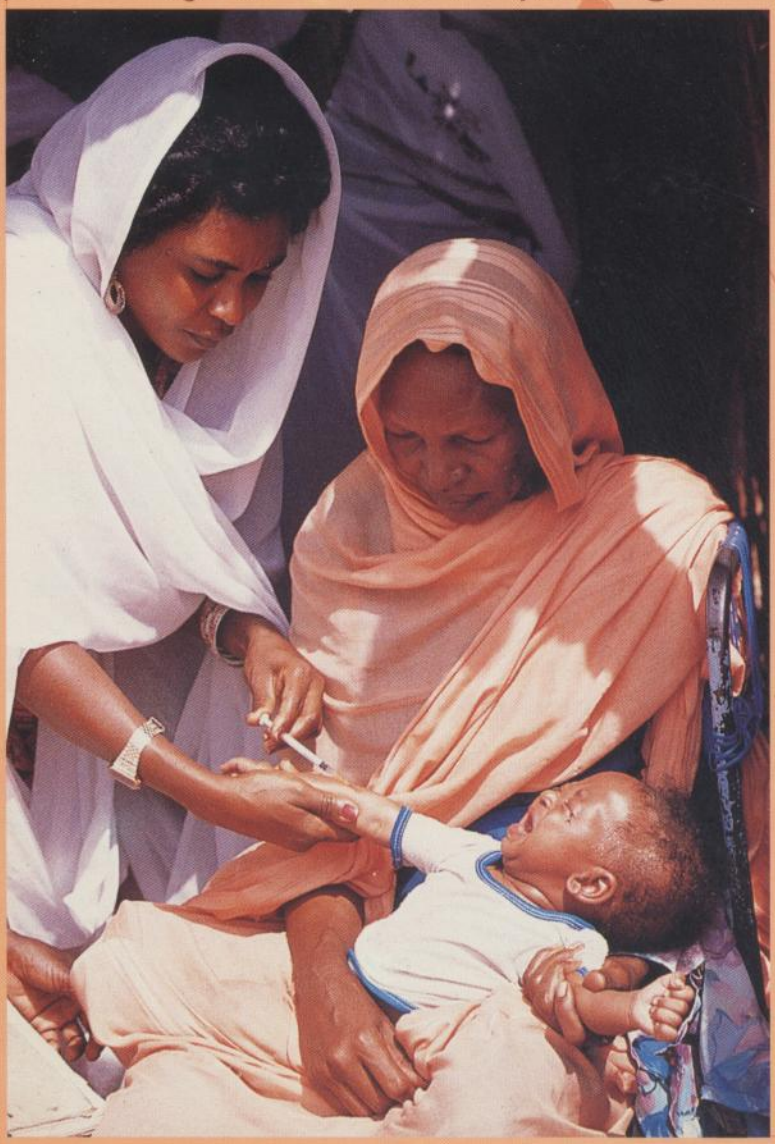
Demographic evaluation of health programmes

Proceedings of a seminar in Paris, February 26-28, 1996



Committee for International Cooperation in National Research in Demography (CICRED)

United Nations Population Fund (UNFPA)

French Ministry of Cooperation

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So as to promote collaboration between its affiliated centres, the CICRED encourages them to give special attention to the themes that its Council has identified as important (Fertility and the family, Mortality and Health Policy, Urbanization, Ageing, Population and Environment, International Migrations, Demography, Economics and Society) and to participate in gatherings attended by the centres working on these themes.

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Edited by

Myriam Khlat

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FOREWORD

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Longevity has often been taken as an indicator of a robust constitution and of individual success. At the level of an entire society, a decline in mortality, and in particular a decline in infant mortality, has a powerful emblematic value as a measure of progress. This is why national political authorities have traditionally taken a close interest in monitoring mortality and the fight against the diseases directly responsible for infant mortality, notably diarrhoea, respiratory infections, and malnutrition.

The United Nations has shown special concern for public health. Following a report by the World Health Organization's Executive Board that highlighted the general inadequacy of health services in Member States, the twenty-sixth World Health Assembly in 1973 decided to collaborate with the UN in producing a set of practical guidelines which could be applied to national health care systems. Four years later, the World Health Assembly defined the main social target of governments and WHO, as the attainment by all citizens of the world of a level of health that would permit them to lead a socially and economically productive life by the year 2000. This was the political context that produced the initiative in favour of health for all by the year 2000, and in which WHO and the United Nations Children's Fund (UNICEF) co-organized the 1978 Conference on Primary Health Care, that led to the Alma-Ata Declaration. The terms of this went well beyond the fields of action laid down for the International Health Regulations and the Expanded Programme on Immunization; it recommended in particular improved food and nutritional conditions, called for the co-ordinated development of agriculture and food production compatible with conserving natural resources, and stressed the importance of adequate fresh water supplies and basic sanitation.

These ambitious goals did not go unnoticed by the Committee for International Cooperation in National Research in Demography (CICRED) which had been set up a few months before the events described above. The CICRED has mobilized its resources on the theme of mortality on four occasions: the analysis of "Infant Mortality in Relation to the Level of Fertility" (Bangkok seminar, 6-12 May 1975), the study of "Infant and Child Mortality in the Third World" as part of the cooperative research programme between centres set up in Mexico in August 1977 (Final Report in 1983), a large study programme on the "Socio-economic Differential Mortality in Industrialized Societies", whose results extended from 1981 to 1991 (7 volumes produced during five meetings of centres), and lastly the analysis of the "Effects of Social, Political and Structural Change upon Mortality Trends and Levels" (Jakarta meeting, 2-4 March 1992).

From these high points in the work of the CICRED it has emerged that the description of mortality levels and trends at different ages could be used to evaluate the effectiveness of health intervention programmes. On closer inspection, however, the task is found to be harder than it appears. Mortality levels do indeed reflect the intensity of the ravages of the diseases mentioned above, but they also reflect numerous other factors including pre- and post-natal care, diet, drinking water supplies, and environmental conditions. Nonetheless, the decrease in mortality that has occurred in the developing world is in large part due to primary health care

programmes, administration of health services, technology transfers, family planning and vaccination campaigns, all of which have been made possible by the application of modern technology and the conclusion of bilateral or international cooperative agreements.

