producen a continuación de una defunción infantil en las poblaciones de fecundidad natural, además de la extendida amenorrea. Estas investigaciones podrían incluir también diferencias en cuanto a la organización interna de las residencias, hábitos de dormir y, en general, frecuencia de coitos.

2. Efectos de reemplazo

a) Debido a que los datos que se consideran como ideales, para estudiar la amplitud con que los padres "reemplazan" un hijo muerto, no son habitualmente registrados en casi ninguna población, es necesario estudiar la posibilidad de que estos datos sean recopilados. Se sugiere que los datos ideales para este propósito, sean generados prospectivamente para minimizar los errores de información y que, para asegurar la heterogeneidad y evitar los sesgos, incluyan por lo menos las siguientes variables : fecundabilidad, niveles de nutrición y de salud de las mujeres, hábitos sanitarios de la familia, en relación a los niños, residencia urbano-rural, clase social, grado educacional alcanzado, lactancia materna a continuación de cada nacimiento, historia del uso de anti-conceptivos y preferencias acerca del tamaño de la familia.

b) El método más adecuado para el estudio de los efectos de reemplazo, es alguna forma de análisis multivariato en el cual la variable dependiente es el número total de nacimientos acumulados prospectivamente

a partir de un momento dado de la vida reproductiva de la mujer. Los efectos recíprocos deberían ser examinados en todos los casos, destacando la posibilidad de que se produzcan diferentes respuestas en grupos distintos de la misma sociedad.

c) Ya que los datos ideales no estaran siempre disponibles, ni tampoco será siempre posible utilizar el método más adecuado, debe continuarse el estudio, mediante la simulación, de los sesgos más probables que se encontrarán en las investigaciones típicas.

d) El tamaño del efecto de reemplazo debería ser estimado en distintas poblaciones, de tal manera que pudiera cubrir una amplia gama de características socio-económicas, culturales, familiares y de uso de anticonceptivos. Es necesario investigar en que etapa de la transición de la fecundidad empieza a operar el efecto de reemplazo y en que forma se modifica a medida que avanza la transición demográfica. Los estudios de Demografía Histórica que se realizan en Europa, así como los estudios que se realizan en países que están en las etapas intermedias de la transición de la fecundidad, podrían ser extremadamente útiles. Los estudios acerca del efecto de reemplazo deberían estar fundamentados en consideraciones teóricas que ubiquen las relaciones entre la mortalidad de la niñez y la fecundidad en un complejo contexto socio-económico.

3. Efectos de seguridad

a) Para prever la magnitud del efecto de seguridad es necesario tener alguna indicación acerca de la forma en que los padres valorizan diferentes números de hijos y no solamente acerca "del" tamaño deseado de la familia. También es recomendable tener alguna indicación acerca de la edad de los padres hasta la cual la sobrevivencia de los hijos es más importante.

b) De una manera empírica, puede decirse que la estimación de la magnitud del efecto de seguridad, requiere la obtención de informaciones acerca de las percepciones de los padres sobre los riesgos de morir de sus hijos. Los niveles de mortalidad de la comunidad pueden servir como una procuración para esas percepciones. Si es así, el número de comunidades estudiadas debería ser mayor y también deberían controlarse otras variables relativas a la comunidad. Estos estudios proporcionan también una buena oportunidad para investigar otros "efectos contextuales" sobre la fecundidad.

4. Efectos de Demanda

a) Puede suponerse que, cuando la mortalidad baja, la demanda de niños sobrevivientes aumenta, debido a que la utilidad adicional de los niños aumenta y su costo disminuye. Sin embargo esta hipótesis requiere ser investigada, tal vez en un sitio experimental.

5. Relaciones Sociales

a) Si se piensa en el nivel global, las metodologías existantes son inadecuadas para estudiar el cambio de la fecundidad como respuesta al cambio de la mortalidad o a la historia de la mortalidad. Se requieren enfoques que sean sensibles a las diversas opciones que aparecen como respuestas posibles a la presión social de la pobalción y que tomen en cuenta las influencias sociales y culturales que afectan la opción específica adoptada en un caso dado. Debe destacarse que sería muy importante que en investigaciones futuras se tomara en consideración el posible efecto de la mortalidad sobre la fecundidad a través de las variables intermedias del sistema familiar y de la edad al casarse.

b) No hay duda que la hipótesis que sostiene que la alta mortalidad contribuye a formar una actitud de fatalismo, la que a su vez desfavorece la utilización de anticonceptivos, es suficientemente convincente como para merecer estudios más profundos. Los procedimientos podrían incluír pruebas socio-sicológicas y estudios antropológicos de individuos expuestos a diferentes condiciones de mortalidad. Para este y otros fines, podrían ser también muy útiles los estudios experimentales controlados a nivel de aldea.

6. Consideraciones generales

a) La relación entre los diversos mecanismos clasificados más arriba necesita mayor estudio. En la medidad en que los padres confían en que la extensión de la lactancia actúa como una forma de contracepción, el mecanismo biológico adquiere recargos conductuales. Los efectos de reemplazo y de seguridad constituyen motivaciones tan íntimamente correlacionadas que tal vez su combinación sea

major lograda a través de modelos de simulación utilizando computadores. Los estudios mediante modelos de simulación deberían proseguirse, para estudiar principalmente las consecuencias que tiene el cambio de la mortalidad sobre el crecimiento de la población, en especial cuando existen "reglas de contención" acerca del tamaño de la familia.

b) En las investigaciones futuras, debería darse énfasis también, a los estudios de inter-relaciones entre niveles de salud y mortalidad, desarrollo socio-económico y disponibilidad de métodos anticonceptivos, como determinantes de los niveles de fecundidad. Tampoco ha sido bien establecida la forma mediante la cual, cada factor puede operar independientemente o en armonía con otros factores.

c) Si se quiere avanzar más alla del nivel alcanzado en este Seminario, será necesario trabajar mucho más aún sobre la metodología, la necesidad de datos básicos y la teoría. Deben ser especialmente estimulados los estudios indirectos y de bajo costo, que permitan perfeccionar la medición de la mortalidad y de la fecundidad.

ANNEX I

LIST OF PARTICIPANTS

Director of the Seminar : Visid PRACHUABMOH (Institute of Population Studies, Chulalongkorn University, BANGKOK, Thailand)

Co-Director of the Seminar : Samuel H. PRESTON (Center for Studies in Demography and Ecology, University of Washington, SEATTLE Washington, U.S.A.)

General Rapporteur : Francis C. MADIGAN (Mindanao Center for Population Studies, Xavier University, CAGAYAN DE ORO CITY, Philippines)

I – NAME OF THE MEMBER CENTRES AND THEIR REPRESENTATIVES

AFRICA

Egypt, Arab Republic of

Institute of Statistical Studies and Research GIZA	Atef M. KHALIFA (*Director*)

Ghana

United Nations Regional Institute for Population Studies, University of Ghana LEGON	S. K. GAISIE

Tunisia

Centre d'études et de recherches économiques et sociales TUNIS	Moncer ROUISSI (*Director of Studies*)

NORTH AMERICA

Canada

Département de démographie, Université de Montréal MONTREAL	Jacques LEGARE (*Director*)

United States of America

Population Research Laboratory, University of Southern California LOS ANGELES	David M. HEER
East-West Population Institute, East-West Center HONOLULU	Robert D. RETHERFORD
The Population Council NEW YORK	Nicholas WRIGHT

LATIN AMERICA

Argentina

Centro de Estudios de Poblacion, Fundacion Bariloche BUENOS AIRES	Susana SCHKOLNIK

Brazil

Centro de Documentação e Pesquisa – População e Familia (CEDOPE), Universidade do Vale do Rio dos Sinos SAO LEOPOLDO	Pedro Calderan BELTRAO (*Director*)

Chile

Centro Latinoamericano de Demografia SANTIAGO	Shea RUTSTEIN

ASIA

Hong Kong

Department of Statistics, University of Hong Kong HONG KONG	Shuh Ching FAN (Head)

India

Demographic Research Centre, Bureau of Economics and Statistics TRIVANDRUM	S. BHAGAVATHEESWARA IYER
Registrar General of India, Ministry of Home Affairs NEW DELHI	Rama Bhadra CHARI (*Registrar General*)
Demography and Statistics Division, National Institute of Family Planning NEW DELHI	Bal Ram KOHLI (*Assistant Director, Head of Demography and Statistics*)
Department of Population Studies, Gandhigram Institute of Rural Health and Family Planning GANDHIGRAM	R. S. KURUP
Demographic Research Centre, Indian Statistical Institute CALCUTTA	M. V. RAMAN (*Head*)
International Institute for Population Studies BOMBAY	J. R. RELE (*Director*)
Demographic Research Centre, Lucknow University LUCKNOW	D. N. SAKSENA (*Assistant Chief*)
Demographic Research Centre, Banaras Hindu University VARANASI	S. N. SINGH (*Director*)

Indonesia

Lembaga Demografi Feui, Fakultas Ekonomi, Universitas Indonesia DJAKARTA	Nathanael ISKANDAR (*Director*)

Iraq

Central Statistical Organisation, Ministry of Planning BAGHDAD	Tahseen Hameed MUSTAFA

Israel

Department of Demography, Hebrew University of Jerusalem JERUSALEM	Dov FRIEDLANDER (*Director*); Helmut V. MUHSAM

Korea

Population and Development Studies Centre, Seoul National University SEOUL	Tae Hwan KWON

Pakistan

Social Sciences Research Centre, University of the Punjab LAHORE	Mazhar HUSSAIN (*Director*)

Philippines

Mindanao Center for Population Studies, Xavier University CAGAYAN DE ORO CITY	Francis C. MADIGAN (*Director*)
Population Institute, University of the Philippines MANILA	Zelda ZABLAN

Thailand

Institute of Population Studies, Chulalongkorn University BANGKOK	Visid PRACHUABMOH (*Director*) ; Benjamin RUNGPITARANGSE; Suwathana VIBULSREATH
National Statistical Office BANGKOK	Anuri WANGLEE (*Director, Population Survey Division*) ; Thip CHALOTHORN ; Mathana PHANANIRAMAI
Institute for Population and Social Research, Mahidol University BANGKOK	Chaiyuth BOONYARITANA Chanya SOMBOONSUP

Turkey

Hacettepe Institute Of Population Studies, Hacettepe University ANKARA	Ferhunde OZBAY

EUROPE

Denmark

Statistical Institute, Demographic Section, University of Copenhagen COPENHAGEN	P. C. MATTHIESSEN (*Director*)

France

Institut national d'études démographiques PARIS	Jacques VALLIN
Institut national de la statistique et des études économiques PARIS	Alain LERY
Office de la recherche scientifique et technique outre-mer PARIS	Pierre CANTRELLE (*Scientific Secretary of the Demographic Section*)

United Kingdom

Centre for Overseas Population Studies, London School of Hygiene and Tropical Medicine LONDON	William BRASS (*Director*)

Yugoslavia

Ekonomski Institut BELGRADE	Miroslav MACURA

OCEANIA

Australia

Department of Demography, Australian National University CANBERRA	L. T. RUZICKA
School of Economic and Financial Studies, Macquarie University NORTH RYDE	Farhat YUSUF (*Director*)

II – INTERNATIONAL ORGANISATIONS

Population Division United Nations NEW YORK, U.S.A.	Gwendolyn JOHNSON ACSADI (*Chief, Fertility Studies Section*)
United Nations Fund for Population Activities (U.N.F.P.A.) BANGKOK, Thailand	K. J. W. LANE (*Regional Coordinator in Bangkok*)
United Nations Children's Fund (UNICEF) BANGKOK, Thailand	Ansgar WELLE (*UNICEF Regional Food and Nutrition Officer*)
United Nations Educational, Scientific and Cultural Organisation (UNESCO) PARIS, France	S. TIMUR
Economic Commission for Latin America (ECLA) SANTIAGO, Chile	Shea RUTSTEIN
International Labour Organisation (I.L.O.) BANGKOK, Thailand	G. P. SEN GUPTA (*Regional Adviser*)
World Health Organisation (W.H.O.) GENEVA, Switzerland	A. OMRAN
International Bank for Reconstruction and Development (I.B.R.D.) WASHINGTON, U.S.A.	K. C. ZACHARIAH
Organisation for Economic Cooperation and Development (O.E.C.D.) PARIS, France	J. MONDOT
International Union for the Scientific Study of Population LIEGE, Belgium	Pierre CANTRELLE
The Population Council NEW YORK, U.S.A.	Nicholas WRIGHT
World Fertility Survey (WFS) LONDON, United Kingdom	Pierre CANTRELLE
International Statistical Institute (I.S.I.) VOORBURG, Netherlands	Pierre CANTRELLE

III – NON-MEMBER CENTRES AND OBSERVERS

India	
Population Centre, World Bank LUCKNOW	Sri Narayan AGARWALA (*Director*)
United States of America	
Center for Studies in Demography and Ecology, University of Washington SEATTLE	Samuel H. PRESTON

IV – INDIVIDUAL EXPERTS

R.D. AGRAWAL – c/o Embassy of India, KABUL, Afghanistan.

Lincoln C. CHEN – The Population Council, NEW YORK, U.S.A.

A.K.M. Alauddin CHOWDHURY – Cholera Research Laboratory, Institute of Public Health, DACCA, Bangladesh.

John KNODEL – Department of Sociology, Brown University, PROVIDENCE, U.S.A.

Atiqur RAHMAN KHAN – Director, National Post-Partum Family Planning Programme, Fertility Research Programme, DACCA, Bangladesh.

K. VENKATACHARYA – Faculty of Economics, University of Benghazi, BENGHAZI, Libya.

V – C.I.C.R.E.D. STAFF

Jean BOURGEOIS-PICHAT
Elisabeth GARLOT
Doan BUI-DANG-HA
Roberta INGRAM

VI – ESCAP SECRETARIAT

J.B.P. MARAMIS – *Executive Secretary.*
H. Rudy GONTHA – *Special Assistant to the Executive Secretary*
Carl M. FRISEN – *Chief, Population Division*
Basilio B. AROMIN – *Demographer, Population Division*
Sultan S. HASHMI – *Chief, General Demography Section, Population Division.*
Sook BANG – *Chief, Fertility and Family Planning Section, Population Division.*
Laura M. OLSON – *Chief, Clearing House and Information Section, Population Division*
K. A. DIKSHIT – *Chief, Programme and Coordination Office*
R. MANI – *Economic Affairs Officer, Programme and Coordination Office*
C. Roy SMITH – *Chief, Division of Administration*
H.P.T. WILLIS – *Chief, Conference and General Services Section, Division of Administration*
Bernard D. DORKENOO – *Chief, Information Service*
Arthur H. COOKE – *Information Officer*
Satis INDRAKAMHAENG – *Information Officer*
N. SUTHIMAI – *Chief, Language Services*
R. KRASKER – *Interpreter*
Jon WORONOFF – *Interpreter*
S. BROWNING – *Interpreter*
N. OFRI – *Interpreter*

ANNEX II

PROGRAMME OF THE SEMINAR

Dates	Topic of the Discussion	Time Schedule	Chairman	Discussant	Authors of Background Papers	Rapporteur
Tuesday 6th May 1975	Measuring Child Mortality and Fertility and Estimating Relations between them	14.00-17.00	P. C. MATTHIESSEN	L. T. RUZICKA	William BRASS & J. C. BARRETT *	M. V. RAMAN
Wednesday 7th May 1975	The Influence of Child Mortality on Fertility : Mechanics of the Relationships	09.00-12.00	Moncer ROUISSI	Dov FRIEDLANDER Helmut V. MUHSAM	Robert RETHERFORD K. VENKATACHARYA	R. S. KURUP
	Influence of Child Mortality on Fertility in pre-Industrial and Industrialising Europe : Results from data on Individuals	14.00-17.00	Pierre CANTRELLE	Jacques LEGARE Bal Ram KOHLI	John KNODEL Jacques VALLIN & Alain LERY	Farhat YUSUF
Thursday 8th May 1975	Influence of Child Mortality on Fertility In Pre-industrial and Industrializing Europe : Results from Aggregate Data	09.00-12.00	Nathanael ISKANDAR	D.N. SAKSENA	P.C. MATTHIESSEN	Mazhar HUSSAIN
	Relations between Child Mortality and Fertility in Asia	14.00-17.00	Rama Bhadra CHARI	Shuh Ching FAN	A.K.M.A. CHOWDHURY, A. RAHMAN KHAN & Lincoln CHEN	Atef M. KHALIFA
Friday 9th May 1975	Relations between Child Mortality and Fertility in Africa	09.00-12.00	Visid PRACHUABMOH	Tae Hwan KWON S. BHAGAVEETHSWARA IYER S.K. GAISIE	R.D. AGRAWAL P. CANTRELLE, B. FERRY* & J. MONDOT D.M. HEER & Hsin Ying WU*	Jacques VALLIN
	Relations between Child Mortality and Fertility in Latin America	14.00-17.00	Zelda ZABLAN	Pedro C. BELTRAO Susana SCHKOLNIK	Vilma N. MEDICA* & Shea RUTSTEIN	Miroslav MACURA
Monday 12th May 1975	Influence of Special Mortality-Reduction Programs on Fertility in Areas not experiencing Substantial Social and Economic Development	09.00-12.00	Ferhunde OZBAY	S. VIBULSREASTH A. OMRAN	R.J. LAPHAM*, N. WRIGHT & A.S. QUANDT*	S.N. AGARWALA
	Priority in Research : Definition of a Programme	14.00-17.00	Jean BOURGEOIS-PICHAT		S.H. PRESTON	F. MADIGAN

* Not present at the Seminar

ANNEX III

CONTRIBUTED RESEARCH NOTES

ESTIMATING TRENDS OF INFANT MORTALITY FROM PREGNANCY HISTORIES*

Miroslav MACURA

Economic Institute
Belgrade, Yugoslavia
and
Hacettepe Institute of Population Studies
Ankara, Turkey

This paper describes three methods for estimating trends of infant mortality from pregnancy histories collected in a sample survey. Trends span a time period of twenty five to thirty years preceding the survey. The application of the methods is illustrated using the histories of women interviewed in a recent demographic survey of Turkey. The paper is divided into six sections. Section 1 provides a brief information of the histories used. Methods are described in Sections 2 to 4. In Section 5 trend estimates derived using the three techniques are compared with alternative estimates reached for various dates from other statistical sources. In Section 6 assumptions employed are listed and possible biases arising from errors in data and assumptions are examined.