But however justified such interventions are in terms of principles, their effectiveness still has to be assessed, not least to provide a rational basis on which to make budgetary choices in this field. This justification procedure can only be provided by a rigorous evaluation. Following its recent reorganization, the CICRED, aware of the growing consensus on the need to evaluate health programmes before, during and after their implementation, and drawing on the experience built up by its associated centres in the study of mortality, decided to devote its first seminar to the theme of "Demographic evaluation of health programmes"

The seminar was ambitious in its conception, but the organizers were reluctantly obliged to limit its scope. Rising living standards, for example, were little discussed, despite their undeniable impact. Likewise, the effects of the introduction of basic sanitation, sewage treatment and processing of household waste have not been examined. Moreover, health protection and promotion involve not only measures for avoiding diseases but also for encouraging the lifestyles and behaviour, developing the social, economic, environmental and personal factors, favourable to the good health of populations - all components of health policies that the seminar did not examine.

The seminar was held in Paris, from 26 to 28 February 1996, and was organized by Dr Myriam Khlat, researcher at the National Institute of Population Studies. True to its mission, the CICRED saw it as a means of encouraging cooperation between research centres on this hitherto neglected theme. In a long term perspective, it hoped the seminar would also contribute to increasing the role of demography in health programme evaluation, to raising awareness of this theme in the demographic teaching and research centres and to expanding technical expertise.

The present volume contains the main contributions, plus a synthesis by the seminar's scientific co-ordinator. The contributions are extremely varied, which is only to be expected given the great diversity that characterizes the community of research centres as regards not only the phenomenon being studied but also the data and methods employed. In addition, the efforts deployed by the centres are not evenly distributed. This is not surprising given the variation in the human and financial resources mobilized for the project by the different participating institutions. The experience must nonetheless be judged a success, first, because of the high standard of the contributions, second, and perhaps most importantly, because of the opportunity the seminar provided for a sharing of experiences.

On behalf of the entire demographic research community, the director of the CICRED would like to extend his thanks to all the centres who participated in the seminar, and in particular to the INED, which is its host-centre, and to one of its researchers, Dr Myriam Khlat, who had the heavy administrative task and great scientific merit of organizing the seminar. The encouragement and financial support of the United Nations Population Fund enabled the CICRED to co-ordinate the planning and realization of the project, while the involvement of the French Ministry of Cooperation has made it possible to have the contributions translated and the present volume published.

1

Program evaluation in the health field

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The great leap forward in health conditions dates from the 1950s, with the discovery of antibiotics and the start of wide-ranging programs transferring modern medical technology to the Third World. Some of these interventions have proved to be more effective than others, and at the present time, given the shortage of resources and the need to ensure that action is targeted in the proper direction, it is crucial that health programs be evaluated before, during, and after their implementation.

Nowadays, the art of evaluation is a discipline in its own right which consists of applying a scientific procedure in order to judge the relevance and the effects of an intervention. The purpose of this introduction is to establish a framework for evaluation research, by defining its purposes in the health field more specifically, by clarifying the vocabulary which is attached to it, and by discussing the concepts which underlie the different types of evaluation.

The example of lung cancer screening

Screening programs are a popular type of health program, which are based on the expectation that early detection and early treatment of diseases is associated with better prognosis. This expectation may or may not be met, depending on the disease and on the screening test, and at the population level screening programs can be extremely costly. For these reasons, the benefits which are attached to this type of health programs have to be demonstrated before they are implemented on a large scale.

The example of lung cancer screening is particularly instructive, as this cancer is the commonest cancer in the world today, and a public health problem of growing importance in a number of developing countries. The major preventable risk factor for lung cancer is tobacco smoking, and health education programs do lead to a reduction of incidence, but only in the long-term. In the short-term, reduction of mortality by early detection is a lung cancer control strategy potentially appealing to health planners.

Cases can be screened by chest X-ray, and there are serious reasons to believe that screening of lung cancer by chest X-ray, and early treatment of screened cases could result in better prognosis and survival. Several trials to investigate the effectiveness of lung cancer screening have been reported. One of them began in Czechoslovakia in 1976 (Kubik, Parkin, Khlat et al., 1990). For the

purpose of this trial, 6,364 high-risk cigarette smoking males aged 40-64 were randomized into an intervention group which received 6-monthly screening by chest X-ray, and a control group of the same size which received no asymptomatic investigation. The two groups were followed up for a period of 6 years, and lung cancer cases were followed up until early 1989, a period of at least 5 years from diagnosis, or until death.

One of the findings in this study was that lung cancer cases detected by screening at an early stage had a significantly better survival rate than cases diagnosed after having reported symptoms. But longer survival is in itself related to earlier diagnosis, and the key outcome variable to consider is in fact mortality. A comparison of the two groups in terms of their lung cancer mortality indicated no significant difference, after a follow-up of more than 10 years. The authors therefore concluded that:

- the results of therapy for this disease are not improved by early diagnosis, and programs of screening by regular X-ray examination confer no benefit, and;

- in terms of prevention, efforts should be devoted to primary prevention, by preventing young people from taking up tobacco smoking, and persuading established smokers to stop.

This example highlights the role of health program evaluation as a key element to consider in health planning decision-making, and also the relevance of mortality as an outcome measure in impact assessment. A few basic questions concerning evaluation are addressed below. What is evaluation? Why evaluate? What are the different types of evaluation? What are the strategies for impact assessment?

Evaluation activities

Evaluation can be looked upon as the final step in the process of program implementation. The first step is planning, which involves the definition of the health problem to be tackled and the layout of a program to deal with it; the second step is program operation; and the third step is evaluation, the aim of which is to measure whether the program has fulfilled its objectives.

Generally speaking, evaluation is defined as "the gathering, analysis and interpretation of information to judge the worth of existing or projected programs or interventions to improve the life of humankind" (Rossi and Freeman, 1993). Alternatively, evaluation can be viewed as "the systematic gathering of information in order to make choices among alternative courses of action" (Borus, Buntz and Tash, 1984). Evaluations of social and health programs have now become commonplace.

There are two main types of evaluations, each of which addresses different questions, but which have to be considered in turn when assessing a program's effects (Borus, Buntz and Tash, 1984):

- **process evaluation**, sometimes referred to as " program monitoring ", asks the question: " how did or does the program operate "? In other words, it can be defined as the systematic examination of the program operation, in order to find out: whether the program is reaching the appropriate target population, and; whether its delivery of services is consistent with the plan for the program. Process evaluation is a prerequisite to impact evaluation, given that no mortality impact can reasonably be expected if the program implementation is unsatisfactory. Process evaluation may be done by the program managers or by members of the program's administrative staff.

- **impact evaluation** asks the question: " what difference has the program made "? It puts emphasis on the changes brought about by the existence of the program, to estimate whether or not the intended effects have been produced. This activity requires comparing what has occurred, given the existence of the health program, with what would have occurred had the program not existed. In principle, impact evaluation seeks to assess the entire spectrum of changes related to the program, and not only those which were originally defined as program objectives, as it is quite likely that health programs will have outcomes other than those expected. Impact evaluation in the health field requires a strong background in epidemiology and demography, and is likely to conflict with the program managers' own interests, which is why evaluations are often contracted out to private researchers or universities.