1. Information Used

Pregnancy histories used come from the 1968 nationwide multi-stage probability sample Survey of Family Structure and Population Problems in Turkey. The histories have been collected for about 3,200 currently married women younger than age 45 at the time of the Survey. Each woman has been asked to report all her children born alive as well as each of her pregnancy losses. Information entered into pregnancy history records included : date (month and year) of birth, sex and survival status of each live born child, and date of death of each child who died before the Survey. Other information entered was : dates of termination of pregnancies other than those resulting in live births, type of pregnancy loss, etc. Pregnancy history data used refer to live born children only. They include year of birth and survival status of live born and year of death of deceased children.

2. Method one

Let d_a denote a proportion dead in a cohort age a years last birthday at the time of the survey and L_a be a life table under number of person-years lived between exact years of age a and $a + 1$. Define the proportion as a fraction of children born in the cohort who die prior to the survey. Suppose that the survey is taken at the end of the year denoted as $t = 0$ and let time be measured in terms of years from $t = 0$ which represents an origin.

There is a relation showing how d_a is expressed in terms of annual survival ratios. If $l_0 = 1$ and if an expression is written for d_a of each cohort, starting with one born in $t = 0$, then the following system emerges :

$$1 - (L_0)_0 = d_0$$

$$1 - (L_0)_{-1} \cdot \left(\frac{L_1}{L_0}\right)_0 = d_1$$

$$1 - (L_0)_{-2} \cdot \left(\frac{L_1}{L_0}\right)_{-1} \cdot \left(\frac{L_2}{L_1}\right)_0 = d_2$$

*This paper has been written at the Hacettepe Institute. The author is grateful to Mahir Ulusoy and Ayse Ergin, a staff member and a graduate student at the Institute respectively, for preparing tables used to illustrate application of the methods described in the paper. Estimates shown in Table 1 have been prepared in collaboration with Ergin.

The subscripts of the survival ratios denote calendar years.

If d_a is given and model life tables of a Coale-Demeny (2) family are used, it is possible to determine a model table for each calendar year. If $q(1)$ embodied in these tables is plotted against time, the trend estimate emerges. The tables are found as follows. Firstly, a table for $t = 0$ is located. This table embodies L_0 that satisfies the first equality and is used to compute survival ratios in $t = 0$ of cohorts born prior to $t = 0$: $(L_1/L_0)_0$, $(L_2/L_1)_0, \ldots$ Next, a table for $t = -1$ is located. Given $(L_1/L_0)_0$, it embodies L_0 that satisfies the second equality. This table is used to compute ratios in $t = -1$ of cohorts born before $t = -1$: $(L_1/L_0)_{-1}$, $(L_2/L_1)_{-1}, \ldots$ A table for $t = -2$ embodies L_0 that satisfies the third equality, given $(L_1/L_0)_{-1}$ and $(L_2/L_1)_0$, etc.

Proportions dead are readily calculated from pregnancy histories. Information on year of birth and survival status of each child is used to separately assemble live born and dead children by year of birth. d_a is computed as ratios of dead to live born children (1).

If mortality falls or remains roughly unchanged over time, then cohort proportions dead rise as the cohort year of birth moves back from the survey date. If mortality experiences short-run fluctuations, the time schedule of proportions zig-zags accordingly. However, when the histories are collected in a predominantly agricultural and illiterate population, observed year-to-year changes in the proportions do not reflect solely short-run mortality variations. They also reflect effects of data errors—particularly those of year-of-birth misreporting. Wherever the survey is taken, sampling variance also affects the proportions. Both misreporting and the sampling variance seem to affect proportions of cohorts born at earlier dates (twenty to thirty years ago) more than those of cohorts born at dates closer to the survey (see Figure 1, Panel I).

If the method is applied to defective data, the trend estimate is defective, too. Time sequence of annual $q(1)$'s reflects errors embodied in the proportions. Too high proportions cause estimates of particular years to be overly high. The years are those in which the cohorts with upward biased proportions are born. And conversely, too low proportions cause corresponding annual estimates to be depressed.

There are at least two ways of removing biases arising from data errors discussed. One of them entails aggregation of annual cohorts into two– to five-year cohorts and conversion of proportions of aggregate cohorts into estimates for two– to five-year intervals. In the systems of equations used, the proportions are expressed in terms of survival ratios for consecutive two– to five-year time intervals. Results reached from the proportions of aggregate cohorts, even from proportions of five-year cohorts, show that the defects are often too large to be completely offset by aggregation.

Another method entails smoothing the proportions of annual cohorts. The proportions are first plotted against time and approximated by a smooth time schedule of proportions. Then, the schedule is converted into a trend estimate. The time period spanned by the schedule is divided into two or three intervals of approximately equal length. A ratio is calculated for each interval. The denominator of the ratio is the reported number of deaths occurring prior to the survey in cohorts born within the interval. The numerator is the number of deaths that would have occurred before the survey if the cohorts born within the interval had been exposed to mortality conditions consistent with the smooth proportions. This number is computed as a sum of deaths that would have occurred in annual cohorts born within the interval.

Let d'_a be a smooth proportion dead in a cohort age a years last birthday at the time of the survey and S_a be the reported number of children belonging to the cohort who survive till the survey. The number of deaths implied by d'_a, D'_a, is calculated as $d'_a.S_a/(1-d'_a)$. The formula is derived from the definition of the proportion dead $d_a = D_a/(D_a + S_a)$, where D_a is the actual number of cohort deaths.

If the smooth schedule is a poor approximation of the observed proportions, one or more ratios differ from unity and/or the trend line is saw-toothed or kinked in the years immediately prior to the survey. It is often necessary to draw a few schedules before the one that approximates observed proportions well is reached. The ratios derived from this schedule are close or equal to unity and the trend line is smooth throughout.

Smoothing is illustrated in Figure 1 using the East model life tables and the proportions computed from the 1968 histories. Firstly, schedule A_1 is drawn through observed proportions in Panel I. Trend estimate A_2 of Panel II is calculated from A_1 by solving the system of equations expressing d_a in terms of survival ratios. Ratios of the time intervals 1954-67 and 1940-53, shown in Panel I, are written above A_1 to the right and left of a vertical line D that corresponds to the date separating the two intervals. Both ratios indicate that the overall level of A_1 is too high. In Panel II it is seen that the segment of the trend line A_2 is kinked in the years immediately before the survey. Therefore, another smooth schedule, B_1, is drawn, ratios are calculated and a new trend estimate, B_2, plotted. The ratios corresponding to the intervals, shown below B_2, are equal and very close to one respectively. B_2 is smooth throughout, and it is an ultimate estimate of the trend.

3. Method Two

Let $i = 1,2,3, \ldots$ stand for five-year age groups of women 15-19, 20-24, 25-29, ... and $-T = -1,-2,-3, \ldots$ for time intervals 0-5, 5-10, 10-15, ... years before the survey taken at the end of $t = 0$.

(1) The Survey was taken late in the summer of 1968. In order to avoid dealing with a fraction of the year, proportions dead used are those of cohorts born before January 1, 1968 and refer to time intervals ending on this date. Children who died in 1968 were excluded from the numerators of d_a using information on year of death.

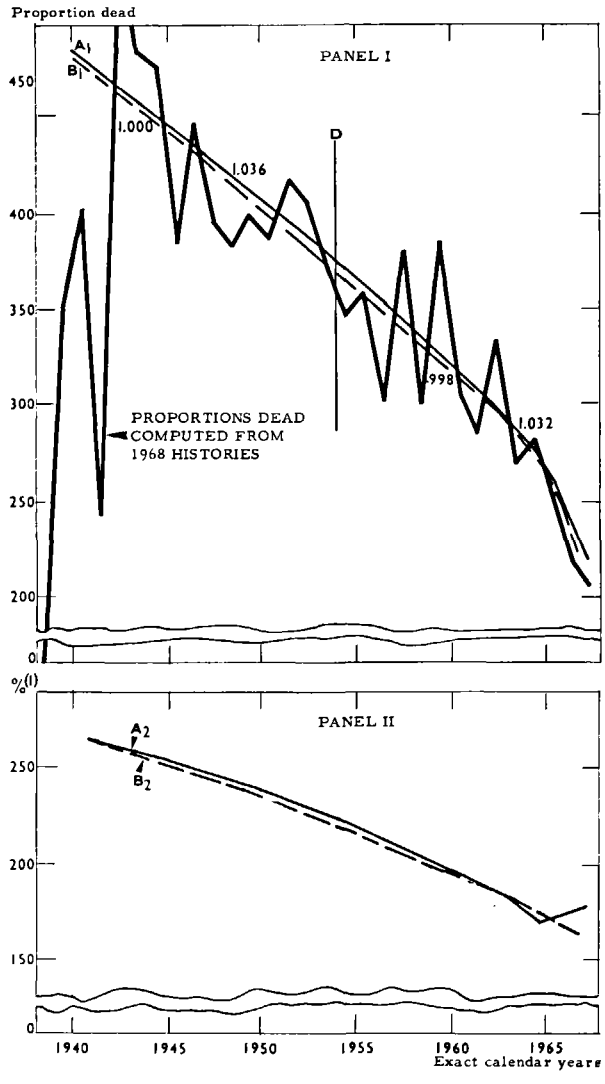

Figure 1 – Smoothing Cohort Proportions Dead and Estimating the Trend.

Denote the number of children ever born to women belonging to the ith age group at the time of the survey with CEB_i. Finally, let $S(-T,i)$ be the number of children born during period $-T$ to women at age group i at the time of the survey who survive till the survey.

There is an equation that shows the relationship which exists between mortality, children ever born and children surviving who are distributed by time of birth. Surviving and ever born children are those of women of a particular age. If childbearing starts at age 15 or later and if an equation is written for each five-year age group of women, starting with the earliest one, then the following system emerges :

$$\frac{S(-1,1)}{\left(\frac{{}_5L_0}{5.l_0}\right)_{-1}} = CEB_1$$

$$\frac{S(-2,2)}{\left(\frac{{}_5L_0}{5.l_0}\right)_{-2}\cdot\left(\frac{{}_5L_5}{{}_5L_0}\right)_{-1}} + \frac{S(-1,2)}{\left(\frac{{}_5L_0}{5.l_0}\right)_{-1}} = CEB_2$$

$$\frac{S(-3,3)}{\left(\frac{{}_5L_0}{5.l_0}\right)_{-3}\cdot\left(\frac{{}_5L_5}{{}_5L_0}\right)_{-2}\cdot\left(\frac{{}_5L_{10}}{{}_5L_5}\right)_{-1}} + \frac{S(-2,3)}{\left(\frac{{}_5L_0}{5.l_0}\right)_{-2}\cdot\left(\frac{{}_5L_5}{{}_5L_0}\right)_{-1}} + \frac{S(-1,3)}{\left(\frac{{}_5L_0}{5.l_0}\right)_{-1}} = CEB_3$$

Survival ratios are centered at the middle of five-year time intervals. They are denoted with subscripts representing time intervals.

Let us now suppose that information on ever born and distributions of surviving children exists. Using the information and the C-D model life tables it is possible to determine a model table for each five-year time interval and thus reach an estimate of the time trend of infant mortality. One possible way of estimating the trend is as follows. Firstly, a model table for a period immediately prior to the survey is found. This table embodies ${}_5L_0/5.l_0$ that satisfies the first equation and is used to calculate survival ratios of the period to which children born in earlier periods are subject : $({}_5L_5/{}_5L_0)_{-1}$, $({}_5L_{10}/{}_5L_5)_{-1}$, . . . Then, the table for the period 5-10 years before is located. Given $({}_5L_0/5.l_0)_{-1}$ and $({}_5L_5/{}_5L_0)_{-1}$, the table embodies ${}_5L_0/5.l_0$ (for period 5-10 years before) that satisfies the second equation, etc. $q(1)$'s of the model tables found are estimates of the past infant mortality.

Although neat, the procedure is not used because if applied to data that are slighlty to moderately defective, it is likely to yield biased estimates. Information on ever born children and surviving children of youngest women is as a rule quite defective even when the overall quality of data is good. As a result, the life table found for the most recent period is bound to under– or over-state true mortality. Furthermore, if the mortality estimate for the period 0-5 years before is moderately erroneous, the subsequent estimates (those for earlier periods) are likely to be grossly biased. Even if the estimate for the most recent period is accurate, an error in any earlier period leads to much greater errors in subsequent estimates. This is a consequence of the shape of the time distribution of births of women belonging to age groups beyond age twenty.

An alternative procedure makes it possible to reach reasonably accurate estimates despite data defects. The rationale of the procedure is as follows. Given CEB_i and $S(-T,i)$, $T = 1,2,\ldots,i$, there are several, perhaps many combinations of i model tables that make the two sides of the ith equation of the system equal. Given the distributions of surviving children and number of ever born children for age groups i and $i+1$, there is only one combination of $i+1$ model tables that simultaneously makes the left and the right hand sides of equations i and $i+1$ equal. If the information used was perfectly accurate, it would be possible to determine $i+1$ model tables using data of the two age groups only. The tables would be close estimates of past mortality conditions. When the data are not perfect however information of several age groups ought to be used. If necessary, groups 15-19 and those beyond age 40 or 45 are excluded. The number of time periods for which the tables are reached depends on the last age group used. Thus if childbearing begins at age 15 or later and 35-39 is the last group used, life tables for five time intervals are found.

Left hand side of each equation can be used to compute expected number of children ever born from the distribution of surviving children and model life tables selected for the time periods involved. Different combinations of model tables selected result in different expected numbers. Discrepancies between expected and reported numbers reflect deviations of selected model from unknown actual mortality conditions. Let us define an index of deviation, I, as an absolute value of

$$\left[(k - e + 1) - \sum_{i=e}^{k} \frac{\widehat{CEB}_i}{CEB_i}\right] . 100,$$

where $\widehat{CEB}_i$ and CEB_i are respectively an expected and a reported number of children ever born to women of the ith age group. e and k are indices of the earliest and the latest age group used. The smaller the deviation between selected and unknown mortality conditions, the smaller the I, and vice versa. When the conditions coincide, and $\widehat{CEB}_i = CEB_i$ for each i, then $I = 0$.

If only model tables at integer levels of mortality are used, it is almost impossible for I to get equal to zero. However it can get very close to zero for several integer level combinations provided that numerous combinations are tried and requisite calculations performed. This is impossible to do unless an electronic computer is used. Therefore, the computer is programmed to select a number, say five or six, levels at the time, compute expected children ever born and calculate I. This is repeated over and over again. Then, I's smaller than a preassigned value and the underlying combinations of levels are printed. Final level estimates by period are reached by averaging levels of several combinations resulting in I's close to zero. Estimates of $q(1)$ by period are derived from the final level estimates (2).

Numbers of ever born children and distributions of surviving children are readily tabulated from pregnancy histories according to the age of the mother. Information used is : age of mother at the time of the survey, survival status of each live born child and year of birth of each surviving child (3). From the tables prepared using the 1968 histories only information for age groups 25-29 to 35-39 were used. Data for the age group 20-24 were excluded because mortality of children born to women of this group was implausibly high. Group 40-44 was not used because of likely omission of children. Estimates were reached for five consecutive five-year time intervals prior to 1968.

Results obtained from the computer using the East model tables and the data of the three age groups mentioned revealed three clusters of level combinations with I very close to zero–below .5 (see Table 1). The level combinations shown in the table were used to reach (i) average levels by period within each cluster, and

(2) A different technique applicable to census information basically of the same type as the one used here has been recently described by Cho (1). The census data Cho used are those of (i) own children ever born tabulated by age of mother and (ii) own children surviving tabulated by age of mother and age of child.

(3) In order to avoid dealing with a fraction of 1968 only children born before January 1, 1968 were included among children ever born. Children alive on the same date were included among surviving children. Information on year of death was used to find children who were alive on January 1 but were reported dead in the survey.

(ii) ultimate level estimates (all shown in the same table). Final level estimates were reached by averaging cluster average levels. Estimates of $q(1)$ by period corresponding to the final level estimates are also shown.

TABLE 1 – RESULTS OF ESTIMATING WITH METHOD TWO

Cluster	Time Period					I
	1943-47	1948-52	1953-57	1958-62	1963-67	
			Level Combinations			
I	1	8	10	10	13	.442
	6	9	9	10	13	.413
II	6	9	9	11	12	.050
	5	9	9	11	12	.146
	4	9	9	11	12	.258
	3	9	9	11	12	.391
III	5	9	11	11	11	.432
	4	9	11	11	11	.321
	3	9	11	11	11	.186
	2	9	11	11	11	.029
	1	9	11	11	11	.167
	6	8	11	11	11	.278
	5	8	11	11	11	.167
	4	8	11	11	11	.052
			Cluster Averages			
I	3.5	8.5	9.5	10.0	13.0	
II	4.5	9.0	9.0	11.0	12.0	
III	3.7	8.6	11.0	11.0	11.0	
			Final Level Estimates			
	3.90	8.70	9.83	10.67	12.00	
			q (1) Estimates			
	.369	.252	.220	.203	.179	

4. Method Three

This technique is the simplest of all. Trend estimate is reached from annual numbers of births and infant deaths occurring in the year of birth. The numbers are tabulated using information on year of birth of live born and year of death of dead children.

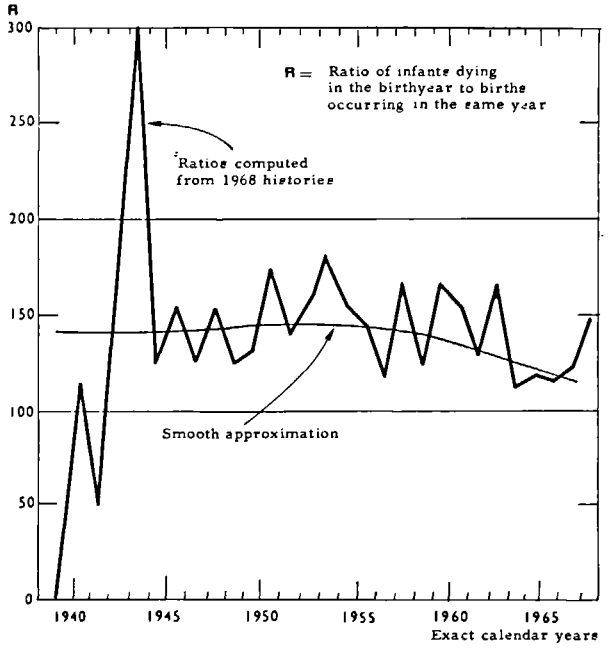

Figure 2 – Smoothing the Ratios.

Estimation proceeds as follows. Ratios of infants dying in the course of birthyear to children born during the same year are calculated and plotted against time. Then, a smooth time schedule approximating the ratios well is found after trying a few alternative approximations. The ratios calculated from the 1968 histories and the corresponding smooth schedule are shown in Figure 2. The time period spanned by the schedule is divided into two intervals. The smooth schedule is a good approximation of the ratios provided that the following condition holds for each interval. The reported number of infants dying during the birthyear within the interval equals the implied number of infants dying in the birthyear in the same interval. The latter number is consistent with the smooth time schedule. The trend estimate is reached as a product of the schedule and a constant 1/(1 – separation factor). The separation factor used is .3.

5. Comparing Alternative Estimates

Trend estimates reached using the three methods are shown in Figure 3. Also shown are eight point-in-time estimates derived from alternative sources.

It is obvious from the figure that the trend derived by Method One and the post-1950 segment of the trend reached by Method Two are largely compatible with the point-in-time estimates. Method Two estimate for 1943-47 is grossly biased (4). Method One estimates for early 1940s are perhaps somewhat low. Nevertheless, trends reached by the first two methods seem to be fairly credible. On the other hand Method Three trend is obviously badly defective.

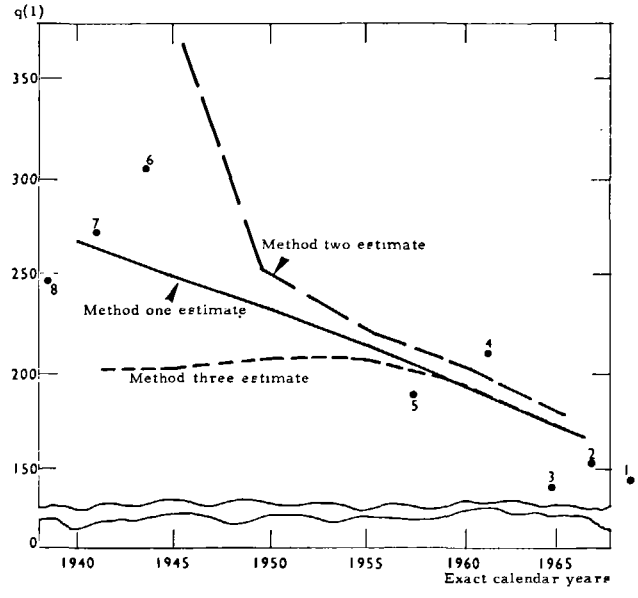

Figure 3 – Comparing Alternative Estimates.

Notes:

Estimates 1, 3, 4, and 5 were all derived from corresponding estimates of $q(2)$ using the C-D East model life tables. $q(2)$ underlying estimates 1 and 3 were derived from data on child survival by age of women using the Sullivan East age model (5). Data for the two estimates were collected in the 1970 population census of Turkey and in the 1966-67 Turkish Demographic Survey, respectively. Estimate 2, reported in (6), was reached from current 1966-67 TDS data. $q(2)$ underlying estimates 4 and 5 were calculated by Shorter (3) from child survival data of the 1963 national survey of population using the Brass technique. These two estimates represent mortality below age two among children born to women age 20-24 and 20-34 in 1963 respectively. Estimates 6, 7 and 8 were derived from Shorter's estimates of adult mortality by sex for the time periods 1940-45, 1935-45 and 1935-40, reported in (4), via the East model. Adult mortality was estimated by Shorter from the age-sex distributions of the 1935, 1940, and 1945 population censuses using the cumulative census survival method.

6. Biases Arising from Errors in Data and Assumptions

The application of the first two methods entails the use of the model life tables. Therefore one of the assumptions employed is that on similarity between an age pattern of mortality embodied in the C-D family used and the corresponding age pattern of the population for which the trend is estimated. An additional

(4) This estimate was derived from (i) a small number of children surviving till 1968 who were born during the 1943-47 period to women age 35-39 at the time of the Survey, (ii) children ever born to the same group of women and (iii) life tables for four periods 1948-52 to 1963-67 found simultaneously with that for the 1943-47 period. It is almost certain that slight to moderate errors in estimates for the four periods forced the estimate for 1943-47 to be too biased. If data of the age group 40-44 had been also used, 1943-47 and 1938-42 estimates would have been respectively more accurate and probably very defective.

assumption is built into Method Two : births occurring to women of any given age group during any five-year time interval following the onset of childbearing in the group are evenly distributed within the interval. The assumption is needed to justify centering survival ratios at the middle of the five-year time intervals. The use of Method Three requires that the separation factor of .3 be a good approximation of the unknown factor prevailing in the population. Finally, each of the methods is based on a condition of no association between mortality of mothers and mortality of their children.

If the assumptions are violated and the data are defective, then the trend estimates are biased. Although no detailed analysis of biases arising from errors in data and assumptions was made, it is possible to get some idea about possible distortions in the estimates.

Let us consider effects of data errors first. Effects on the trend estimate derived by Method Three are the clearest of all. Rising underestimation of infant mortality from 1960 backward is a consequence of a year-of-death misreporting. Apparently, the misreporting causes a net transfer of infant deaths from the year of birth into the subsequent year that increases as one moves from 1960 backward. This illustrates how unreliable a trend estimate might be if it is derived from information obtained through responses to a question that is impossible for many women to answer accurately. The trend estimate derived from the information on age at death would have been perhaps equally unreliable, if such information had been collected and used.

Two types of data defects could affect estimates reached by the first two methods : (i) underreporting of children born alive who subsequently die, and (ii) systematic year-of-birth misreporting.

If misreporting of years of birth of children born a long time (say, twenty to thirty years) ago takes a form of exaggerating time occurrence of birth (placing it longer ago than it should), then proportions dead of cohorts born a long time ago are depressed. Therefore, the Method One estimates for the early years are too low. If the misreporting is systematic in the described sense, distributions of children who were born to older women and who survive are extended into the past more than they should. Duration of exposure to mortality is too long for the oldest of these children. As a result, Method Two estimates for the early years are necessarily too low, because, other things equal, only lower mortality is consistent with artificially extended exposure.

If some of the children who were born a long time ago and who died are omitted, the proportions and the Method One estimates for the early dates are depressed. Omission has the same depressing effect on the Method Two estimates.

It is certain that the omission has affected Method One estimates for the 1940s. Underreporting of female dead children was detected in rural areas of South-Eastern Turkey after computing and plotting proportions dead by sex, region and community size. The possible effect of underreporting on Method Two estimates for 1943-47 seems to be insignificant compared with the opposite effect of slight to moderate errors in estimates for the periods after 1947.

Biases that arise from errors in assumptions are probably minor compared with those resulting from data defects. The assumption on an even distribution of births within each five-year time period is certainly not fulfilled whenever the births are occurring to a group of women who are either in their early or late years of childbearing. The condition of similarity between model and empirical age patterns of mortality is likely to be violated often. What are the effects of these violations is difficult to say unless a numerical analysis of possible errors in assumptions is performed – the analysis that has not been done yet. At least an effect of nonfulfilling the assumption of no association between mortality of mothers and that of their children is possible to predict. The association is likely to be a positive one with a depressing effect on the estimates.

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EFFECT OF DECLINES IN INFANT AND CHILD MORTALITY ON FERTILITY AND BIRTHSPACING : PRELIMINARY RESULTS FROM RETROSPECTIVE AND PROSPECTIVE DATA IN FOUR GUATEMALAN VILLAGES

Charles TELLER, Ph. D., *Demographer-Sociologist*
William BUTZ, Ph. D., *Statistician*
Charles YARBROUGH, Ph. D., *Economist (Rand Corporation)*
Aaron LECHTIG, M.D., M.P.H., *Epidemiologist*
Jean-Pierre HABICHT, M.D., M.P.H., Ph. D., *Epidemiologist*
Hernan DELGADO, M.D., M.P.H., *Epidemiologist*
Reynaldo MARTORELL, Ph. D., *Physical Anthropologist*

Division of Human Development
Institute of Nutrition of Central America and Panama
(INCAP)

Introduction

Over the past 6 years the Division of Human Development at INCAP has been carrying out longitudinal research on the relationship between nutrition and physical and mental development. These studies are being conducted in four Ladino Guatemalan communities which range from 600 to 1 000 people in size. Subsequently, in 1973, a three-year study of the socioeconomic and biomedical factors related to birthspacing and lactation was begun in these same four communities. This latter study has developed instruments which add retrospective data on the key demographic variables to those prospective data being collected in the longitudinal study, thus providing an expanded time frame within which to analyze the child mortality-fertility relationship.

The data presentation for this report will address itself generally to the much discussed "Child Survival" hypothesis. This hypothesis states that the experience and/or expectation of substantial infant and child mortality hinders movement toward lower fertility. A related proposition, the "overcompensation" hypothesis, states that couples tend to overcompensate with many births more closely spaced due to expected infant and child deaths. Although our longitudinal project has not yet collected and/or analyzed sufficient data to test these proportions in a comprehensive manner, we are taking this opportunity to present a preliminary analysis of trends in increasing child survivorship in our experimental communities and within cohorts of families and relate them to trends in age-specific fertility and birthspacing. These observations are expected to generate hypotheses which will subsequently be tested in larger sample populations.

Three approaches are proposed in the analysis of the Guatemalan data that are not commonly found in the literature on this subject. While most of the empirical studies have concentrated on the effect of early parity death rates on subsequent fertility within the same couple, we will also attempt to measure the effect of *community* declines in infant and child death rates on community fertility. Secondly, we are as interested in the impact of an infant death *within* a birth interval on the timing of the next conception, and in the *interaction* effect of this death with past child deaths on the next conception, as in the sole impact of past deaths. And, thirdly, we will disaggregate the birth interval into its biologically component parts and concentrate on the post-post partum amenorrhea interval, that is, the at-risk period between the return of menstruation and the next conception (1).

One of the basic problems in investigating the relationship of infant mortality and fertility is that the experience of mortality may be differently related to various parts of the birth interval. Infant mortality, for example, occurs mainly in the first four months, and so reduces lactation time and results in a more rapid return of post-partum ovulation. On the other hand, mortality might have either biological correlates or behavioral sequelae which dramatically affect fertility. Thus the total length from birth to birth might be longer, shorter, or unchanged by the death of a suckling child. We here have shown preference towards an analysis of the separate components of the birth interval. The most interesting component is the time from return of menses until the next conception since this is essentially the woman's fecund time.

Methodology

The data are based on a sample of 432 mothers or ever-united women between the ages of 15 and 49 in four Ladino Guatemalan villages. The sample represents all women with these characteristics who were present

(1) In this report, we do not use a direct measure of the at-risk period, since reliability checks on the reporting of the post-partum amenorrhea interval have been done only on the pretest data.

in these communities in November and December,1974. The sole data collection instrument used in this analysis is the "Female Retrospective Life History", which included a detailed pregnancy history along with data on lactation, post-partum amenorrhea and other important biological and non-biological life cycle events related to birthspacing.

The quality of the data on month and year of birth and death and duration of post-partum amenorrhea and of lactation is crucial for this type of analysis. Dates of birth and death since 1969 were checked with the prospective data, and since 1963 with official vital registration data (2). Dates prior to 1963 were aided in recall by the structure of the Retrospective instrument itself which chronologically relates births and deaths to other important life cycle events in the woman's life. Data on length of post-partum amenorrhea and lactation are available on a prospective basis from the longitudinal study and will be used in future analysis to estimate the reliability of the data from the Retrospective (3).

There are several advantages in using these couples for the present study. One is that to study the consequences of rapid declines in infant mortality, such communities need to be identified and made feasible for intensive study. In the six years of INCAP intervention in nutrition supplementation and medical care, infant mortality has been cut in half (see Table 1). Secondly, reporting of normally high memory-loss events (age of infant death, time of return of menses, end of lactation, etc.) has been aided by repeated contact with, and questioning of, these women fortnightly in their homes, and periodically on demand in the medical clinic. This interaction has not noticeably influenced the non-biological (cultural, socioeconomic, psychological) factors related to these events. Thirdly, this population is probably largely non-contracepting : 93.1 % of the couples interviewed in 1972 stated that they were not currently using any contracepting devices or techniques.

There are also several limitations in the analysis of pregnancy histories. The death of mothers or their outmigration means that community level analysis can be made only on survivors within the community, which may be a biased sample. A second problem is that the analysis is made only on closed birth intervals, so that women with exceptionally long intervals will be missed at the end of their pregnancy history. A third limitation is the paucity and/or under-reporting of data on abortion and on subfecundity.

The analysis in this report is preliminary due to insufficient time for cleaning and editing of the data. The central concern is a description of the trends and suggested alternative approaches in looking at the infant mortality-fertility relationship.

Data presentation — Some Initial Findings and Possible Interpretations

A) Demographic Trends

Table 1 sets the background for subsequent analysis. It reveals that there has been a substantial reduction in infant and child mortality in the four villages in the past twenty-five years. The rapid declines occurred since 1969, with the 1969-73 rate approximately half that of the 1960-1968 rate. Consequently, child survivorship increased by about one-third since the decade of the 1950's : from 71 % to 91 % of all births surviving beyond age 4. The key factors responsible for this decline are thought to be more related to public health interventions (preventive medical care, especially immunization, and food supplementation) than to general socio-economic development.

Trends in age-specific fertility are presented in Table 2 and Figure 1. It appears as if the villages are in the midst of a classic demographic transition, with fertility falling in the higher age groups and bunching in the prime childbearing years (4). However, there has been no overall reduction in total number of live births. Women 45-49 average 11 pregnancies, 10 live births and seven surviving children. Younger women, at the present pace, will wind up with as many live births but more surviving children than the older women. However, these younger women may be reacting to perceived increases in child survival and be trying to reduce their over-30 reproduction.

B) Intra-Interval Death and Length of Same Birth Interval

One of the new questions we are raising is the possibility of not just an immediate biological but also a behavioral response to an infant death. Will there be a replacement effect in that the subsequent birth will come sooner than if there had not been an intra-interval death ? An indication of such would be a shorter at-risk (post-partum amenorrhea) period following an intra-interval death. In Table 3, no such evidence is apparent. The at-risk period is longer for those women experiencing an intra-interval death (Cols. B & C) than those with no death (Col. A). The biological effect is apparent, however. Presence of death is associated with shorter lactation (Row 1) and shorter birth interval (Row 4). The shorter lactations in Group C may induce more deaths than in Group A.

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(2) If there was a discrepancy in the data reporting, the prospective or the registration data source was used. The retrospective instrument did pick up data on in-migrants plus the fetal losses that were not covered in the other two sources.

(3) Pretests showed high reliability correlations on length of lactation and unacceptable correlations on length of post-partum amenorrhea.

(4) The older age figures for the first two time periods appear biased upward, and further analysis is now in progress to see if there are, in fact, reporting biases.

TABLE 1 – TRENDS IN COHORT INFANT AND CHILD MORTALITY OF CHILDREN BORN TO WOMEN 15-49 PRESENT IN FOUR LADINO GUATEMALAN VILLAGES IN NOV-DEC., 1974

Periods of Death	Time Period of Birth			% Change 1960-68 to 1969-73
	Prior to 1960	1960-1968	1969-1973	
Perinatal[a]	90.1 $\frac{50}{555}$	80.0 $\frac{73}{912}$	54.1* $\frac{40}{739}$	32.4
Infant[b]	170.1 $\frac{92}{541}$	151.6 $\frac{132}{871}$	73.9 $\frac{44}{595}$	51.3
Neonatal[c]	88.7 $\frac{48}{541}$	105.6 $\frac{92}{871}$	47.1 $\frac{28}{595}$	55.4
Postneonatal[d]	81.3 $\frac{44}{541}$	45.9 $\frac{40}{871}$	26.8 $\frac{16}{595}$	41.4
Child (1-4)[e]	125.8 $\frac{56}{445}$	74.2 $\frac{56}{755}$	34.5** $\frac{8}{232}$	53.5

Source : Preliminary Data, DDH-INCAP, 1975

* Deaths 1969-1974

** Deaths (1-4) to live birth in 1969-1970 minus infant deaths

a $\frac{\text{Fetal + lst week death}}{\text{Live Births + Fetal Deaths}}$ .1000

b $\frac{\text{Deaths lst year}}{\text{Live Births}}$ .1000

c $\frac{\text{Deaths lst month}}{\text{Live Births}}$ .1000

d $\frac{\text{Deaths 2-11 months}}{\text{Live Births}}$ .1000

e $\frac{\text{Deaths 1-4 years}}{\text{Live Births}}$ .1000

TABLE 2 – TRENDS IN AGE SPECIFIC FERTILITY OF WOMEN 15-44 PRESENT IN FOUR LADINO GUATEMALAN VILLAGES in NOV. – DEC. 1974

Age Group	Period of Birth		
	Before 1960	1960-1968	1969-1973
15-19	.118	.164	.220
20-24	.304	.362	.415
25-29	.396	.369	.362
30-34	.410	.348	.305
35-39	–	.373	.213
40-44	–	*	.156

* Based on less than 100 woman-years.

Source : Preliminary data, DDH-INCAP, 1975.