Issues in impact evaluation

The two key concepts in impact evaluation are effectiveness and efficacy, in response to the two basic questions: can it work, does it work?

- **Efficacy** refers to the program effects in optimal conditions, in which all the target population is reached by the program, and in which the observance is perfect (can it work?).

- **Effectiveness** refers to the program effects in real-life conditions, in which part of the target population is not reached, and in which compliance with the program is more or less strict (does it work?). A high level of efficacy is necessary but not sufficient: a health program which has high efficacy but low efficiency is of little use.

One important point is that all impact evaluations are comparative: as explained by Rossi and Freeman (1993), determining impact requires comparing, with as much rigor as possible, targets who have experienced an intervention (" experimental ") with equivalent targets who have experienced

something else (“ control ”), be it alternative treatments, or simply going untreated (placebo).

It is crucial that control targets be equivalent to experimental targets, in order to be able to establish the causal link between intervention and outcome: if they are not, then the difference between the first and second sets of targets may be due to other factors. The notion of internal validity of an evaluation study precisely reflects the degree to which external factors have been accounted for.

The relevance of mortality as an outcome measure of evaluation studies in the health field is questionable (Fournier, 1994). Morbidity data have to be considered in the first place, but in many instances a very convincing indication of the effectiveness of a health program is the occurrence of a mortality decline. It has also been suggested that programs should be assessed on the basis of their reduction of mortality differentials within a population, which in itself is a direct indicator of the broader goal of equity (Graham, 1989).

The feasibility of measuring the mortality impact depends mainly on two aspects of the problem (Ewbank, 1995; Ewbank and Gribble, 1993):

- the **magnitude of the expected mortality reduction**: it is possible to measure the effects of interventions which can produce substantial reductions in mortality, whereas if the expected reduction is too small the required sample size may be unattainable.

- the **pace of the expected mortality reduction**: if the program reduces mortality very slowly, it becomes very difficult to isolate the program effect from other long term factors affecting mortality.

The demonstration of an actual drop in death rates can be very difficult, due to lack of adequate data in many settings where evaluation is needed, and demographers play a crucial role in producing measurement instruments applicable for use within program budgets, and at the same time sensitive to short-term changes in survival. In this perspective, demography can contribute significantly to increased knowledge in the field of evaluation and be of considerable help to health planners in making sound policy decisions.

From clinical trials to large scale programs

The logical sequence in health program implementation may be briefly described as follows (Ewbank, 1995). First, the efficacy of the intervention is supported by a clinical trial which measures the impact on mortality and other indicators such as incidence of disease or serum antibody level, or on the basis of simple biological or epidemiological models. Second, field trials allow the demonstration that the uptake of the recommended practices (in terms of delivery of health services and coverage of target population) is feasible, and

measure the epidemiological effects on populations. There may be large differences between clinical trials and field trials. For instance, in clinical trials it is the clinic staff who generally prepare and administer the medicines to the patients, whereas in field trials these tasks are performed by the patients themselves without supervision. In addition, programs to prevent infectious diseases can reduce the number of active cases, and thus change the epidemiology of these diseases by changing the risk of infection for the entire population, including those going untreated.

It is worth noting that the effect of large-scale interventions which have already been evaluated in field trials still needs to be measured, as the benefits to populations can be very different from the benefits to individuals. Indeed, large scale programs rarely achieve the coverage rates found in well supervised field trials, due mainly to improper procedures, incomplete observance, or selective factors. For example, if those who receive services belong to the upper socioeconomic groups, and are therefore at lower risk of infection or complication, then the effects of large scale programs might be smaller than the effects of field trials. In particular, when interventions are implemented in government programs, the quality of services can be considerably affected, as can the coverage rates.

Relevance of different types of health programs

Disease-targeted interventions based on technologies are increasingly being questioned (Graham, 1989), and their relevance has been discussed in a recent IUSSP-sponsored workshop held in Brazil on the evaluation of the impact of health interventions (Rashad, Gray and Boerma, 1995). Experts argued that the risks of dying are unevenly distributed in large populations, and that individuals who die are a particular group in the population characterized by a higher than average exposure to health hazards. In addition, it has been pointed out that interventions centered around diseases are not able to modify the conditions which produced the ill-health in the first place.

Overall, the dominant opinion was that interventions should derive from comprehensive approaches with a full appreciation of the various dimensions (social, behavioral, economic,...) of the health problems, rather than mechanically targeted at specific diseases.

Seminar outline

The Committee for International Cooperation in National Research in Demography (CICRED) convened a meeting in Paris on February 26-28, 1996, to stimulate involvement of demographers in evaluation research, and help increase their role in the evaluation of health programs. About twenty centers were invited to participate in this meeting, and the representatives who attended belonged to one of three groups:

- experts in health program evaluation, put in charge of discussing the methodological issues attached to impact evaluation in the health field (data sources, mortality indicators (direct vs. indirect), study designs and methods for data collection, alternative indicators, etc);

- demographers and epidemiologists experienced in evaluation research, invited to present a project design and substantive findings;

- demographers involved in an ongoing project, invited to give a brief presentation of their protocol and objectives for discussion and advice.

This volume assembles the contributions of the first two groups of participants, divided into three sections: the first comprises the papers focused on methodology, the second includes various types of health program evaluation projects, grouped according to the data source (survey data, demographic surveillance systems, death registration data), and the last touches on a topic of more general interest, namely " who benefits from health programs? ", with detailed presentations of two health programs, one of which generates additional health differentials along social lines, and the other which leads to a reduction of the differential mortality between the sexes at early ages. The various presentations and the main points of the discussions are summarized below.

In the first section of the seminar, the specific role of evaluation was positioned in the wider context of health planning, and the role of demographers in health program evaluation was clearly delineated:

- provision of information on health indicators, to draw a baseline picture of the population and pinpoint needs and priorities;

- provision of information on the determinants of health and survival of individuals, to elaborate appropriate interventions;

- provision of appropriate measurement tools to monitor changes related to interventions.

The distinction between process evaluation and impact evaluation was stressed, and one important point which has been raised is that, although death is the ultimate outcome to be considered in evaluations, efforts should

be made to also collect data on morbidity, physiological parameters, behavioral variables, and even quality of life to complete the picture.