Several interpretations stem from this apparent lack of a behavioral effect. One is that some "no-death" intra-interval mothers (Col. A) may have had prior deaths. If there is a replacement effect associated with these deaths, then the number in Col. A, Row 3, is biased downward in comparison with Cols. B, C, and D for purposes of testing for replacement (5). A second possibility is that mothers whose children die are biologically selective on factors which lengthen the estimated at-risk interval : higher early fetal loss, subfecundity, malnourishment, greater infection and a longer post-partum amenorrhea period. Thus, in fact, the length of the period at which women are really biologically fecund may be shorter for these post-death women than estimated in Table 3. Finally these high-risk women may be trying to avoid an early subsequent pregnancy for fear of a similar fatal outcome.

(5) Moreover, the replacement effect (if present) may work most strongly for older women, since many of these women would be through with childbearing except for a recent child death. For this reason, Col. A might even contain relatively more of these women and thus be further biased downward.

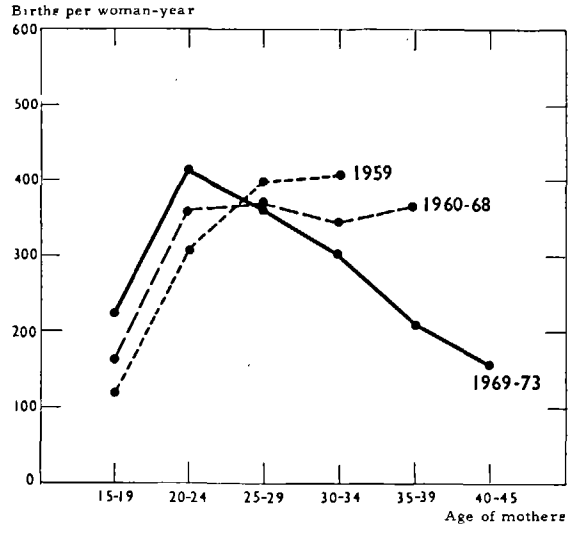


Figure 1 – Age specific fertility rates for all women 15-49 present in four Ladino Guatemalan villages, nov-dec, 1974 by time period (Each observation based on over 100 woman-years)

TABLE 3 – MEAN BIRTH AND INTRA-BIRTH INTERVALS FOR ALL WOMEN[a] 15-49 PRESENT IN FOUR LADINO GUATEMALAN VILLAGES, NOV-DEC., 1974 BY INFANT DEATH-LACTATION TIMING

Interval	Type of Pregnancy Interval							
	No Death		Death					
	A		During Lactation B		After Lactation Before Next Conception C		After Lactation After Next Conception D	
	Months	N	Months	N	Months	N	Months	N
1. Birth to end of lactation	16.7	(1447)	4.2	(282)	9.6	(63)	14.6	(65)
2. Estimated length of amenorrhea[b]	8.4	(1400)	4.2	(272)	4.8	(52)	7.3	(60)
3. Length of Post-amenorrhea risk	10.1	(1400)	12.1	(272)	15.6	(52)	8.1	(60)
4. Birth to Birth	27.5	(1588)	25.3	(266)	29.4	(52)	24.4	(63)

a Women with closed intervals

b Months of amenorrhea estimated to equal approximately one-half of months of lactation, except Col. B.

Source : Preliminary Data, DDH-INCAP, 1975.

C) Effect of Prior Infant Mortality on Length of Post-Lactation Interval

Here there looks like evidence in favor of compensation (see Table 4). There is a monotonic decline in the length of the post-lactation interval with an increase in the number of dead children prior to the interval (6). There is no apparent influence, however, of past mortality experience on the post-lactation interval with no intra-interval death. This suggests a synergism between past and present mortality experiences which seems to produce the expected compensation response.

D) Effect of Prior Infant Mortality on Length of Lactation

The length of lactation does not decrease in the present "no-death" birth interval with increasing number of past child deaths. But in the "death present" birth interval, the length of lactation decreases monotonically with increasing number of deaths. Here there is no evidence that women are purposely

(6) One sort of bias here is that women with shorter intervals may have, on the average, more children and relatively many child deaths, without any direct causal relationship between deaths and intervals. However, the results do not change using a survival ratio (an age control for mothers) used instead of the number of children dead.

breastfeeding less to compensate for past child deaths. They may, in fact, be breastfeeding longer to guard against another death. Col. B suggests that high risk women have earlier subsequent child deaths (i.e., breastfeed loss time), and that these women may likely be in poorer health and nutritional status.

TABLE 4 – MEAN POST-LACTATION-TO-NEXT-BIRTH-INTERVAL FOR ALL WOMEN[a] 15-49 PRESENT IN FOUR LADINO GUATEMALAN VILLAGES, NOV-DEC, 1974 BY NO. OF PREVIOUS DEAD CHILDREN

No. of Dead Children (Prior to Interval)	Type of Pregnancy Interval			
	No Death	Death		
	A	During Lactation B	After Lactation Before Next Conception C	After Lactation After Next Conception D
0	12.7 (788)	23.4 (121)	21.0 (31)	9.0 (37)
1	13.0 (355)	20.1 (69)	19.6 (12)	11.1 (14)
2	12.4 (169)	17.6 (38)	*	*
3	12.1 (50)	17.5 (21)	*	*
4	12.7 (36)	*	*	*
All	12.8 (1406)	19.6 (262)		

* Less than 10 events.

a All women with closed intervals.

Source : Preliminary Data, DDH–INCAP, 1975.

TABLE 5 – MEAN LENGTH OF LACTATION (IN MONTHS) FOR ALL WOMEN[a] 15-49 PRESENT IN FOUR LADINO GUATEMALAN VILLAGES, NOV.-DEC., 1974 BY NO. OF PREVIOUS DEAD CHILDREN

No. of Dead Children (Prior to Interval)	Type of Pregnancy Interval	
	No Death A	Death During Lactation B
0	16.1 (798)	5.4 (125)
1	17.0 (365)	4.8 (71)
2	17.4 (172)	3.5 (40)
3	22.0 (53)	1.6 (24)
4	16.2 (37)	.6 (8)

a All women with closed intervals.

Source : Preliminary Data, DDH-INCAP, 1975.

IV. Concluding Comments

Three uncommonly-found approaches to the study of the effects of infant mortality on fertility were used in a preliminary test of the overcompensation hypothesis with data on non-contracepting rural Guatemalan women.

1. Effect of community declines – the data show that INCAP interventions in food supplementation and medical care have rapidly lowered infant and child mortality and increased child survival. Concomitantly there has been a bunching of births in the 15-24 age group of women and a thinning among the post-30 group, but no change in total fertility. Whether this is in response to increasing child survival or to changes in the socio-cultural matrix of life awaits further analysis of more direct information on perceptions and expectations about child survival.

2. Intra-interval infant death – no consistent evidence was found for overcompensation mechanisms (i.e. shortening of at-risk interval) operating in response to an intra-birth interval infant death. Women do not seem to be "overcompensating" for an intra-interval death by hastening the coming of the next conception. However, when an intra-interval death occurs on top of a history of prior infant deaths a shortening of the post-lactation interval appears.

3. Disaggregation of birth interval – separating the post-post partum amenorrhea (or at-risk) part of the birth interval helps in sifting out the biological from the behavioral responses to present and past child survivorship. The at-risk interval was found to be longer for those women experiencing an intra interval death than those with no death. An argument can be made that women with intra-interval infant deaths are "biologically" selective towards lower fecundity which leads to longer at-risk intervals.

Further research on larger samples in prospective studies are needed in order to test the child survival hypothesis and its corollaries. New approaches are needed to separate the biological from the behavioral responses to past *and present* child mortality, and the community and peer group from the couple-induced responses. The approach of separating the at-risk part of the birth interval has shown promise and merits further methodological development.

INFANT MORTALITY AND MARITAL FERTILITY DECLINE IN BELGIUM, 1880-1910 – A SHORT RESEARCH NOTE

R. LESTHAEGHE
Centrum voor Sociologie
Vrije Universiteit Brussel
Département de Démographie
Université Catholique de Louvain

In this brief document we have put together the major points that emerge when marital fertility is analyzed in relation to the evolution of infant mortality in a particular European example. All evidence stems from ecological data and not from observations for individual cases. In addition, this note is intended solely to yield some background information and should not be quoted.

A. Infant mortality

The picture of 19th century infant mortality in Belgium is characterized by two features :

a) the lack of any significant decrease before 1895

b) the maintenance of a constant geographical pattern during the entire century.

The first feature can be considered as "usual", given the fact that it is a well-nigh universal fact that the decline in overall mortality affects the younger age groups much later than the adults.

The second point is to some degree corollary of the first : with no significant decline in infant mortality one would expect that the regions with high levels during the Napoleonic times were still characterized by high levels at the end of the century. Evidence for these two points can be found in Table 1 where the values of ${}_1q_0$ are shown by province. There it can be verified that the two provinces with the highest values of ${}_1q_0$, West and East Flanders, occupied the first places in the ranking from high to low at the very start of the century and at the very end of it. Alternatively, the provinces of Hainaut, Namur and Luxembourg had considerably more favorable rates in 1802-12 and maintained their position during the entire century. Apart from these two features, the third characteristic of Belgian infant mortality is its important regional variation. Infant mortality rates varied approximately between 115 and 220 per 1 000 live births in the 9 provinces during the entire century. If we were to take smaller geographical aggregates than provinces and go down to the level of the 41 arrondissements, still larger regional differences will emerge. In this respect, Map 1 indicates that values of ${}_1q_0$ as high as .260 were found in three Polder-arrondissements of West Flanders in 1889-1891 whereas values between 107 to 120 were registered in several Walloon arrondissements. If values of ${}_1q_0$ were broken down by legitimacy of the births, still larger variations can be found and also by social class or occupational category very substantial differences emerged. On the whole, these data indicate that infant mortality in the Flemish regions was 30 to 40 % higher than in the Walloon regions during the entire 19th century.

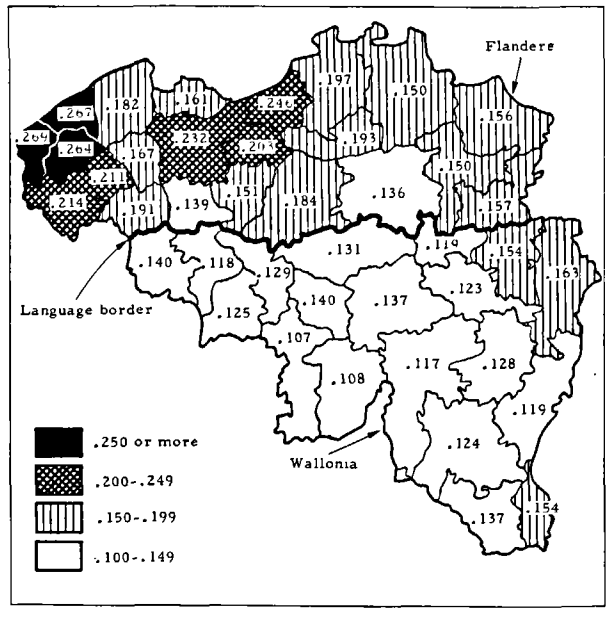
Which factors assume the responsability for this substantial regional variation in infant mortality ? According to C. Jacquart, head of the Statistics Institute just after the turn of the century, the following factors should be considered :

TABLE 1 – INFANT MORTALITY RATES, SEXES COMBINED, BELGIUM 1802 - 1910, BY PROVINCE.

Province	1802-12		1878-80	1881-85	1886-90	1891-95	1896-1900	1901-05	1906-10
	Recorded	Estimated							
Antwerp (F)	.153	.165 (W)	.182	.167	.173	.176	.165	.154	.149
Brabant (F + W)	.155	.179 (W)	.164	.155	.159	.158	.149	.133	.128
West Flanders (F)	.171	.199 (W)	.213	.188	.202	.207	.211	.201	.193
East Flanders (F)	.181	.213 (W)	.208	.188	.199	.195	.188	.179	.171
Hainaut (W)	.119	.131 (N)	.128	.116	.128	.128	.122	.115	.102
Liège (W)	.139	.162 (W)	.151	.149	.144	.144	.128	.118	.113
Limburg (F)	—	—	.143	.133	.134	.139	.135	.124	.127
Luxemburg (W)	.147	.147 (N)	.116	.118	.119	.119	.119	.105	.096
Namur (W)	.105	.127 (N)	.121	.119	.116	.120	.114	.099	.095
Kingdom	—	—	.168	.156	.163	.164	.157	.148	.141

Notes : The estimated values of $_1q_0$ for 1802-12 are obtained on the basis of the Princeton model life tables, the growth rate and the recorded cumulative distribution of deaths by age. The retained values of $_1q_0$ correspond with the median level of mortality in the West or North model life tables (indicated with W or N). The infant mortality rates for the Napoleonic period are those of départements and not of the later provinces. However, most Napoleonic départements coincided with the post-1846 provinces, except for the département de l'Escaut which contained the Dutch province of Zeeland, for the département des Deux-Nèthes which covered a part of Dutch Northern Brabant and for the Département des Forêts which contained also the Grand Duchy of Luxemburg and a small German area. In practice, this implies that the values for 1802-12 should be interpreted with care when the comparison is made with later values of the provinces of East-Flanders, Antwerp and especially Luxemburg. W = Walloon (French speaking) F = Flemish (Dutch speaking) area.

Sources : C. Jacquart (1921, p. 108) ; J. Duchêne et R. Lesthaeghe (1975).



Map 1. – Infant Mortality Rate ($_1q_2$), by arrondissement, Belgium 1889-1891, sexes combined.

1) The lack of breastfeeding in Flanders and the large female labor force participation in several Flemish arrondissements.

In a series of reports drafted by the provincial medical commissions, the abandoning or lack of breastfeading is nearly always mentioned as the prime cause of high infant mortality. Very shortly after birth children are weaned and receive a concoction of water, milk, flour and butter, often fed through an infected bottle and nipple. This lack of lactation was associated with high rates of female labor force participation. As soon as the mother started working in the Flemish textile mills or in other light industries or returned to the land as an agricultural laborer, the infant was left with a relative, a neighbor or another child (C. Jacquart, 1907, p. 19-32). In a sample of 6 312 live births occurring to women employed in the linen industries, an infant mortality rate of .403 was found and of the total number of deaths, 46.3 percent occurred in the first three months of life. Slightly lower rates were found among mothers employed at home (cottage industries) but according to P. Verhaeghen (1902, vol. 2, p. 9) the *dentellières* or lace makers – who made up for a considerable part of the female labor force – were equally negligent with respect to breastfeeding.

2) The use of opiates

Especially in Flanders widespread use was made of an extraction of poppy heads (slaapkoppen) or of opiate syrup (slaapgoed). This extraction or syrup was commonly given to keep crying infants and children quiet. The use of such opiates may not have been a cause of death by itself, but it cut off the normal "alarm system" through which infants indicate that something may be wrong with them.

3) The infection of drinking water

In many parts of Flanders a serious problem of drinking water existed until after World War I, when water supplies collected in the Ardennes were distributed over the entire territory. Before that period, the countryside remained exclusively dependent on local artificial wells. In the alluvial plains of the Polders, for instance, the impermeable clay layers polluted the water very severely. In addition, the drinking water of the urban centers was often taken from the canals which became increasingly polluted by industrial or organic wastage (e.g. retting of flax). Obviously, several social and environmental factors may have been responsible for the very high infant mortality in the Western part of Flanders. But, very specifically, the use of opiates shows that the local mentality was not particularly exemplary of a high degree of child-orientedness.

B. Marital Fertility

In the chronological list of countries which reduced their births rate below 30 %, Belgium occupies the second place but follows France with a time lag of half a century. Already in 1840 two adjacent French *départements* (dépt. de la Meuse, dépt. des Ardennes) had reduced their values of I_g below the .500 mark and only in 1870 a spill over across the border can be found : the arrondissement of Philippeville, a typical rural area which had even lost its small charcoal operated metal industry, shows signs of fertility decline. In 1880 the movement had definitely spread to the entire Hainaut industrial belt, in 1890 about half of the area of Wallonia was affected and by 1900 only three arrondissements located on the Ardennes-plateau had values of I_g that still exceeded .600. In 1910, no area in Wallonia was left that had resisted the unprecedented decline in marital fertility.

Perhaps one of the most characteristic features of the fertility decline in Wallonia is that this geographical dispersion pattern stops at the language border : in a very narrow strip of no more than 5 miles wide, very steep fertility differentials can be found : in 1900 marital fertility in the Flemish villages along the language border was on the average 40 % higher than in the adjacent Walloon communities just south of the language border. Contrary to what has probably been true for Wallonia, we find no traces of the fact that a geographical dispersion pattern starting at the French border emerged in Flanders. Rather, the urban agglomerations of Antwerp, Brussels and Ghent set the trend, but still with a time lag of two decades in comparison with the Walloon province of Hainaut.

As can be seen in Table 2, the group of provinces that had a late decline in marital fertility is made up exclusively of Flemish areas : East and West Flanders, Limburg. In the former two provinces I_g rose considerably during the last decades of the 19th century and started to drop precipitously only after 1900. In Limburg, I_g stayed well above .800 without any interruption until after 1910, and its transition would only start after World War I. Even after 1920, Limburg would be characterized by a slow transition that contrasted strongly with the experience of the rest of Belgium. In 1961 for instance, its I_g was still higher than .400, a level that had been passed in Hainaut before 1900, i.e. more than half a century earlier. These considerable time lags and differences occur on an extremely small geographical scale : the heart of Limburg is only 70 miles away from the center of Hainaut. But, purely physical distances do not seem to have played a very significant role in Belgium's demographic history.

TABLE 2 – INDEX OF MARITAL FERTILITY (I_g), BELGIUM 1802-1920, BY PROVINCE

Province	1802-12	1829	1846	1856	1866	1880	1890	1900	1910	1920
Antwerp (F)	.706	--	.786	.799	.861	.837	.761	.661	.508	.403
Brabant (F + W)	.788	--	.737	.765	.784	.710	.626	.517	.365	.302
West Flanders (F)	.907	--	.810	.897	.939	.918	.878	.838	.671	.518
East Flanders (F)	.893	--	.793	.923	.930	.921	.849	.780	.594	.467
Hainaut (W)	.740	--	.717	.722	.700	.577	.478	.394	.298	.277
Liège (W)	.766	--	.765	.790	.791	.704	.598	.490	.333	.293
Limburg (F)	--	--	.773	.839	.863	.881	.872	.877	.822	.722
Luxemburg (W)	.854	--	.774	.768	.782	.733	.669	.625	.527	.462
Namur (W)	.745	--	.743	.745	.731	.618	.536	.469	.364	.350
Kingdom	--	.873	.757	.827	.830	.751	.678	.596	.443	.370

Notes : W = Walloon (French speaking province), F= Flemish (Dutch speaking province)
The same remarks as in Table 1 apply for the data of 1802-12.