The issue of methods of data collection in evaluation studies was tackled, and the point was made that moving away from the randomized trial gold standard was feasible, provided sufficient care was exercised in order not to over-interpret the studies. A very useful framework was proposed for the design and evaluation of child survival programs, according to the intended uses of the study. Underlying the discussion on this topic was the crucial problem of causal inference, and the idea that the stronger the inference needed, the heavier and the more costly the design, keeping in mind that an evaluation study should not cost more than the program it is intended to assess.

The methods of mortality measurement (direct vs. indirect) were examined, and the poor performance of indirect estimations in reflecting short-term changes was stressed. More generally, it was argued that indirect estimates do not seem to be appropriate in situations where mortality is changing rapidly. The findings presented illustrated very well the reversibility of the child mortality decline in a developing country, in response to political upheaval, or to worsening economic conditions. All progress may ultimately be called into questioned and reversals are likely to occur, which fully justifies the importance of long-term monitoring of mortality trends.

Another idea which was supported was that qualitative research, and more precisely in-depth open interviews are potentially very fruitful in the context of evaluation studies. Knowing the exact circumstances of a death, be it a maternal or a child death, can certainly help identify behavioral or sociological factors amenable to interventions, or help understand why a program has not functioned properly.

The question of the relevance of mortality as an outcome measure in evaluation studies was raised and safe motherhood programs were presented as one example where morbidity indicators and in particular "near-miss death" morbidity (a severe clinical condition preceding death) could be more appropriate to reflect changes.

As an alternative design, the case-control method is potentially promising in the field of evaluation. A number of selection biases are inherent to this retrospective type of study, but can be overcome provided sufficient information is collected. The main advantage is that this study design is quick and relatively cheap to implement, and, when properly analyzed, can be very informative. The main challenge now is to move these studies out of the hospital setting into the community, and especially, to use the death registers as a potential source of cases.

The Demographic and Health Surveys and the CDC-assisted reproductive health surveys are extremely useful in providing baseline data and a potential for international comparison. In addition, the availability of surveys at different points in time in the same countries can serve to assess behavioral changes

and changes in health status, possibly in response to health programs. One point which was considered concerns the under-utilization of the DHS surveys in general, and the communication gap between the demographic and public health communities.

With regard to vaccination against measles, the study presented revealed a huge reduction in juvenile mortality (roughly 50 %) after this intervention. The data collection method may be questionable, however more controlled studies have in the past shown a reduction of about 20%, which in any case is greater than would be expected on the basis of deaths directly related to measles. This raises a number of questions concerning the repercussions of vaccination against measles on the incidence of other diseases, and about the inter-relations between measles and malnutrition.

The study in Madagascar is particularly instructive, and clearly illustrates the wealth of information which can be extracted at very low cost from the local health office registers in cases where death registration is almost complete. The processing of this information provides an excellent monitoring instrument in the capital city of Madagascar. Coupled with regular cross-sectional surveys at a national level, it can even generate a complete picture of mortality trends and differentials in the entire country, and reflect the effects on mortality of the national health programs.

The demographic surveillance system set up in Matlab, and, on a smaller scale, the population laboratories functioning in rural Senegal provide wonderful opportunities for evaluation studies, using either the Intervention/Control contrast, or the Before/After contrast. Regardless of the fact that ideal designs of this type are very costly, it has to be pointed out that when programs are expanded beyond limited populations, the quality of services tends to decline, which means that the outcomes of the evaluation should be treated with caution.

Although the demographic impact of health programs is generally expressed in terms of change (mortality change or fertility change) in the population as a whole, a concern with equity also leads to the examination of differentials within the populations. If certain socio-economic sections of the population benefit more than others from health programs, these may result in either a narrowing or a widening of differentials: while the former is certainly desirable, the latter indicates that the program is not reaching those who need it most and that definite action is needed to improve coverage.

Two papers illustrated the potential impact of health interventions on health differentials within the population according to social lines or to gender, with opposite effects depending on the context: a widening of socio-economic-based differences with a very modern health technology in a Western country (France), and a reduction in differentials between the sexes with a multi-purpose health program in a developing country (Bangladesh).

Proposals for evaluation of specific health programs were presented, and these concerned a wide variety of interventions, ranging from the introduction of running water to training of midwives and the setting up of social services for the elderly (see List of other contributed papers). The discussions which followed helped to identify the objectives, select the appropriate indicators, and set out the analysis.

As already mentioned, the objectives of the CICRED in convening this meeting were to contribute to a transfer of technical know-how and expertise between centers, and to provide a discussion forum in order to stimulate and initiate the development of collaborative projects. The usefulness of the meeting can only be evaluated over the next five years; in the meantime it is hoped that this volume will further these objectives and give them a wider audience.

The CICRED wishes to thank the United Nations Population Fund and the French Ministry of Cooperation, whose generous financial assistance made it possible to hold the seminar in excellent conditions, and to publish the proceedings both in English and in French. Dr. Philippe Collomb, Executive Director of CICRED, and Drs. André Quesnel and Jacques Véron, officers in charge of priority demographic orientations in CICRED, provided valuable advice during the planning stage of the seminar. The practical organization of the seminar was in the competent hands of Mrs Silvia Huix-Adamets and Nelly Puyraud from the CICRED, and the technical editing of the proceedings was carried out by Dr. Godfrey Rogers.

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2

Panorama of evaluative studies:

Mortality indicators, data sources and methods of estimation *

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There is no doubt about the contribution of demography within the field of programme evaluation. Until recently, demographers were involved primarily in evaluative surveys for checking the efficiency of family planning programmes implemented in many developing countries since the 1970s.

For a number of years the evaluation of health programmes has been the domain of the medical community, its administrators and its scientists. They have concerned themselves mostly with the evaluation of resources invested, of the quality of the services and of the effects of the programmes on morbidity.

During the 1980s, the debate opposing the medical and social sciences regarding health and survival research shifted and the current context favours an interdisciplinary approach. At the same time the substantial contribution of demography in the field of health planning and more specifically the evaluation of health programmes is becoming recognized. The literature on the evaluation of health programmes, especially evaluation of the effects of programmes on mortality, gives a clear sign of this new trend.

As we have shown recently (Fournier, 1992, 1994), the evaluation of health programmes is generally based on two aspects familiar to demography: 1) adequate informational support; 2) appropriate theoretical and empirical support to back intervention or programmes. It should be noted that the first aspect has always been important in literature on evaluations, to the detriment of the second (Domato, 1994). Thanks to their expertise in methods for gathering data, for measuring and analyzing data and for demographic statistics and other results derived from demographic analysis, for example, health indicators, demographers are able to provide a response, at least a partial one, to the first requirement. As for the second requirement, demographic studies have greatly contributed to improved knowledge about health and survivorship factors.

* Translated from French by Paul Belle.

This article deals mainly with the first type of support which no doubt represents the most important contribution of demographers in the evaluation of health programmes because demography is behind several pertinent indicators in the field (Chevalier et al., 1995; Dhillon, 1989; Péron and Strohmenger, 1985; Pineault and Daveluy, 1986). The different evaluation strategies presented here are not exhaustive. The relevant measures and indicators, the different evaluation methods and data sources providing information for evaluative studies are reviewed and so are the methodological problems linked to their use. The contexts of developed countries and developing countries are taken into consideration.

The evaluation of health programmes: different strategies

There are a great number of different evaluation strategies mentioned in publications which target one or more components of a programme and which can be carried out during the programme or retrospectively (Domato, 1994; Patton, 1982; WHO, 1973). Clemenhagen and Champagne (1986) built a conceptual framework presenting different evaluation strategies which they put into two main categories: 1) administrative evaluation; 2) evaluative research. Inspired from this conceptual framework the model presented in Figure 1 uses the strategies presented by these authors adding to it the dimension of the required informational, empirical and theoretical support for their realization and provided by demography.

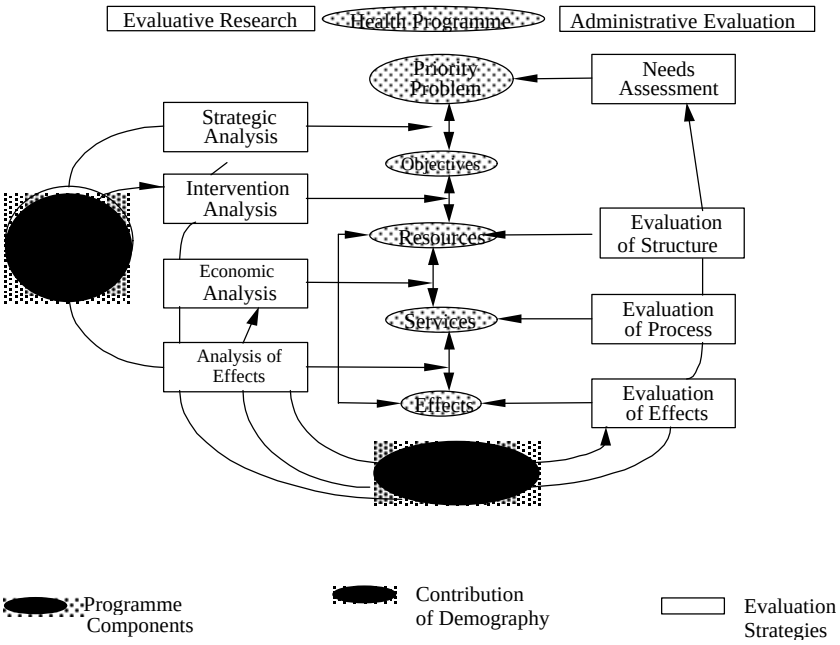

Figure 1 . Demography's contribution to the evaluation of health programmes.

Administrative evaluation is part of a descriptive approach and its objective is to look at the different components of a programme one by one. According to whether it concerns identifying the priority health problems of a given population, allocated resources, the services offered and the impact of the programme, the evaluation is referred to respectively as an evaluation of needs, an evaluation of structure, an evaluation of process, an evaluation of effects. In each case it consists broadly of assessing a component of a programme by applying a criteria (a norm or a standard) established empirically or by experts or by measuring the difference between what has been planned in the programme (the criteria) and what has been achieved after a given period. This type of evaluation is based on the assumption that there is a causal link between the structural and process elements and the effects, without verifying it. An example of an administrative evaluation is the "Evaluation of the strategy for Health for All by the Year 2000" by WHO.

On the other hand evaluative research is intended to be analytical. Rather than considering the components of a programme separately, it analyses rigorously the links between them, whether they concern adequacy or causality, by using a scientific method in the latter case. The results of this analysis enable an assessment of the programme or the components being looked at. Clemenhagen and Champagne (1986) identified as a part of this category strategic analysis, programme analysis, economic analysis and analysis of effects (see Figure 1). Strategies for evaluative research based on informational support where demography plays a role are examined briefly.

Strategic analysis is an attempt to assess the appropriateness of objectives in addressing health priorities and the global health problems of a population. To do so the evaluator must be able to have access to as much information as possible concerning the population in addition to information about the health problems which affect it (Champagne et al., 1987; Daveluy and Pineault, 1986; Dever and Champagne, 1984).

The economic analysis is concerned with studying the link between the resources invested and the services, which is a productivity analysis, or the link between resources and the effects of the programme, which is an efficiency analysis. There are different types of efficiency analysis, which include cost-effectiveness. The costs are expressed in monetary terms and the effects in the form of health indicators. This type of economic analysis can be carried out before implementation of the programme (*ex ante*) or after (*ex post*). Its objective is to decide whether investing resources in a programme is justified in relation to the effects expected or observed. It also allows a comparison between programmes so as to choose the most advantageous.

In the analysis of the effects, verifying whether or not there is a causal link between the programme and the effects observed is the basis for the evaluation. The following question is formulated: "Is the effect Y attributable to cause X ?" To answer this question, a scientific approach with the use of research designs allowing a maximum degree of control whilst maintaining a

satisfactory degree of validity, is the most desirable. Different designs can be considered, depending on the information available: 1) quasi-experimental design with or without a control group; 2) time series with measurements before and after implementation of the programme; 3) case-control studies, etc.

Informational support and evaluation strategies

Figure 1 presents the evaluation strategies for which demographic data is useful or even necessary. One may distinguish information of a general nature characterizing the population targeted by the programme and information for measuring the state of health of the population and its changes. In this section, the emphasis will be on information requirements for evaluation strategies focused on the effects of a health intervention programme.

Demographic characteristics of the population

A minimum amount of information about the population, its demographic characteristics, its age structure, its projected growth and migration flows if possible, is the basis for health planning and for evaluation. This information is necessary to identify priority health problems among all the health problems affecting a given population. This stage corresponds to the first component of a health programme and is part of the assessment of needs and the strategic analysis. For example, estimations of migration flows of a population subjected to an epidemic is perfectly relevant. In the case of the HIV infection, several studies on this epidemic take into account the migration factor (Lalou and Piché, 1994).

Information on the state of the population and its composition is generally made available through census data. In developing countries these data often require adjustments. Demographic projections are based on fertility and mortality assumptions applied to a given population, and a migration assumption can also be integrated.