Sources : A. Quételet et E. Smits (1832), J. Duchène et R. Lesthaeghe (1975), R. Lesthaeghe (1975).

C. The decline in marital fertility and the reduction of infant mortality : the problem of timing

Several theories have been forwarded to link marital fertility to infant mortality. The gist of these theories can be specified very briefly as follows : given that fertility falls within the calculus of conscious choice, the future fertility of couples is influenced by realized parity and by the ultimate desired family size. Infant mortality operates precisely in this balance equation as an important intervening variable. More specifically, if the objective is to have *surviving* children, parents would have to produce fewer births to realize their desired size of surviving off-spring in a situation characterized by declining infant mortality (see for instance R. Easterlin, 1972, p. 6). Given that couples would not have immediately a tangible indication that infant mortality is in fact declining, a time lag should develop between the start of an infant mortality decline and the start of a fertility decrease (see H. Habakkuk, 1972, p. 63-65 ; G. Ohlin, 1973, p. 6 ; T.P. Schultz, 1973, p. 12-13). The mechanism leading toward such a time lag can take different forms. According to H. Leibenstein, for example, the decline in infant mortality would first increase the number of "child-utility" years, and with it the desired and actual number of children. Fertility would consequently increase during the first phase. This increase is labelled the "infant mortality hump". During a second phase, it would be realized that the costs of caring for this extra load would outweigh the ultimate benefits and fertility would decline (H. Leibenstein, 1956, p. 164).

Whatever the precise terms of the mechanisms be, most authors expect a cause-effect relationship and the time lag follows a well defined sequence : the infant mortality decline *precedes* the drop in marital fertility and not the other way round.

It should be stressed that these mechanisms are taken as operating on the level of individual behavior of couples and it may well be that aggregate data conceal the relationship to some extent. However, if the effect of lowering infant mortality on marital fertility is sufficiently strong, some traces must be found in ecological data as well. This should be especially true in Belgium : the aggregation of individual data into data for arrondissements does not lead to a drastic reduction of the variance of ${}_1q_0$ and I_g.

Let us now tackle the first problem : was there indeed a time lag in the expected direction between the decline in infant mortality and the drop in marital fertility ? First, it should be stressed that the reduction of ${}_1q_0$ starts shortly after 1895 *at the earliest.* By that time, marital fertility levels had gone down to about 60 % of their 1870 or 1880 levels in 3 provinces (Hainaut, Namur and Liège) and to about 70 % in another 3 provinces (Brabant, East-Flanders and Luxemburg). This is shown in Table 3 and on the corresponding figures. Clearly, in 6 out of the 9 provinces the drop in I_g preceded the decline in ${}_1q_0$, contrary to what was originally expected. In fact, only very faint traces of parallelism can be found in the provinces of Antwerp and West Flanders, whereas Limburg remains the sole province where one can admit that the expected sequence holds. Moreover, traces of an "infant mortality hump" could not be detected by superposing the evolutions of I_g and ${}_1q_0$ in any area in Belgium, even when the analysis was performed on the level of arrondissements rather than provinces.

TABLE 3 – EVOLUTION OF INFANT MORTALITY RATE (${}_1q_0$) AND INDEX OF MARITAL FERTILITY (I_g), 1880 = 100, BELGIUM 1880-1910, BY PROVINCE

Province		1880	1885	1890	1895	1900	1905	1910
Antwerp	${}_1q_0$	100	91.8	95.1	96.7	90.7	84.6	81.9
	I_g	100	--	90.9	--	79.0	--	60.7
Brabant	${}_1q_0$	100	94.5	97.0	96.3	90.9	81.1	78.0
	I_g	100	--	88.2	--	72.8	--	51.4
West Fl	${}_1q_0$	100	88.3	94.8	97.2	99.1	94.4	90.6
	I_g	100	--	95.6	--	91.3	--	73.1
East Fl.	${}_1q_0$	100	90.4	95.7	93.8	90.4	86.1	82.2
	I_g	100	--	91.9	--	70.0	--	55.0
Hainaut	${}_1q_0$	100	90.6	100.0	100.0	95.3	89.8	79.7
	I_g	100	--	82.4	--	62.3	--	57.9
Liège	${}_1q_0$	100	98.7	95.4	95.4	84.8	78.1	74.8
	I_g	100	--	81.9	--	55.7	--	49.0
Limburg	${}_1q_0$	100	93.0	93.7	97.2	94.4	86.7	88.8
	I_g	100	--	100.6	--	94.3	--	82.8
Luxemburg	${}_1q_0$	100	101.7	102.6	102.6	102.6	90.5	82.8
	I_g	100	--	93.4	--	78.8	--	69.1
Namur	${}_1q_0$	100	98.3	95.9	99.2	94.2	81.8	78.5
	I_g	100	--	87.5	--	67.9	--	65.3
Kingdom	${}_1q_0$	100	92.9	97.0	97.6	93.5	88.1	83.9
	I_g	100	--	90.3	--	79.4	--	59.0

D. The decline in marital fertility and the reduction of infant mortality : associations in cross-sections

Given that we should not expect the postulated time lag to emerge, we can now turn to the second problem : was there any association between levels and changes in both, ${}_1q_0$ and I_g ; and if so, to what extent can the original correlations resist the effect of introducing other variables associated with infant mortality and/or marital fertility ?

A first idea about the strength of the relationship between ${}_1q_0$ and I_g can be obtained by inspecting the correlations coefficients shown in Table 4. On the basis of these coefficients we can answer 4 questions :

a) Can we predict the level of I_g for the arrondissements on the basis of the knowledge of the level of ${}_1q_0$?

b) Can we predict the subsequent relative changes in I_g (i.e. ΔI_g) for a certain period on the basis of the knowledge of the level of ${}_1q_0$ at the start of that period ?

c) Can we predict the subsequent levels of I_g on the basis of the knowledge of the relative change in ${}_1q_0$ (i.e. $\Delta_1 q_0$) during the just preceding period ?

d) Can we predict ΔI_g on the basis of the knowledge of $\Delta_1 q_0$?

The answer to all four questions tends to be negative for both language regions. Especially in Flanders, the area with the largest variation in both variables, lower levels of ${}_1q_0$ tend to be associated with higher levels of I_g and higher levels of ${}_1q_0$ tend to be associated with faster reductions of I_g. These observations are absolutely in contradiction with the expected direction of the associations. The same can be said for Wallonia when ΔI_g is predicted on the basis of $\Delta_1 q_0$: the higher the relative change in ${}_1q_0$, the smaller the drop in I_g.

TABLE 4 – MARITAL FERTILITY (I_g) AND RELATIVE CHANGES THEREOF (ΔI_g), CORRELATION COEFFICIENT WITH THE INFANT MORTALITY RATE AND RELATIVE CHANGES THEREOF ($\Delta_1 q_0$), BY LANGUAGE REGION IN BELGIUM, 1880-1910

Flanders (N = 22)		I_g			ΔI_g			
		1890	1900	1910	1880-1900	1890-1900	1900-1910	1890-1910
${}_1q_0$	1890	+.085	–.156	–.252	+.419	+.432	+.363	+.260
	1900		–.005	–.152			+.304	+.227
	1910			–.100				
$\Delta_1 q_0$	1890-1900		–.337	–.267	+.243	+.168	+.125	+.100
	1900-1910			–.123			+.086	+.110
Wallonia (N = 19)								
${}_1q_0$	1890	+.218	+.094	–.031	+.009	+.167	+.266	+.230
	1900		+.135	+.064			+.219	+.208
	1910			–.112				
$\Delta_1 q_0$	1890-1900		+.102	+.154	–.331	–.296	–.325	–.325
	1900-1910			+.280			–.443	–.401

Notes : $\Delta I_{g_{t,t+x}} = \dfrac{I_{g_t} - I_{g_{t+x}}}{I_{g_t} - 0.200}$ and $\Delta_1 q_0 = \dfrac{{}_1q_{0_t} - {}_1q_{0_{t+x}}}{{}_1q_{0_t} - 0.050}$

All values of $\Delta_1 q_0$ and ΔI_g are positive ; N indicates number of arrondissements

Obviously, the associations between ${}_1q_0$ and I_g cannot be studied in a vacuum as was done in Table 4 : other variables have to be introduced which possibly correlate with both, ${}_1q_0$ and I_g. In short, a more multivariate approach has to be taken. As a result, a regression model can be established and quantified.

In the subsequent work, we have performed the analysis for the two language regions separately. It was found that the regression lines for Flanders and Wallonia linking the endogenous to the exogenous variables tended to be parallel and significantly different. In other words, when scattergrams were produced, the points tended to form two district clouds and the first cloud contained nearly exclusively the observation for Flemish arrondissements whereas the other contained the observations for Wallonia. Clearly, if regression lines were to be fitted for Belgium as a whole, this line would just link the two separate clouds and overlook the tendancies emerging in each cloud separately. In doing so, one would fail to recognize that the distinction Flanders-Wallonia (nominal factor in co-variance analysis) has a highly significant impact of its own and one would accept erroneous slopes and correlation coefficients during further multivariate work.

Let us briefly describe the format of the regression model. First, the index of marital fertility (I_g) and the proportion of ever-married women in the age group of 20-24 (EM) are taken as endogenous variables. The quantity EM measures not solely the tempo of nuptiality but correlates also very highly with its final intensity.

The following exogenous variables were also introduced :

– the level of industrialization and urbanization of each arrondissement ;

– the degree of language homogeneity (presence of francophone subpopulations in Flemish arrondissements and presence of non-francophone populations in Wallonia) ;

– the degree of literacy, measured as the proportion of the population older than 15 years which is able to read and write ;

– infant mortality ($_1q_0$, sexes combined) ;

– a measure of secularization (i.e. non-adherence to Catholic ideology) operationalized as the proportion of the Non-Catholic vote (Liberals + Socialists + Communists) in each arrondissement.

First of all, we assume that the levels and relative changes in I_g (ΔI_g) depend on the five exogenous variables simultaneously. The higher the degree of urbanization, industrialization and secularization, the lower the level of I_g in each arrondissement should be or, the greater the relative change of it. According to the theories of Leibenstein, Schultz, Easterlin or Ohlin, one would expect that a lower infant mortality rate would be associated with lower values of I_g and higher values of ΔI_g. Also, we expect that marital fertility drops faster in the Flemish arrondissements with a substantial francophone population and slower in Walloon arrondissements with a larger non-francophone population. In other words, a high degree of language homogeneity should be a reason for expecting a slower fertility decline in Flanders and a reason for a faster fertility decline in Wallonia. In addition, nuptiality (EM) is related to industrialization, urbanization and secularization and positive effects are expected : the typical Malthusian restrictions on nuptiality should decline first in those areas which were also more modernized with respect to their socio-economic structure and level of secularization. Nuptiality is supposed to be unrelated to the other exogenous variables as we see no theoretical reason why literacy, infant mortality and language homogeneity should have an effect on EM. Finally, I_g or ΔI_g are taken as dependent on EM or Δ EM. Earlier work had indicated that the reversed sequence did not hold, so that it is postulated that the modernization of nuptiality patterns could have triggered off a modernization of fertility behavior.

All these relationships are graphically presented on Figure 1 and this non-recursive model was quantified through ordinary least square techniques. The Beta-coefficients or standardized regression coefficients are given in Tables 5 and 6, together with the effects of the unspecified variables (U-variables). Correlations between U-variables themselves were negligible in all cases.

Just focussing on infant mortality (Z_6) and marital fertility (X_1), it should be noted that the correlations between the former and the other independent variables are very small indeed, so that the Beta coefficients of Z_6 are not abnormally inflated or deflated as a result of multicollinearity. Compared to the other Beta's, the coefficients of infant mortality are only important when the levels of I_g are predicted for Wallonia 1900 (Table 5). When the relative change in marital fertility (ΔI_g) is predicted (Table 6), the Beta's of Z_6 turn out to be very small and their sign indicates that higher infant mortality leads to a higher rate of fertility decline, a result which is clearly in contradiction with what should be expected on the basis of the theories of Leibenstein et al. Again, this reversal of sign is not the result of multicollinearity, but stems from the positive correlation coefficients between $_1q_0$ and ΔI_g already reported in Table 4.

E. Conclusions

The inspection of the time series of $_1q_0$ and I_g and the results of the correlation analysis in cross-sections indicate :

1) that the drop in infant mortality occurred *after* the start of the marital fertility decline and can therefore hardly be considered as one of the factors that triggered off the trend toward greater control of fertility ;

2) that levels and changes in marital fertility can not be associated with levels or changes in infant mortality in the Belgian arrondissements. As a result, an explanation of the regional patterns of the marital fertility decline in Belgium should be based on variables other than infant mortality. In this perspective variables such as industrialization, urbanization, secularisation and the presence of linguistic minorities have shown a much greater explanatory power.

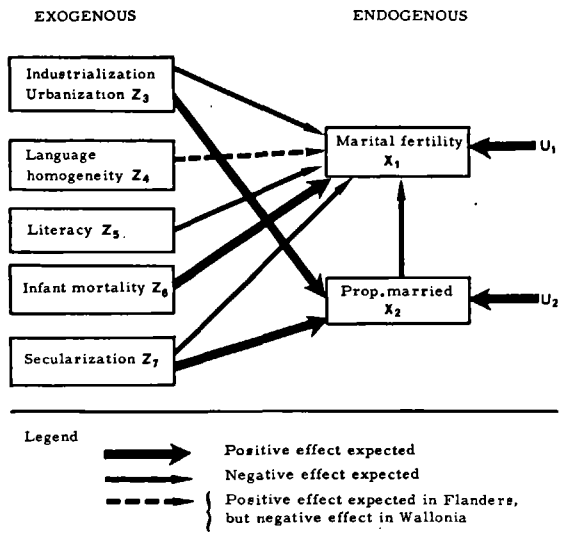


Figure 1 – Causal model describing effects of social and demographic variables on the index of marital fertility (I_g)

TABLE 5 – QUANTIFICATION OF EFFECTS IN CAUSAL MODEL LINKING SOCIAL AND DEMOGRAPHIC VARIABLES TO THE INDEX OF MARITAL FERTILITY, BETA-COEFFICIENTS OBTAINED IN MULTIPLE REGRESSION ANALYSIS ; BY LANGUAGE REGION, 1880-1910

Flanders (N = 22)		Dependent vars.		Wallonia (N = 19)	Dependent vars.	
		EM X_2	I_g X_1		EM X_2	I_g X_1
Ind + Urb Z_4	1880	+.665°	–.241	I	+.645°	–.245
	1890	+.674°	–.312		+.721°	–.218
	1900	+.772°	–.322		+.722°	–.388
	1910	+.665°	–.159		+.511°	–.162
Lang. hom. Z_5	1880		+.418°			–.119
	1890		+.527°			–.207
	1900		+.487°			+.071
	1910		+.303°			–.197
Literacy Z_6	1880		–.161			–.050
	1890		–.207			–.133
	1900		–.067			+.015
	1910		+.126			–.143
Inf. mort. Z_7	1880		+.428°			+.178
	1890		+.218			+.083
	1900		+.118			+.336
	1910		–.038			+.042
Secular. Z_8	1910	+.131	–.489°		+.228	–.673°
Nuptial. X_2	1880		–.348			–.524
	1890		–.120			–.637°
	1900		–.256			–.569°
	1910		–.112			–.303
		U_2	U_1		U_2	U_1
	1880	.756	.507		.764	.744
	1890	.739	.548		.693	.697
	1900	.636	.539		.692	.532
	1910	.496	.515		.530	.492

Notes : 1) The effects of the unspecified variables (+ measurement error) are obtained as $\sqrt{1 - R2}$, where R is the multiple correlation coefficient corrected for the effect of *n* (number of variables) approaching N (number of cases). (see Mc Nemar, 1955).
2) B/Standard Error B ⩾ 2.0 indicated by (°).

TABLE 6 – QUANTIFICATION OF EFFECTS IN CAUSAL MODEL, LINKING SOCIAL AND DEMOGRAPHIC VARIABLES TO RELATIVE CHANGES IN MARITAL FERTILITY, BETA-COEFFICIENTS OBTAINED IN MULTIPLE REGRESSION ANALYSIS, BY LANGUAGE REGION, 1880-1910.

Flanders (N = 22)		Dependent vars.		Wallonia (N = 19)	Dependent vars.	
		Δ EM X_2	ΔI_g X_1		Δ EM X_2	ΔI_g X_1
Ind.+ Urb. Z_4	1)	+.423	+.609°		+.600°	+.333
	2)	+.259	+.628°		+.549	+.471°
	3)	–.169	+.602°		+.364	+.516°
	4)	–.146	+.536°		+.439	+.682°
Lang. hom. Z_5	1)		–.190			+.002
	2)		–.229			+.095
	3)		–.299			+.134
	4)		–.395°			+.110
Literacy Z_6	1)		+.093			–.609°
	2)		–.204			–.563°
	3)		–.354°			–.483°
	4)		–.410°			–.341
Inf. Mort. Z_7	1)		+.254			+.030
	2)		+.172			+.095
	3)		+.089			+.156
	4)		+.054			+.008
Δ EM	1)		+.099			–.031
	2)		+.015			–.097
	3)		+.128			–.190
	4)		+.106			–.265
		U_2	U_1		U_2	U_1
	1)	.906	.467		.632	.557
	2)	.966	.545		.836	.453
	3)	.986	.570		.931	.480
	4)	.989	.566		.898	.547

Legend : 1) X-variables measured as Δ 1890-1900 and Z-variables in 1890
2) X-variables : Δ 1890-1910 ; Z-variables : 1890
3) X-variables : Δ 1900-1910 ; Z-variables : 1890
4) x-variables : Δ 1900-1910 ; Z-variables : 1900
B/SE (B) $\geqslant$ 2.0 indicated by (°)

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SOME FINDINGS ON THE INFLUENCE OF INFANT MORTALITY ON FERTILITY IN A RURAL ENVIRONMENT IN INDIA

S.N. SINGH and K.C. CHAKRABARTY
Demographic Research Centre
Banaras Hindu University
Varanasi (INDIA)

Introduction

The present global population dilemma is largely the result of birth rates in less developed countries failing to respond to death rate decline. Since world war II, the rapid mortality decline, specially that of infants, in developing societies has been achieved through importation of modern health technology, with little accompanying socio-economic change and fertility decline. In recent years social scientists have postulated different relationships between infant mortality and fertility, particularly in connection with the fertility decline. David Heer (1966), with data from 41 countries, has concluded that high fertility is positively associated with infant mortality. On the basis of a study in Egypt, Hassan (1966) has claimed that the incidence of infant and childhood mortality tends to raise fertility. Results of several studies [Westoff (1974), Raina (1969) ; Heer and Smith (1967)] also suggest that reduction of infant and child mortality is one of the necessary preconditions for acceptance of the idea of a small family norm.

The possible effect of infant and child mortality on fertility can be broadly subdivided into three components-the effect of (i) individual experience (ii) community experience and (iii) societal experience.

The individual experience of child loss may have important consequences for fertility behaviour and attitude of couples. There are two main ways in which child mortality experience of individual couples might affect their fertility. The first, which can be termed as 'physiological' effect derives from the results of studies conducted in populations practising universal breastfeeding and no fertility control. Here infant mortality affects the spacing between births and hence the total number of births independent of any type of fertility preferences. The observed association between infant mortality and birth interval has been considered as a result of the relationship between lactation and post partum amenorrhea (p.p.a.). Lactation prolongs p.p.a. and thus even in the absence of contraception tends to delay conception. The death of an infant interrupts lactation, and as a consequence, ovulation is resumed sooner and pregnancy follows earlier than otherwise. The reasoning here is based purely on the physiological relationship between lactation and p.p.a. and not on the conscious control of fertility.

The second effect of individual experience of child loss on fertility, termed as 'replacement' effect, implies that couples continue bearing children,replacing those who die young until they reach some number of surviving children which they consider sufficient. 'Replacement' could only occur in population practising fertility control, since otherwise, the decision whether to replace or not cannot be carried out.

Community experiences of child loss is that which reaches the couple by knowledge of child deaths that have occurred among family, friends, neighbours or the community in general or knowledge or feeling about the child mortality level in the community or local area. The effect of community experience posits that couples adjust their fertility in anticipation of possible future child deaths, thus ensuring the survival of at least the minimum number of offspring considered sufficient (Heer and Smith, 1968). This effect assumes that couples adjust their fertility considering the community level of child mortality independent of their own experience.

The experience of child mortality in the past which has now been incorporated into the social structure is called the societal experience. Societal effect would operate indirectly through social customs to ensure that the community's fertility level is brought into some sort of balance with the community level of child mortality. Such customs might govern age at marriage, sexual relations within marriage, use of fertility control etc., in a way totally independent of the individual couples' fertility intentions. We should however expect such fertility norms to change with changing community levels of child mortality only after a long time lag, perhaps, longer than one or two generations.

Both the 'physiological' effect and 'replacement' effect, if they operate, should be apparent in the reproductive histories of individual couples. Demonstration of the effect of community experience of child loss, however, would require relating the individual fertility behaviour to the community level of child mortality (or at least their perception of it). Finally, the societal effect would be revealed by a comparison of child mortality and fertility characterising societies as a whole rather than through comparison of the reproductive experience of individual couples.

The purpose of the present paper is to study the relationship between infant mortality on fertility based on individual data. Obviously, the analysis is limited to'physiological' and 'replacement' effects. It should however be mentioned that the relationship between these two variables is influenced by a number of additional factors acting on each of these two variables so it is difficult to isolate the direct influence of infant mortality on fertility in such a manner that interpretations of the analysis become unambiguous.

Necessary data for the present study are taken from the 'Demographic Survey of Varanasi (rural) 1969-70', conducted under the auspices of the Demographic Research Centre (sponsored by Population Council, New York), Banaras Hindu University, India. A brief description of the data is given in section 2.

The analysis is carried out in sections 3 and 4. The third section deals with the relationship between infant mortality and birth interval. The effect of infant death among the first three births upon the subsequent fertility of females is examined in section four. Conclusions are given at the end.

Data

Varanasi is one of the districts in Eastern Uttar Pradesh (U.P.), which is thickly populated with relatively low per capita income in the state. Varanasi district consists of four tehsils, namely, Varanasi, Chandauly, Chakia and Bhadohi. The rural population of Varanasi is similar in characteristics to the population of other neighbouring districts. Till recently no extensive demographic survey in Eastern U.P. was carried out to provide data which can be utilised in studying the characteristics of the population. Keeping in view the above facts and the resources available, the Demographic Survey of Varanasi Tehsil (rural) was conducted in 1969-70. There were 1245 villages with a total population equal to 0.73 millions in Varanasi Tehsil in 1961 census. About 2200 households, scattered in 52 villages, were selected in the survey following the two-stage stratified sampling procedure in which villages were the first-stage units and households were the second-stage units. A household was defined as a group of persons who usually stay together and take food from a common kitchen. Married daughters and their children were treated as visitors. The information on household structure, household facilities, fertility, migration, morbidity and mortality were obtained from each selected household in the sample. A couple was defined eligible if both the partners were alive on the reference date (October, 1969), and female was less than 50 years of age. The information relating to (a) the interval between marriage and first birth and between successive births, (b) the detailed birth record and (c) the attitude towards family planning were obtained from all eligible couples in the household. The birth intervals were recorded in completed years and months. Data on the above items were collected through personal interview method by contacting the male and female partners separately. A detailed account of the survey is given in Singh et al (1970).

It should be mentioned that for Varanasi (rural) population, mortality, specially infant mortality, has declined by a considerable amount during the last twenty years but still the rates are very high (for example, the infant mortality rate is about 160 for the period 1965-68) and are expected to decline further in future (Singh and Chakrabarty ; 1975). On the other hand, fertility rates remain constant at a high level at least for the last two decades. Since this population has experienced a declining mortality and constant fertility for the last two decades we may say that it is at the initial stage of demographic transition. Therefore, it is important to investigate the effect of infant mortality on the level of fertility for this population.

Infant Mortality and Birth Interval

The study of interval between successive births, according to the fate of the infant in a population where deliberate attempts to control fertility are absent is of considerable importance for our study. The difference between the average length of the interval following infant death, $B_{I.D.}$, and the average length of the interval following infant survival, $B_{I.S.}$, may be taken as a measure of the effect of infant mortality on birth interval.

Table I presents the values of these intervals for several populations in the absence of fertility control. The results are based on the studies of Gautier and Henry (1958) ; Henripin (1954) ; Knodel (1968) ; Adalkha

TABLE I – INTERVALS BETWEEN SUCCESSIVE BIRTHS ACCORDING TO THE FATE OF THE INFANT BORN AT THE BEGINNING OF THE INTERVAL : RESULTS FROM POPULATIONS USING NO FERTILITY CONTROL.

Village or group	Country	Approximate period of study	Mean interval (months)	
			After infant survival	After infant Death
Crulai	France	1674-1742	29.6	20.7
French Canadians	Canada	1700-1730	25.0	19.4
Mömmlingen	Germany	1840-1890	30.0	19.4
Ankara	Turkey	1930-1965	33.8	23.0
Patna	India	1920-1955	33.0	27.8

Sources : Crulai from Gautier and Henry (1958), French Canadians from Henripin (1954), Mömmlingen from Knodel (1968), Ankara from Adalkha (1973), Patna from Khan (1973)

(1973) ; and Khan (1973). In all cases the average interval between births following infant death is shorter than the average interval between births if the infant survives. This difference $B_{I.S.} - B_{I.D.}$ was however attributed to the effect of lactation on p.p.a. Above studies indicate that in situations where deliberate attempts to control fertility are absent and women typically breastfeed their children for extended periods, infant mortality has an effect on the interval between births through lactation, and the physiological effect of infant mortality on fertility is apparent. Apart from this physiological effect, Knodel (1968) has argued that infant mortality might shorten the duration of menstruating intervals and this may be termed as an effect of infant mortality on birth interval independent of lactation.

Only a few attempts have been made to examine the possible effect of infant mortality on birth interval independent of lactation. In three Bavarian villages, Knodel (1968) tested the effect of infant mortality on interval by investigating the effect of the first born on the interval between second and third birth. Although his results are not conclusive, Knodel points out that the interval between second and third birth is longest if the first two infants survive and shortest if the first two infants die. A similar type of analysis of Turkish data made by Adalkha (1973) has revealed that infant mortality has some effect on birth interval independent of lactation.

In the following analysis we use the available data to study (i) whether the relationship between infant mortality and birth interval observed in the case of other populations holds true for Varanasi (rural) and (ii) whether infant mortality has an effect on birth interval independent of lactation.

The 2591 eligible couples interviewed in Varanasi survey have provided us with 6024 complete birth intervals. Since the Varanasi survey is retrospective, some of the data problems listed below may affect the interpretation and findings of our results.

(i) Truncation effect : Since the survey is one point retrospective, longer birth intervals have relatively less chance of being included in the sample and hence birth intervals are under-estimated. Obviously the magnitude of truncation effect on birth interval increases with the birth order.

(ii) Pregnancy loss : Intervals utilised in this study relate to births and are not adjusted for foetal deaths. Potter et al (1965) report that on the average pregnancy wastages prolong the interval by two months. If infant deaths and foetal losses are positively associated, our analysis generates over-estimated birth intervals following deaths.

(iii) Memory bias : Since the study relates to the retrospective survey the earlier birth intervals of older couples may involve memory bias. Also there is the possibility of under-reporting of infant deaths, because of recall lapse.

The average intervals $B_{I.S.}$ and $B_{I.D.}$ associated with different birth orders are given in table II. The results are similar to those found for other populations : the average interval following an infant death, $B_{I.D.}$ is shorter than the average interval when the child survives age I, $B_{I.S.}$. The value of $B_{I.S.} - B_{I.D.}$ for all births comes out to be about 7 months.

Potter et al.(1965), Van Ginniken (1974), on the basis of data from less developed countries where the practice of prolonged breast-feeding is common, report that on the average lactation prolongs p.p.a. by 6 to 9 months. Since prolonged breast-feeding among Varanasi women is universal, the difference of about seven months between $B_{I.S.}$ and $B_{I.D.}$ may be presumed to be the result of physiological effect of infant mortality on fertility.

TABLE II – AVERAGE BIRTH INTERVAL (IN MONTHS) FOLLOWING INFANT SURVIVAL OR DEATH, BY BIRTH ORDER.

Birth Order	Outcome of the Birth					
	Infant Survived			Infant Died		
	Number of Intervals	Average Interval ($B_{I.S.}$)	S.e.* of $B_{I.S}$	Number of Intervals	Average Intervals ($B_{I.D}$)	S.e. of $B_{I.D.}$
1	1 161	36.7	0.5	391	29.5	0.8
2	981	34.9	0.5	275	27.4	0.9
3	771	33.6	0.5	238	27.5	0.9
4	614	33.1	0.5	165	26.2	1.0
5	441	33.8	0.6	127	26.0	0.9
6	319	33.6	0.8	74	26.8	1.4
7	191	32.6	0.7	40	23.7	1.7
8	97	34.3	1.5	33	26.2	2.5
9+	81	32.0	1.8	25	29.2	3.7
All Births	4 656	34.5	0.2	1 368	27.6	0.4

* S.e. = Standard error

TABLE III – AVERAGE INTERVAL (IN MONTHS) BETWEEN SECOND AND THIRD BIRTH, BY NUMBER OF SURVIVING CHILDREN AT TIME OF SECOND BIRTH.

Number of Surviving Children at time of Second Birth (i)	Outcome of second Birth					
	Infant Survived			Infant Died		
	Number of Intervals	Average Interval (N^i_{2-3})	S.e. of N^i_{2-3}	Number of Intervals	Average Interval (L^i_{2-3})	S.e. of L^i_{2-3})
0	260	34.8	0.8	113	26.3	1.3
1	721	34.4	0.6	162	28.2	1.1

TABLE IV – AVERAGE INTERVAL (IN MONTHS) BETWEEN THIRD AND FOURTH BIRTH, BY NUMBER OF SURVIVING CHILDREN AT TIME OF THIRD BIRTH

Number of Surviving Children at the time of Third Birth (i)	Outcome of Third Birth					
	Infant Survived			Infant Died		
	Number of Intervals	Average Interval (N^i_{3-4})	S.e. of N^i_{3-4}	Number of Intervals	Average Interval (L^i_{3-4})	S.e. of L^i_{3-4}
0	76	34.1	1.4	49	24.4	1.4
1	300	35.3	0.9	97	26.4	1.5
2	401	33.0	0.7	92	28.9	1.7
1 or 2	701	34.0	0.6	189	27.6	1.1

TABLE V – AVERAGE INTERVAL (IN MONTHS) BETWEEN FOURTH AND FIFTH BIRTH, BY NUMBER OF SURVIVING CHILDREN AT TIME OF FOURTH BIRTH

Number of Surviving Children at the time of Fourth Birth (i)	Outcome of the Fourth Birth					
	Infant Survived			Infant Died		
	Number of Intervals	Average Interval (N^i_{4-5})	S.e. of N^i_{4-5}	Number of Intervals	Average Interval (L^i_{4-5})	S.e. of L^i_{4-5}
0	32	31.7	2.2	24	24.0	1.8
1	118	33.0	1.1	31	27.1	2.2
2	224	32.8	0.9	70	26.1	1.7
3	240	33.6	0.9	40	26.8	1.8
1,2 or 3	582	33.1	0.8	141	26.7	1.1

Additional evidence is thus required before a relationship between infant mortality and birth interval, independent of lactation, can be conclusively established. One approach for testing this hypothesis is to investigate the possible effect of the surviving children on the succeeding interval for various birth orders.

Let L^i_{k-k+1} = the average interval between the kth and $(k+1)^{th}$ birth, where the kth birth results into infant death and number of surviving children at the time of kth birth is i, (i = 0, 1, 2, . . ., k) for $k = 2, 3, \ldots$

and

N^i_{k-k+1} = the average interval between k^{th} and $(k+1)^{th}$ birth, where the kth child survives up to age 1 and number of surviving children at the time of kth birth is i ($i = 0, 1, 2, \ldots, k$) for $k = 2, 3, \ldots$

A comparision of L^i_{k-k+1}'s or N^i_{k-k+1}'s may indicate some effect of intant mortality on k^{th} birth interval independent of lactation. Thus, for example, the difference $L^1_{2-3} - L^0_{2-3}$ and $N^1_{2-3} - N^0_{2-3}$ may be regarded as an effect of infant mortality on second birth interval independent of lactation and differences $L^1_{2-3} - N^1_{2-3}$ and $L^0_{2-3} - N^0_{2-3}$ will be attributed to the effect of infant mortality on the second birth interval through lactation.

The numerical values of N^i_{k-k+1}'s and L^i_{k-k+1}'s for $k = 2,3$ and 4 are given in table IV. Although these results do not support the existence of an effect of infant mortality on birth interval independent of lactation positively, it is of interest to note that for $k = 2, 3$ and 4, the value of L^i_{k-k+1} is minimum when $i = 0$, i.e., the average birth interval following an infant death is minimum for all birth orders if there is no surviving child in the family.

In this connection, it should be mentioned that an alternative procedure to examine the effect of infant mortality on birth interval independent of lactation is to apply analysis of variance technique with unequal number of observations per cell, to the data on birth intervals. The calculations for Varanasi data are not yet available.

Infant Mortality and Subsequent Fertility

Couples who lose infants are expected to try to make up the loss by having more births. This replacement hypothesis is relevant only in context of deliberate efforts to control fertility ; otherwise couples would continue to bear children until one of the spouses becomes permanently sterile, or dies. Any evidence of the 'replacement' effect operating in Varanasi population would therefore suggest the existence of some indirect control of fertility. A method to examine the replacement effect is to analyse the couple's subsequent fertility behaviour according to the survival of earlier children. For this let C_i ($i = 0, 1, 2, 3$) denote the number of females with at least three births who have experienced i infant deaths among the first three births and B_i ($i = 0, 1, 2, 3$) denote the average number of subsequent births after the third for these C_i females. Now if we assume that the event of infant death at any parity is independent of previous infant deaths to the couple, then differences in B_0, B_1, B_2 and B_3 may be attributed to replacement effect. But if there is some dependence, it is difficult to arrive at a definite conclusion. A crude verification of the hypothesis of independence of infant death at each birth order may be obtained as follows : If P_i is the probability of the infant death at the ith parity, then under the hypothesis C_0, C_1, C_2 and C_3 should be proportional to $(1-P_1)(1-P_2)(1-P_3)$; $(1-P_1)(1-P_2)P_3 + (1-P_1)(P_2)(1-P_3) + (P_1)(1-P_2)(1-P_3)$; $P_1P_2(1-P_3) + P_1(1-P_2)P_3 + (1-P_1)P_2P_3$; and $P_1P_2P_3$ respectively.

For the present data the values of B_i's and C_i's are given in table VI. Also the estimates of P_1, P_2 and P_3 are 0.24, 0.20 and 0.22 respectively. Thus the expected frequencies corresponding to C_0, C_1, C_2 and C_3 are 593, 503, 141 and 13 respectively. The calculated value of χ^2 comes out to be 82.0, which is highly significant. This shows that there is some interdependence between infant deaths at different birth orders. Also the values of I_i, (see table VI), the average number of infant deaths after the third birth for C_i females, $i = 0$, 1, 2 and 3 strengthen the hypothesis of interdependence of infant deaths. Thus even though $B_0 < B_1 < B_2 < B_3$, it is difficult to say anything about the replacement effect because females having a greater number of infant deaths among first three births have experienced more infant deaths later on and consequently they have a greater number of subsequent births.