Health indicators, data sources and methods of estimation

Health indicators are indispensable for health planning. They enable decisions as to health priorities. In addition their aptitude at revealing changes makes them useful tools for monitoring health improvements, for example the monitoring of certain health indicators by WHO, and for evaluating health programmes and interventions.

There are several health indicators based on mortality and they present great potential for evaluating health programmes. However, these indicators must fulfill certain requirements. Different authors have defined the criteria for choosing indicators. A certain consensus is illustrated in the literature on the

subject. The criteria are as follows: 1) validity: the ability of an indicator to supply the "... entire range of values necessary to evaluate the state and the development of the phenomenon for which it was chosen." (Péron and Strohmenger, 1985, p.16); 2) reliability: the ability of an indicator to give stable results in different times and locations; 3) sensitivity: the ability of an indicator to react to changes of the phenomenon it represents, especially short-term variations; 4) specificity: the ability of an indicator to vary only because of modifications affecting the phenomenon under observation or because of interventions; 5) intelligibility: the indicator's property of being comprehensible for non-specialists such as decision-makers, donor organizations and practitioners (Hill, 1989; Jenkinson, 1995; Mbacké, 1988; Péron and Strohmenger, 1985, Pineault and Daveluy, 1986; Van Lerberghe, 1987; Yach et al., 1990). Of course, all the indicators do not correspond perfectly to these criteria. These criteria are guidelines for making a choice based on the information available and the objectives defined within the framework of the evaluation.

The case of developed countries

Compared to life expectancy at birth or life expectancy in good health[1], mortality rates are usually more sensitive to variations in the phenomenon they represent (Hansluwka, 1987). They are based on data from civil registries (death and still-birth certificates, birth certificates) and the census, enabling a direct evaluation of the rates. Among them, the infant mortality rate (IMR) is no doubt the most well known. However, with decreased mortality in all developed countries the IMR has fallen considerably, making this indicator less relevant (Hansluwka, 1987; Pineault and Daveluy, 1986). In the context of developed countries, it is preferable to look at perinatal mortality rates or early neo-natal mortality rates where deaths at an early age are concentrated. What is more, these indicators are more sensitive and specific to perinatal health care given the fact that they are determined to a great extent by such health care (Péron and Strohmenger, 1985).

Mortality rates according to cause of death are also interesting indicators that must, however, be used with precaution because they can be influenced by the age structure of the population. But the solution is to use a rate per cause and per age.

Whereas the quality of mortality data sources is generally good, information about cause of death can introduce errors. The cause of death indicated in the death certificate is the initial cause. This may not reflect reality when, for example, the death is due to multiple causes (Chevalier et al., 1995; Pineault and Daveluy, 1986). Chevalier et al. (1995) add another warning. The geographical and temporal comparability of data on the causes of death may

[1] This indicator is an indice based on the life table and data on morbidity and disabilities from hospital statistics and surveys.

be limited because of several problems: 1) improved medical diagnoses over time; 2) variations in the methods used for declaring and classifying deaths. The ICD-10, International Classification of Diseases is the one currently in use.

Within the analysis of the effects of a programme aimed at reducing deaths due to a given cause, the fact of using the cause-specific mortality rate rather than the global mortality rate from all causes adds specificity to that indicator. This will make it possible to check more easily the causal link between the programme and the effects observed, especially if one is able to prove that mortality due to other causes has not changed. However, as Ewbank (1984) points out, one would have to be sure that in such a case there is no synergy between certain diseases.

One indicator used in the economic analysis of health programmes is the number of potential years of life saved (PYLS). Its counterpart, the number of potential years of life lost (PYLL) has been developed to measure premature mortality, and notably premature mortality due to one particular cause of death (Chevalier et al., 1995; Pineault and Daveluy, 1986; Péron and Strohmenger, 1985). In both cases, the calculation uses data on deaths (civil registry) and on the population (census), and depending on the method of calculation the life table may be necessary (Chevalier et al., 1995; Péron and Strohmenger, 1985). For instance, deaths between the ages of 1 and 75 years are taken into account, this last figure corresponds to the life expectancy of the population, for both sexes.

The objective of the economic analysis is to estimate the PYLS by one or several different health programmes, *ex ante* or *ex post*, with the aim of: 1) determining whether a programme is worthwhile from the point of view of gains in the number of years of life, taking into account the sums expended, or 2) choosing the programme which ensures the greatest gain in the number of years of life. To calculate this indicator, the simplest method is to multiply the number of deaths due to a cause occurring between the first birthday and the 75th birthday by the difference between 75 and the average age, for each of the age groups. The next step involves making the sum of the results obtained. However, this method tends to overestimate the gains in years of life. A method based on the comparison between the life table observed and a hypothetical life table in which the cause of death would no longer be effective represents a better choice (Péron and Strohmenger, 1985).

By the way it is calculated this indicator gives greater weight to causes of deaths occurring at an early age. There is, therefore, a value judgement at the heart of this indicator, which results in a prejudice in favour of interventions affecting young people (Chevalier et al., 1995; Péron and Strohmenger, 1985; Pineault and Daveluy, 1986). However, this bias can be got around by introducing a weighting factor in the calculation which will make it possible to confer more weight on the years still to be lived in the close future compared to the years to be lived in a more remote future. This notion of current value is one used in economics (D'Souza, 1989; Ewbank, 1984).

Also critical of this indicator, Preston (1993) adds that the method of calculation used is not appropriate because it supposes that the health programme will be completely efficient from the first year of its implementation, therefore the gains in years of life will be almost immediate. According to this author, the effects of a health programme are in general felt gradually and should also benefit future generations. He therefore believes that the calculation should be established on the basis of demographic projections.

Other indicators concern potential years of life saved but include information on morbidity and quality. One of the indicators most often used is the quality-adjusted-life-years (QALY) (Green and Barker, 1988; Pineault and Daveluy, 1986). Although this indicator has been very often used for the economic evaluation of health programmes it has also been criticized because of the subjective approach regarding the appreciation of health and quality of life.

Finally, given that equity in health is a recognized objective, it is important to check whether health programmes make it possible to reduce inequality in chances of survival. Measuring this phenomenon poses a number of major problems. There is, however, one relevant indicator for the differential mortality between the sexes: the excess male mortality index which relates the rate (or quotient) of male mortality to the rate (or quotient) of female mortality according to age or age group, with female mortality expressed on the base 100. However, when interpreting this indicator one should take into account the role played by biological factors. The existence of excess male mortality during the intrauterine period and the perinatal period (neo-natal component) is well documented. The fact that maternity exposes women to life-threatening risks which men are not subject to should also be taken into account. However, the literature indicates that exogenous factors (cultural, social, behavioral) have an impact on the mortality differences according to sex and therefore that it is possible to reduce the existing differences (Péron and Strohmenger, 1985).

The case of developing countries

The health indicators identified until now are just as valid for developing countries, as long as there is information of sufficient quality to calculate them. However, given the fact that these countries have a different health and epidemiological situation from that of developed countries, it is useful to approach the question of the usefulness of health indicators by taking their context into account.

Given the high mortality level which is generally characteristic of these countries, especially at young ages, the IMR and the child mortality rate (in certain countries) are relevant indicators which add to mortality indicators for the perinatal period. These indicators can be used in analyzing or evaluating the effects of a health programme for improving infant and child health.

In developing countries the fact that the quality of information is often questionable is a major problem. Civil registries are often lacking in coverage and in precision (Ewbank, 1988, 1984; Hill, 1989). In some cases there is no information at all (WHO, 1981). Problems linked to the identification of cause of death which are to be found even in developed countries are even greater in developing countries: 1) diagnosis errors (Graham, 1989; Unger and Killingsworth, 1986); 2) omission in declarations (Rumeau-Rouquette, 1986).

Despite these imperfections, some authors mention the value of data from civil registries (or death registries) when they are of sufficient quality and can be adjusted using various methods which we will not examine here (Fargues, 1986; Fargues and Ouaidou, 1988). What is more, this data makes it possible to identify variations due to seasonal factors (or to other cyclical phenomena which are characteristic of the epidemiology of certain diseases). This type of information is very useful when interpreting causes behind mortality changes during the evaluation of a health programme.

Given the problems related to civil registration, developing countries often use data from surveys or censuses. For developing countries surveys have been and still are today a solution to problems in measuring population phenomena, notably mortality. There are several methods for the gathering of data and the estimation of mortality, each of which has its own advantages and drawbacks (Ewbank, 1984; Palloni, 1991; Zoungrana, 1990). This is a field in which demography has a long-established expertise.

There are direct and indirect methods for measuring infant and child mortality from information gathered in censuses and surveys. Among the direct methods there is the use of the information on events having occurred during the last twelve months, births and deaths, in each household. It is a well known fact that this method is not a good way of estimating infant mortality level, as Zoungrana points out (1990). However, it can provide some indications on long-term changes. The method using birth histories, more appropriate for evaluating infant and child mortality, also provides indications about changes in the phenomena (Zoungrana, 1990). However, according to Mbacké (1988), this method does not enable an estimation of short-term changes. This problem also concerns indirect measurements based on live-born child survivorship of the "Brass" type (Garenne, 1994; Mbacké, 1988), which in any case give a very approximate indication of mortality changes with the problem of timing of estimates (Hill, 1989). Because all these measurements are based on information collected retrospectively, they are tainted by bias due to problems of memory, such as omissions and errors in declarations (Zoungrana, 1990).

According to Zoungrana (1990) another type of survey makes it possible to monitor more closely the rates, age pattern, short-term and long-term trends in infant and child mortality, since they include a prospective approach: these are the multiple-round surveys. Palloni (1991) does not share this positive opinion of this type of survey. After having reviewed the main surveys conducted in

Africa and Latin America he concludes that the results are affected by different sources of distortion, notably those linked to losses affecting samples.

Of all indirect methods for estimating infant and child mortality, one is deemed more promising for the evaluation because it makes it possible to monitor short-term changes in the phenomenon and to identify risk groups (Mbacké, 1988). This technique is the previous birth technique elaborated by Brass and Macrea and taken up by Aguirre and Hill. Based on information gathered following a simple question posed to women attending a health or maternity centre, regarding the survival status of their previous child, it is possible to estimate the mortality quotient ${}_2q_0$ (Mbacké, 1988; Palloni, 1991). Of course, this method is not problem-free because among other reasons, there is selection bias at the level of the sample of women. However, it is an interesting approach.

Sources of continuous reporting such as longitudinal surveys (for example, Ngayokhème in Senegal since 1961) or the population laboratories (for example, Matlab in Bangladesh since 1963) enable direct estimations of infant and child mortality and even of adult mortality, if the size of the population being studied permits it (Palloni, 1991). The quality of these data is widely recognized (Palloni, 1991; Zoungrana, 1990). The monitoring of short-term changes is possible which makes them an almost unique source of data for analyzing the effects of the health programmes on mortality, as reported by Zoungrana (1990). However, although these surveys are particularly adapted to testing certain health interventions, they are very expensive, difficult to replicate, and their results cannot be considered as representative (D'Souza, 1989; Hill and Kaufman, 1986, see Zoungrana, 1990).

Infant and child mortality rates (or quotients) estimated using the methods and sources mentioned previously are useful to try to monitor the effects of a health programme. However, it should be pointed out that these indicators are not specific enough regarding the health interventions since other factors also affect mortality at these ages, notably socio-economic factors, cultural factors, the education of the mother, etc. In addition to infant and child mortality indicators, it would be preferable to use other indicators so as to get a good picture of the sources of influence.

In addition to infant and child mortality, the high levels of maternal mortality observed in several developing countries are a cause for concern. WHO has therefore decided to ensure the monitoring of the maternal mortality rate in the world (WHO, 1981). Increased interest in this phenomenon has been observed in recent years among health planners and demographers, the former requesting the latter to provide them with a reliable portrait of the situation, including indicators and differentials (Fargues, 1992). The maternal mortality rate is a ratio of the deaths of women during pregnancy, at childbirth and shortly after childbirth compared to women of childbearing age. There is also the maternal mortality ratio for which the number of live births is the denominator. This ratio is expressed in x for 100,000 live births.

Fargues (1992) worked at comparing different methods of estimating maternal mortality with the aim of checking their potential for adequately measuring rates, short and long-term trends, and mortality differences. Four methods are compared: 1) direct measurements based on data from continuous reporting; 2) indirect measurements based on the survivorship of the sisters; 3) estimation based on the life table; 4) measurements drawn from case-control studies. The results of his comparative analysis showed the potential of direct measurements and of estimates based on the life table to detect short and long-term variations in maternal mortality. However, the levels must be considered as approximate whichever method is used. Fargues considers case-control studies as a potentially promising method. However, not having tested this method with real data, his evaluation remains unverified.

Conclusion

Different authors have supported the idea of resorting to using different information sources and estimation methods, when they are available (Fargues, 1992; Garenne, 1994; Hill, 1989). Garenne (1994) stressed the usefulness of combining retrospective data for mortality trends prior to the intervention and continuous registration data for short and medium-term mortality trends after the beginning of the health programme.