TABLE VI – AVERAGE NUMBER OF SUBSEQUENT BIRTHS AND INFANT DEATHS AFTER THIRD BIRTH FOR WOMEN WITH AT LEAST THREE BIRTHS BY EXPERIENCE OF INFANT DEATHS AMONG FIRST THREE BIRTHS.

Number of Infant Deaths among First Three Births (i)	Number of Females (C_i)	Average Number of Births after 3rd Birth (B_i)	Average Number of infant deaths after 3rd Birth (I_i)	S.e. of B_i	S.e. of I_i
0	636	2.44	0.39	0.08	0.03
1	405	2.69	0.49	0.11	0.04
2	169	2.79	0.58	0.12	0.08
3	40	4.20	1.20	0.40	0.19

Conclusion

For Varanasi data it is seen that individual experience of child loss has some effect on fertility attributed to physiological effect. The analysis of birth intervals has revealed that infant mortality affects the length of the birth interval through lactation. No significant effect of infant mortality on birth interval independent of lactation is established. The analysis of couples' subsequent reproductive behaviour after third birth does not show any substantial effect of infant mortality on fertility. The infant deaths at different parities are found to be influenced by the experience of previous infant deaths and consequently the small differences observed in B_0, B_1, B_2 and B_3 may not be due to replacement effect. Thus the principal mechanism on which decline in fertility as a result of decline in child mortality depends, is inter-relationship between lactation, p.p.a. and birth interval.

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INFLUENCE OF INFANT MORTALITY ON FERTILITY IN AFRICAN COUNTRIES

B.R. KOHLI
National Institute of Family Planning
New Delhi, India

The demographers and the programme administrators in the field of population control are mostly interested in identifying the fertility. There is a general belief that most demographic and socio-economic factors may be associated with fertility of a country. In this context, an effort has been made to study the influence of infant mortality rate, along with other variables such as per capita gross national product and newspaper circulation individually or in combination on fertility. Here fertility is measured in terms of birth rate of a country.

Multivariate linear regression technique [1] has been applied to study such relationships. Here the regression analysis is considered appropriate since the magnitude of one variable is to be predicted from the knowledge of more than one variable. This technique is applied to achieve the following objectives :

(i) to determine the extent to which the set of independent variables is capable of predicting a given dependent variable.

(ii) to determine the absolute and relative degree of association between each of the independent variables and the dependent variable.

Multiple regression is used for purposes of prediction, estimation and smoothing of the data. Multiple correlation coefficient provides a measure of the significance of the regression. The coefficient of multiple determination is defined as the ratio of the variation explained by the knowledge of the independent variables to the total variation present in the dependent variable and symbolically it is denoted by R^2 and its positive square root is called the coefficient of multiple correlation. The data for 20 African countries have been used for this study. All countries are given equal weight in the present study.

TABLE 1 – VALUES FOR EACH VARIABLE IN AFRICAN COUNTRIES

Country	Values of variables			
	x_4	x_1	x_2	x_3
1. Morocco	46	149	190	17
2. Dahomey	54	110	80	1
3. Ghana	47	156	200	37
4. Ivory Coast	50	138	230	3
5. Liberia	44	188	190	4
6. Mali	50	120	80	0.5
7. Niger	52	200	70	0.4
8. Sierra Leone	44	136	140	10
9. Togoland	50	127	100	6
10. Madagascar	46	102	100	13
11. Mauritius	31	70	220	122
12. Reunion	37	59	560	61
13. Southern Rhodesia	48	122	230	15
14. Tanzania	47	163	80	3
15. Uganda	43	160	100	8
16. Zambia	51	259	180	8
17. Cameroon, West	50	137	130	4
18. Central African Republic	48	190	120	0.3
19. Chad	45	160	70	0.4
20. Congo (Brazzaville)	41	180	190	1.3

x_4 = Birth rate per 1,000 population
x_1 = Infant mortality rate per 1,000 births
x_2 = Per capita gross national product
x_3 = Newspaper circulation per 1,000 population

Source : 1. 1969 World population data Sheet-Population Reference Bureau, 1755 Massachusetts Avenue, N.W., Washington, D.C. 20036.
2. United Nations Statistical Year Book, 1967 ; New York, 1968

The infant mortality rate is an important demographic variable, which may have some effect on fertility. This variable has been taken as an independent variable (predictor) and the other important socio-economic variables, associated with fertility in the developing countries may be per capita gross national product, and newspaper circulation. Normally, many independent variables are taken into account, while fitting a regression model. But due to the paucity of data and computer facilities, only these three independent variables have been taken into account for this study and their values are presented in table 1. To simplify the notations, the variables are designated as follows :

Dependent Variable (Criterion)

Birth rate per 1 000 population = x_4

Independent Variables (Predictors)

1. Infant mortality rate per 1 000 births = x_1
2. Per capita gross national product = x_2
3. Newspaper circulation per 1 000 population = x_3

David M. Heer [2] used two regression models with births per 1 000 males aged 15 to 54 years, net national product per capita aged 15-64 years, newspaper circulation per 1 000 aged 15 and over, infant deaths per 1 000 births, persons per square kilometer and percentage increase in per capita energy consumption, 1937-1953. He used data for 41 countries of the world and studied the various interrelationships of these variables for predicting the general fertility for males for different countries. The two models used by him were of the form :

(i) $y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 \ldots\ldots\ldots\ldots$

(ii) $y = b_0 b_1^{x_1} b_2^{x_2} b_3^{x_3} b_4^{x_4} b_5^{x_5} \ldots\ldots\ldots\ldots$

where y is the dependent variable and x's are independent variables. The first is called the additive model and the second is called the multiplicative model. But in the present study only the additive model is used.

By fitting the additive model to the data by Least Square Method, we get

$$x_4 = 49.95951 - 0.00292x_1 - 0.00769x_2 - 0.13241x_3$$

where x's are the actual values of the variables and are not measured from their respective means. The constants attached with the variables in the above equation are called the regression coefficients. They indicate the association with birth rate for a change in the accompanying independent variable, when allowance has been made for the other independent variables.

Thus $b_1 = (-)\ 0.00292$ is an estimate of the variation in birth rate associated with a variation in infant mortality rate independent of the variation in the other two independent variables i.e. per capita gross national product and newspaper circulation. The other regression coefficients can be interpreted in a similar way. The first term in the left hand side of the equation is the hypothetical value of the birth rate, when the

TABLE 2 – ACTUAL (OBSERVED) AND ESTIMATED (EXPECTED) VALUES OF BIRTH RATE IN AFRICAN COUNTRIES

Country	Observed (B.R.) (O)	Expected (B.R.) (E)	O-E
1. Morocco	46	45.8	0.2
2. Dahomey	54	48.9	5.1
3. Ghana	47	43.1	3.9
4. Ivory Coast	50	47.4	2.6
5. Liberia	44	47.4	3.4
6. Mali	50	48.9	1.1
7. Niger	52	48.8	3.2
8. Sierra Leone	44	47.2	3.2
9. Togoland	50	48.0	2.0
10. Madagascar	46	47.2	1.2
11. Mauritius	31	31.9	0.9
12. Reunion	37	37.4	0.4
13. Southern Rhodesia	48	45.8	2.2
14. Tanzania	47	48.5	1.5
15. Uganda	43	47.7	4.7
16. Zambia	51	46.8	4.2
17. Cameroon West	50	48.0	2.0
18. Central African Republic	48	48.4	0.4
19. Chad	45	48.9	3.9
20. Congo (Brazzaville)	41	47.8	6.8

other variables have a value of zero. The estimate of birth rate for any country is the sum of the net amounts associated with each independent variable plus the value (49.95951). These estimated values of birth rates along with their original values and their differences are set out in table 2.

By applying X^2 test (1), the fitted model was tested for goodness of fit and it was found to be a good fit. The calculated value of X^2 was 4.2.

The zero order, first-order and second-order coefficients of correlation involving x_4 i.e. birth rate as the dependent variable are presented in tables 3, 4 and 5 respectively.

The t.test(2) shows that the zero-order correlation coefficients (r_{42} and r_{43}) are statistically significant. The negative sign with them indicates that birth rate decreases as either per capita gross national product or newspaper circulation increases. The percentages of variation explained individually by x_3, x_2 and x_1 in x_4 are 62, 28 and 19 respectively in order. This indicates that the independent variable x_3 i.e. newspaper circulation is more associated with birth rate than the other two independent variables.

Partial correlation coefficients, such as $r_{42.1}$ and $r_{41.2}$ etc., are referred to as first-order coefficients since one variable has been held constant. Thus the subscript after the decimal point indicates that variable which has been held constant. Thus $r_{42.1}$ measures the relationship between birth rate and per capita gross national product when infant mortality rate has been kept constant.

The simple correlation coefficient r_{41} between birth rate and infant mortality rate was 0.4399. Removing the effect of variation in either per capita gross national product or newspaper circulation has decreased the relationship, since $r_{41.2}$ = 0.2972 and $r_{41.3}$ = (–) 0.0037. Similarly, the simple correlation coefficient (r_{42}) between birth rate and per capita gross national product was (–) 0.5268. Removing the effect of variation in either infant mortality rate or newspaper circulation has also decreased the relationship.

Partial coefficients, such as $r_{42.13}$ which is a measure of the correlation between the variables x_4 and x_2 with x_1 and x_3 held constant is referred to as the second-order coefficient. Since $r^2 43.12$ is 0.4458, it means that the use of the independent variable x_3, i.e. newspaper circulation, explains about 45 per cent of the variation in birth rate which x_1 and x_2 had failed to explain. Similarly $r^2 42.13$ = 0.0453 tells us that 4 per cent of the variation, which x_1 and x_3 had failed to explain, is accounted for by the use of the independent variable x_2, i.e. per capita gross national product. A similar interpretation holds good for $r^2 41.23$.

TABLE 3 – ZERO ORDER CORRELATION COEFFICIENTS

Variable	x_1	x_2	x_3
x_4	0.4399	(–) 0.5268	(–) 0.7858
x_1		(–) 0.3942	(–) 0.5622
x_2			0.5300

TABLE 4 – RESULTS OF FIRST-ORDER PARTIAL CORRELATION COEFFICIENTS WITH BIRTH RATE AS THE DEPENDENT VARIABLE

Variable	Partial correlation coefficient	t	Significant
with x_1 as constant			
x_2	(–) 0.4282	1.9536	Non-significant
x_3	(–) 0.7252	4.3428	**
with x_2 as constant			
x_1	0.2972	1.2834	Non-significant
x_3	(–) 0.7028	4.0732	**
with x_3 as constant			
x_1	(–) 0.0037	0.01526	Non-significant
x_2	(–) 0.2103	0.8869	Non-significant

** Significant at 1 % level of significance.

(1) $X^2 = \Sigma \frac{(0-E)^2}{E}$, where 0 and E are the observed and expected frequency respectively.

(2) $t(n-2)\ d.f = \frac{r}{\sqrt{1-r^2}} \sqrt{n-2}$ where r is the zero-order correlation coefficient and n is sample size.

TABLE 5 – RESULTS OF SECOND-ORDER PARTIAL CORRELATION COEFFICIENTS WITH BIRTH RATE AS THE DEPENDENT VARIABLE

Constant Variable	Partial correlation coefficient	t	Significance
$x_1 \epsilon x_2$	(–) 0.6677	3.5878	**
$x_1 \epsilon x_3$	(–) 0.2128	0.8711	Non-significant
$x_2 \epsilon x_3$	(–) 0.0337	0.1349	Non-significant

** Significant at 1 % level of significance.

Since the coefficient of multiple determination, i.e. $R^2 4.12$ is 0.3414, we have explained 34 per cent of the variation present in birth rate by introducing x_1 and x_2 in our model. $R^2 4.12$ is greater than either $r^2 41$ or $r^2 42$, the values of which were found to be 0.1935 and 0.2775 respectively. It is also observed (a) that $R^2 4.13$ exceeds $r^2 41$, but it is equal to $r^2 43$ or (b) at $R^2 4.23$ is larger than either $r^2 42$ or $r^2 43$. The value of $R^2 4.123$ is 0.6342. It is, therefore, concluded that by use of the three independent variables, we have explained 63 per cent of the variation in the dependent variable. The values of multiple correlation coefficients can be seen from table 6.

TABLE 6 – RESULTS OF MULTIPLE CORRELATION COEFFICIENTS WITH BIRTH RATE AS THE DEPENDENT VARIABLE

Variable	Multiple correlation coefficient	F	Significance
$x_1 \epsilon x_2$	0.5843	4.4062	*
$x_1 \epsilon x_3$	0.7858	13.7212	**
$x_2 \epsilon x_3$	0.7964	14.7424	**
$x_1, x_2 \epsilon x_3$	0.7967	9.2665	**

* Significant at 5 % level of significance.
** Significant at 1 % level of significance.

TABLE 7 – RESULTS OF THE STANDARD ERRORS OF THE ESTIMATE OF BIRTH RATE

Using the following Variable in the model	Value of the standard error
x_1 only	4.70 ($s_{4.1}$)
x_2 only	4.45 ($s_{4.2}$)
x_3 only	3.23 ($s_{4.3}$)
$x_1 \epsilon x_2$ only	4.24 ($s_{4.12}$)
$x_1 \epsilon x_3$ only	3.23 ($s_{4.13}$)
$x_2 \epsilon x_3$ only	3.14 ($s_{4.23}$)
$x_1, x_2 \epsilon x_3$ only	3.12 ($s_{4.123}$)

TABLE 8 – ANALYSIS OF VARIANCE

Source of variation	Degree of freedom	Sum of square	Means sum of square	F	Remark
Due to regression	3	347.30784	115.76928	9.2665	**
Due to deviation from regression (R.S.S.)	16	199.89216	12.49326		
Total	19	547.20000			

** Significant at 1 % level of significance.

The significance of multiple correlation coefficient was tested by applying F test (3) and it was found that all the coefficients are highly significant except $R_{4.12}$ which is significant only at 5% level of significance. The standard error of the estimate is the lowest if all the three independent variables are taken into account in our model. The standard errors of the estimates with different combinations of independent variables used in our model are shown in table 7. It is concluded that the estimates of birth rates made by the use of all the independent variables in our model will be more satisfactory than those made by using any two independent variables, although the utilization of x_1 in the model does not help much in explaining the variation present in the birth rate. Analysis of variance technique was also applied in testing the significance of the sum of square due to regression and it was found to be highly significant. The results are set out in table 8.

Abstract

Regression model [3] is very useful in finding out the inter-relationship among various variables and for predicting purposes. The association of fertility with infant mortality rate, per capita gross national product and newspaper circulation, individually or in combination, was studied by fitting an additive regression model to the data of 20 African countries. It is observed that newspaper circulation had the highest association with fertility. As the per capita gross national product or newspaper circulation increases, the birth rate decreases. 63 per cent of the variation present in birth rate had been explained by these three variables, although an addition of x_1, i.e. infant mortality rate in our model, does not help much in explaining the variation present in the birth rate. The standard error of the estimate is the lowest, if we use all the three independent variables in our model. Therefore, the estimates of birth rates made by the use of all the three independent variables will be more satisfactory than those made by using any two independent variables.

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(3) $F = R^2(n-p-1)/(1-R^2)p$ with $(p, n-p-1)df.$ where R is the multiple correlation coefficient, p is the number of independent variables used and n is the sample size.

EFFECT OF INFANT AND CHILD MORTALITY ON SUBSEQUENT FERTILITY IN INDONESIA

N. ISKANDAR and Gavin JONES
Lembaga Demografi FE. UI,
Jakarta, Indonesia

1. Introduction

With the sharp declines in mortality that have occurred very widely throughout the developing countries since World War II, one of the props has been knocked from under the edifice of beliefs and attitudes supporting high fertility in these countries. This is the belief that it is necessary to have a large number of children to ensure that some of them will reach maturity. This belief was until recently well grounded in fact, and still is in those countries where mortality is still relatively high. Heer and Smith (1967) have demonstrated through a computer simulation model that, given the assumption that couples want to be 95 per cent certain that they will have one son still alive when the father reaches his 65th birthday, at Indonesian levels of mortality ($e_0^0 = 47.5$ years) the average couple would need to give birth to more than 5 children (1). At levels of mortality prevailing in Indonesia only 3 decades ago ($e_0^0 = 40$ years) they would need to bear more than 6.5 children.

The Javanese peasant farmer has never studied such computer-based probabilities. He simply knows that many babies die in infancy and early childhood, and that this has always been so. The extent to which he is aware that it is less so now than it was in the 1950's is difficult to determine. Surveys in at least one other country which has experienced sharp declines in mortality indicate that there is a general awareness that mortality has decreased (2). Unfortunately, in the Indonesian fertility-mortality survey of 1973, on which the present paper is based, it was not possible to delve into people's awareness of mortality trends and their implication for their own lives.

High infant and child mortality in a community can be expected to affect the desired number of births not only of those who experience the loss of a child but also of those who do not. Indeed, we can hypothesize that the average parent living in a still-high risk mortality situation is likely to give more weight to the extreme example of infant mortality than to the average experience of his community. For example, the successive deaths of all three of his neighbour's boy-babies, leaving only 2 girls living, is likely to etch itself indelibly on his memory, despite the fact that most of his community were losing only one baby in six (3) and have been losing even fewer during the past few years.

There have been a few sophisticated studies showing the impact of prior child loss on an individual's subsequent fertility. Heer has summarized their findings :

"A study by Knodel concerning 19th century rural Bavaria indicated that there was no compensation in subsequent fertility on the part of women (Knodel, 1968). On the other hand, two studies dealing with the recent situation in Taiwan and in northern India respectively have each revealed that compensation took place but that this compensation was incomplete (Wyon and Gordon, 1971 and Rutstein, 1970)".

A recent study by Heer and Wu (1973) also shows (incomplete) compensation taking place in Taiwan, as does an earlier study by Hassan (1966) for Egyptian mothers and one by Schultz (1970) for Bangladesh.

Even though there are no data in the Indonesian Fertility-Mortality Survey (4) to test parents' awareness of community mortality trends and their implications, there are some data wich enable us to test the relationship between their own experience of infant and child mortality and its effect on realized subsequent birth spacing, as well as on their desire for more children. These data will be presented in this paper. First, however, let us show the general relationship between parity and infant and child mortality in our survey.

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(1) Our estimate based on data in Table 1 of Heer and Smith (1967).

(2) Rutstein, 1970.

(3) This is roughly the rate of loss applying in Java during the 1960's.

(4) The Indonesian Fertility-Mortality Survey (1973) is a very large one-round sample survey, covering the topics of marriage and marriage dissolution, fertility, mortality and knowledge, attitudes and practice of contraception (KAP) in Java, Sumatra, Sulawesi and Bali. A sample totalling 54,214 households was drawn from the population of these islands by random cluster sampling, using a stratification for urban and rural areas. For details, see Demographic Institute, Faculty of Economics, University of Indonesia, *Indonesian Fertility Mortality Survey 1973. Preliminary Report :* West Java (March 1974), Central Java (August 1974), East Java (October 1974), Bali (November 1974), Sulawesi (December 1974) and Sumatra (January 1975).

2. Parity and proportion of children dead

Table 1 shows the percentage of children dead according to the woman's total number of live births. Indonesia still has relatively high fertility levels : the average rural woman (aged below 45) with parity 5 or 6 has lost one child ; with parity 8 or 9 she has lost two children (5). In all regions, the *proportion* dead rises steadily as the number of children ever born increases. Two (not mutually exclusive) explanations could be put on these data :

(1) higher-parity women are generally older women and on average, the interval since birth of their children is longer than that of lower-parity women. This implies both that the average child of high-parity mothers has had a longer interval at risk of death than the average child of low-parity mothers, and that if there has been a secular decline in infant and child mortality (as there has been in Indonesia) a higher proportion of the children of high-parity women were born at a time when higher mortality levels were prevailing. Both of these factors would help explain the higher proportion of children dead among higher-parity mothers.

(2) Women who experience one or more infant or child deaths end up with more births than women who do not, because they compensate for the deaths by having more children.

We would like to know the relative importance of factors (1) and (2) in explaining the pattern observed in Table 1. Unfortunately, to do this we would need the table broken down by age of mother or interval since marriage to give some control for the "length of time since childbearing commenced" effect. We do not have such a table, although a table of this kind for Jordan shows that the proportion of children dead rises with parity *within each age group of mothers.* (Schultz and de Vanzo 1970, Table 7) (6). Although this finding gives added support to the hypothesis that child deaths are being compensated for, it is still not conclusive because even within age groups of mothers higher-parity women are likely to have started their childbearing earlier, and parity may also be related to social or economic factors which have an influence on mortality and are not controlled for.

TABLE 1 – PERCENTAGE OF CHILDREN DEAD BY NUMBER OF CHILDREN EVER BORN, INDONESIA, 1973

Number of children ever born	Region										
	Bali	West Java		Central Java		East Java		Sumatra		Sulawesi	
		Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
1	8.9	9.0	10.0	8.7	8.1	7.2	10.4	6.6	8.6	5.7	10.9
2	10.0	10.1	14.2	10.5	10.1	11.6	11.3	8.1	13.6	11.3	12.0
3	14.1	11.5	14.6	13.3	11.7	9.9	12.4	8.4	14.5	13.0	17.1
4	15.0	12.9	17.7	11.6	14.9	10.6	12.7	11.9	15.7	12.8	17.3
5	17.6	18.2	19.6	15.2	15.0	12.7	15.6	12.4	17.3	16.6	19.9
6	20.4	14.1	21.9	13.2	19.2	12.7	18.0	12.6	20.1	16.7	22.7
7	20.1	21.3	25.9	15.6	23.1	16.1	19.8	13.9	21.0	17.5	22.7
8	22.3	20.2	27.6	15.9	22.9	17.8	19.8	13.7	22.4	21.0	25.0
9	24.3	23.8	32.2	19.7	29.7	22.8	27.7	16.3	26.4	21.6	25.0
10(*)	23.4	21.6	39.5	21.1	35.8	26.4	32.7	21.5	31.9	26.2	31.5

(*) Calculated on the assumption that all women with 10 + births had only 10 births.

3. Effect of infant and child mortality on subsequent birth intervals

Fortunately, we hope to be able to dig deeper into the data from the Indonesian fertility-mortality survey. The detailed pregnancy histories collected in the survey gave details not only of the date of all births but also of the subsequent deaths to these babies. We have prepared tabulations presenting the data for all women aged 15-39 who had a second child and similarly for all women aged 15-39 who had a third child, in a way that shows the effect of infant and child mortality on the subsequent spacing of children (7).

(5) Moreover, mortality levels are usually under-stated in surveys of this kind.

(6) Doubt is thrown on the quality of the data on which this table is based by the fact that women aged 15-19 are represented at each parity up to 11 + (except at parity 9), a surely impossible finding.

(7) The data were tabulated only for women who had their second or third birth at least four years before the date of the survey, so that it would be possible to discover their fertility performance during the subsequent four years.

Women of parity 2 are divided into four groups : (1) those who experienced no infant or child deaths before two years after the birth of their second child (naturally, the largest group) ; (2) those whose first baby died before the birth of their second child but whose second child was still alive after two years ; (3) those whose first baby was still living at the time of their second birth, but one of whose babies died within the next two years ; (4) those who lost their first baby *and also* a second within two years of the birth of their second child.

The results are certainly in the direction expected. For example, in all regions, among women who had experienced no child deaths, 23 to 29 per cent had not had their third child within three years of their second, whereas for women who experienced a child death after their second birth, only 1 1/2 to 4 1/2 per cent had not had their third child within 3 years.

The consistency of these figures across regions is striking. But perhaps it is too striking. Because of an oversight, the computer program used to extract the tables did not specify that the death which occurred within two years after the birth of the second child must be the death of only the first or second child. Therefore the possibility arises that some of the deaths were deaths to *third* children who were born within two years of the birth of the second child. If this is so, it introduces a serious bias into the results, because all those women whose *3rd* baby died within two years of the birth of the second are of course by definition women who had another birth within two years of their second birth. Since the numbers of women who had a child death within two years of their second birth are relatively small (9 to 15 per cent of all women having a second birth in urban areas, 11 to 19 per cent in rural areas) it would not take very many cases where the death analyzed was the death of a 3rd child to significantly affect the results.

Because of this weakness in our data, we do not present the detailed results in this paper, but hope to be able to do so once the computer program has been adjusted to yield more reliable results. If, as we expect, we still find a tendency for the experience of infant mortality to lead to a shortening of the spacing of the subsequent birth, two key questions will remain : (1) is this closer spacing deliberate or involuntary ? (2) is there only partial compensation, exact compensation or overcompensation for infant deaths ? Partial compensation would lead to a slower rate of population growth than would have occurred in the absence of the infant deaths, whereas overcompensation would lead to a more rapid rate of population growth.

We can venture a number of hypotheses on the reasons for the closer spacing, none of which are mutually exclusive. One hypothesis is that women of low parity (2 or 3) who experience an infant or child death badly want to compensate for the loss of this infant as quickly as possible by producing another baby. This hypothesis seems reasonable in view of the fact that in the great majority of cases loss of a child by a parity 2 or 3 woman would leave her with fewer than her desired number of living children and also with an acute awareness of the capriciousness of fate in the matter of child survival.

A second hypothesis is that the great majority of infant or child deaths experienced by a parity 2 woman within two years of her second birth will in fact be the death in infancy of that second child. Given the long periods of breastfeeding typical in Indonesia (8), and the common practice of abstinence during this period, death of the infant will tend to lead to quicker subsequent pregnancy by exposing the woman more rapidly to the risk of pregnancy through termination of post-partum amenorrhea and resumption of intercourse. This more rapid exposure to the risk of pregnancy would result automatically from an adherence to conventional sexual mores, but resumption of intercourse might be further hastened by the desire for an early pregnancy.

A third hypothesis is that in some cases, a woman falls pregnant while she is still breastfeeding her second child. The pregnancy causes her to stop breastfeeding the child earlier than she would otherwise have done, resulting in poorer nutrition and a greater probability that the child will die within two years of its birth.

Effect of infant and child mortality on desire for more children

The first hypothesis above, namely that women want to compensate for infant deaths, can be further tested with data collected in the survey on desire for more children according to parity and number of children dead. Using these data, we have prepared a set of tables showing the percentage of women wanting and not wanting more children according to parity and number of children dead. These tables are reproduced, for ease of analysis, in Figure 1. They cover only rural areas, because the urban samples were too small to yield large enough numbers of women with more than one child death. However, a summary table for urban areas comparing women with one or more children dead with women with no children dead is presented in Table 2. There is on the whole evidence of a compensation effect operating. Women with one or more children dead are more likely to want additional children than are women who have had no children die, when we control for parity. The data for women of parity 3 and above are likely to be more meaningful than data for women of parity 1 and 2, because most women of parity 1 or 2 have not yet reached their ideal family size, even if they have experienced no infant deaths. The fall in desire for more children among women of parity 2 who had lost both children, evident in rural East Java, Central Java and Sumatra, is perhaps partly

(8) There are no reliable data for Indonesia as a whole. But in some regions, average period of breastfeeding is very long. In Jogjakarta, studies in one area show a mean length of breastfeeding of 25.6 months and in another area, of 13 months. (Singarimbun and Manning, 1974, Table 29, p. 69).

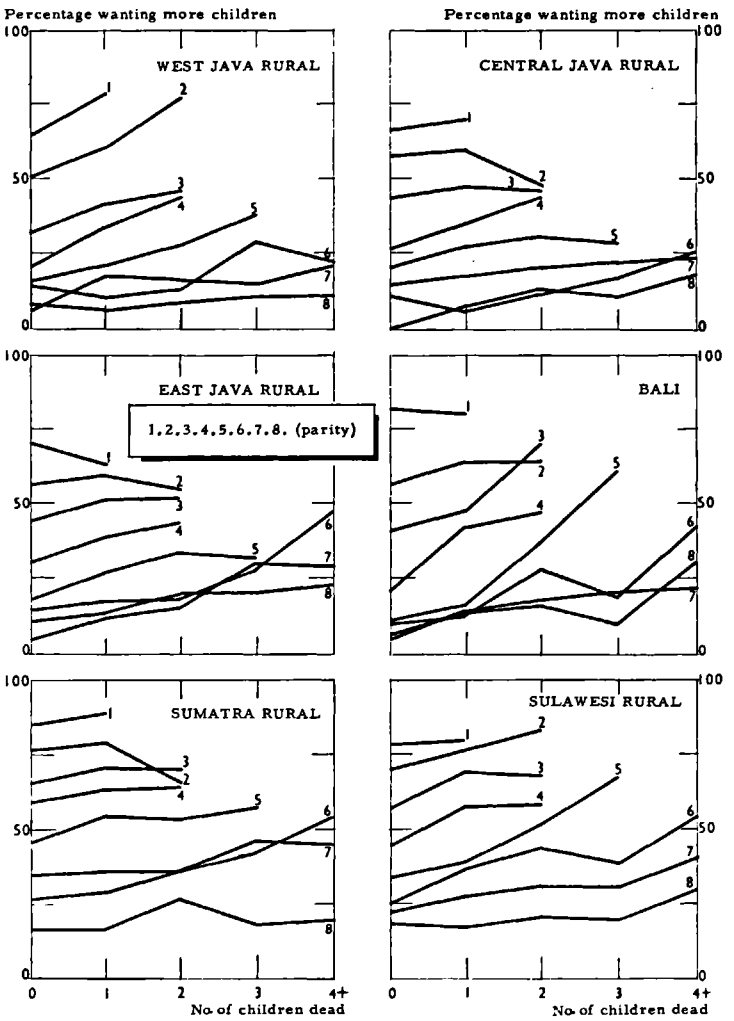

Figure 1 – Percentage of women who want more children, by parity and number of children dead, Indonesia 1973.

TABLE 2 – PERCENTAGE WANTING MORE CHILDREN ACCORDING TO PARITY AND NUMBER OF CHILDREN DEAD, URBAN AREAS

Number of Children dead	Percentage wanting More children :					
	Parity 1	Parity 2	Parity 3	Parity 4	Parity 5	Parity 6
WEST JAVA URBAN						
0	69.2	59.5	41.8	30.1	11.5	10.1
1+	71.4	62.7	54.5	46.8	18.5	25.4
CENTRAL JAVA URBAN						
0	66.1	57.7	40.5	29.9	12.0	20.0
1+	77.8(*)	55.0	53.7	26.0	21.4	27.3
EAST JAVA URBAN						
0	60.7	49.3	34.0	29.2	11.7	4.3
1+	59.3	42.5	41.5	29.6	18.1	14.1
SUMATRA URBAN						
0	84.1	70.1	70.6	42.3	30.2	20.6
1+	76.5(*)	80.9	71.9	64.4	37.2	31.9
SULAWESI URBAN						
0	78.8	69.1	55.7	39.5	22.7	22.2
1+	80.0 (*)	75.4	61.2	50.0	38.1	34.5

(*) Based on fewer than 20 women.

due to sampling variability, since very small numbers of women are involved (between 20 and 30 for each region) (9). Another factor may be that women who have lost both of their children are a very atypical group, perhaps subject to some special circumstances which influence their desire for more children. (Discouragement because of their unhappy experience may be the key factor).

The data on women of parities 3, 4 and 5 are perhaps the most reliable indicators of the compensation effect of infant deaths because they refer to women whose parity, on average, is fairly close to their desired family size (10). Women of parity 6 and above will on average be older and their desire for more children perhaps increasingly influenced by their advancing age, health problems and subfecundity or sterility.

Concentrating, then, on the data for women of parities, 3, 4 and 5, we find consistent evidence of a compensation effect operating. In every region, for all of these parities, the percent of women wanting more children is higher for those who have experienced at least one infant death than for those who have not. The consistency of results across the different regions of Indonesia, with their wide cultural differences, wide range in fertility levels and fairly wide range in ideal family size, is striking.

The data for urban women confirm the rural data. At parities 1 and 2, the tendency for desire for more children to be stronger among those who have lost a child although it is the norm, is not characteristic of every region. But at parities 3, 4, 5 and 6 there is almost universally a stronger desire for more children among women who have lost at least one child than among those who have not. The sole exception is women of parity 4 in East Java.

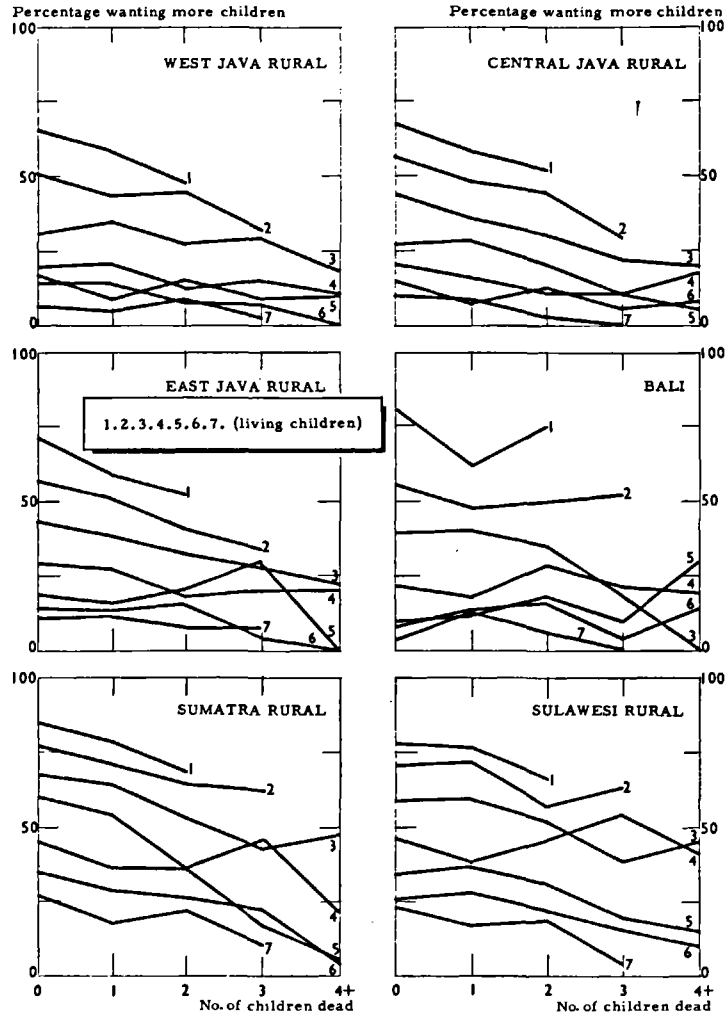

Figure 2 – Percentage of women wanting more children, by number of living children and number of children dead, Indonesia 1973.

(9) It should be noted that in drawing the graphs, data were only plotted if based on more than 20 women. Thus for example, for most regions values are plotted for women of parity 2 who had experienced 2 child deaths. But for Bali, because there were only 11 women in this category, their data were combined with women who had experienced one child death to give a value for women who had experienced one or more child deaths. At higher parities, the final value plotted is for women who had experienced the specified number of child deaths *or more*; e.g. women of parity 5 who had experienced 3 or more child deaths.

(10) Desired family size was not asked in the fertility-mortality survey, but mean ideal family size varied between 3.7 (Bali) and 5.2 (Sumatra).

Relationship between desire for more children, number of living children and number of children dead

Although it is of only marginal relevance to the subject of this paper, in Figure 2 we present data similar to that in Figure 1, except that desire for more children is related to number of living children and number of children dead. In this diagram there is a clear *inverse* relationship between number of children dead and desire for more children, controlling for number of living children. This is not unexpected, since when we control for number of living children, women who have experienced child deaths are both higher parity and, on average, older, than women who have not experienced child deaths.

Conclusions

The present paper indicates that in Indonesia, one factor keeping fertility high is the tendency to compensate for the relatively high infant and childhood mortality levels. This implies that the steady decline in mortality levels during the past two decades should be making for lower fertility levels.

The evidence for a compensation effect is that a higher proportion of women want more children among those who have experienced one or more child deaths than among those who have not, when we standardize for parity.

Unfortunately, our data do not permit us to explore in more depth the mechanisms or motivations underlying these observed facts. Nor do they permit us to discover whether there is overcompensation or undercompensation for child deaths. These subjects should be the focus of further studies.

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