The advantage of using other health indicators, for example, the incidence and the prevalence rates of certain diseases, has also been established as a condition for conducting evaluative studies on the effects of health programmes. Mortality measures one aspect of a population's health and it is important to use other measurements which will help complete the picture of the health situation and how it changes (MBacké, 1988; Miller and Hirschhorn, 1995). Other information is also relevant, for example, information concerning the use of health services (prenatal services, oral re-hydration salts, etc.) provided by surveys. Qualitative methods can also prove very useful for checking whether interventions are favourably considered by target populations, and for which reasons (cultural or economic factors, time allocation, etc.).

The use of information from different sources can facilitate the interpretation of the results of an evaluative study on the effects of a health programme insofar as these results appear to converge. In the opposite case, of course, it may well complicate matters. However, this will simply contribute to increasing the depth of the analysis.

The evaluation of health programmes involves a combination of several disciplines and approaches. Demographers, thanks to their expertise in the collection, exploitation and management of data, in estimation techniques and in the production of demographic and health statistics, play an important role in programme evaluations. In collaboration with researchers from other disciplines and with health planners and administrators, it is up to them to

continue contributing to this field of research and action to improve sanitary conditions.

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3

Monitoring and evaluating health programmes from the perspective of health providers and donors:

Identifying appropriate indicators and methods of data collection

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What is the objective of impact evaluation?

From the start of the movement toward "Health for All by the Year 2000", the World Health Organization stressed the broad view of programme evaluation as an integral part of the HFA2000 strategy:

> "To permit governments to know whether they are making progress toward attaining an acceptable level of health for all their people, it is important that they introduce at the earliest stages a process of evaluation. This will include the assessment of the effectiveness and impact of the measures they are taking, and the monitoring of the progress and efficiency with which these measures are being carried out." (WHO, 1981a, cited in WHO 1981b, p. 10)

The main reason to carry out a programme evaluation is to influence decision-makers. An evaluation should identify any changes necessary and result in actions being taken to make those changes. Decisions may be made at many different levels: to redefine objectives if they are inappropriate, to restructure strategies and programmes if ineffective, or to confirm the current programme if indicators show that it is on target toward attaining its objectives.

It is clear that health programme evaluation is multi-faceted, and only one aspect is concerned with demographic and health impacts. Nevertheless, for most health programmes, mortality reduction is the ultimate goal, the yardstick by which achievements are measured.

Clinical and field trials are used to assess mortality impact, but ask questions that are different from those asked by health programme evaluations. The former ask: *Can this intervention reduce mortality?* and *How safe is it?* while the

latter ask: *Does this programme reduce mortality when delivered on a regular basis?* and *Is it likely to have the same effect elsewhere?* The results from controlled trials are used to demonstrate the potential value of new interventions. The findings of programme evaluations are used to ascertain whether national health policies are appropriate to achieve stated aims, to assess the role of new interventions in strategies for health service delivery, and to identify the reasons why some programmes succeed while others fail.

Despite the obvious importance of evaluating the impact of a programme on overall mortality and morbidity, health programme evaluations often stop with operations research to assess the efficiency of service delivery. Since clinical and field trials have usually demonstrated the value of the interventions they are delivering, programme administrators often assume that as long as the programme is operating well, its ultimate aims (mortality or morbidity reduction) will be achieved.

Estimating programme impact by extrapolating from clinical or field trials is unsatisfactory, however, and calculations such as numbers of "deaths averted" by an intervention are inadequate to estimate the overall impact of services delivered in large-scale programmes. It is now well-recognized that disease conditions interact (disease synergy) and that competing risks or acquired frailty may either lessen or increase the impact of individual health interventions (Mosley, 1986; Mosley and Becker, 1991). These mechanisms may also complicate the link between intermediate measures of programme impact, such as morbidity or nutritional status, and their impact on mortality, further strengthening the case for measuring 'ultimate' impact (Ewbank, 1988; Gray, 1986). Moreover, there is now a much greater awareness that medical-biological inputs are not the only ones necessary for health to improve. A broader conception of how health improves has identified a host of social and behavioral changes, including the acceptance and effective use of services, that are necessary before any impact may be felt (Mosley and Chen, 1984; Gadomski, Black and Mosley, 1990).

Evaluating the mortality impact of an intervention, whether it is done in clinical or field trials or for programmes, usually involves two separate tasks: a measurement of mortality level and changes over time, and a test for a causal relationship between the change and the intervention. Both these tasks can present considerable difficulties, but they are much more difficult to carry out when evaluating an on-going programme of routine service delivery than when they are done under the more controlled conditions of research trials. The expense and complexity involved in measuring mortality, the limitations imposed on design of population-based impact studies by practical, political and ethical considerations, and the fact that programme evaluations are often carried out by personnel untrained in mortality measurement, have limited the number of successful programme impact studies carried out in less-developed countries (Ewbank, 1988).

The need for evaluation of programme impact is evident, because measures of mortality change are indisputable and influential indices of programme achievement. For example, chief among the "Goals for Children and Development in the 1990s" adopted at the World Summit for Children (WSC) in 1990, and now agreed by almost all countries, are these:

- Between 1990 and the year 2000, reduction of infant and under-5 child mortality rate by one third or to 50 or 70 per 1,000 live births respectively, whichever is less;

- Between 1990 and the year 2000, reduction in maternal mortality rate by half; ... (UN, 1990, p. 20).

In addition to the prominence these goals have been given by the WSC, both health programme managers and ministries of health want to know if the efforts and resources put into health projects have improved the well-being of the population, and one of the clearest measures of the success of a health intervention is a decline in death rates. Donor agencies want unambiguous evidence that their investment is worthwhile, and may take decisions about whether to continue support or to expand a programme based upon the evidence - or lack of evidence - of a change in mortality rates.

One drawback to using measures of mortality is that they respond to changes in numerous factors. Improvements in economic and social, as well as directly health-related, conditions all contribute to improved survival chances. Infant and under-five mortality rates are fairly sensitive indicators of overall development and related quality of life as well as the health status of a population, but are not very specific for measuring changes in any one factor (UNICEF, 1993; WHO, 1981b; Graham, 1986). They are very widely-used, however, and have been adopted by UNICEF for use in their influential publication *State of the World's Children* and for ranking national achievements in *The Progress of Nations* (1993).

Furthermore, the data bases for monitoring indicators of these ultimate programme and policy goals are not well-developed in the very countries where such monitoring is most needed, and the task of producing information for these purposes was perhaps initially underestimated. Nevertheless, it is now abundantly clear that the task of producing the information to evaluate policies and programme strategies is important (UNICEF, 1995).

The main problem is that in many settings where impact evaluation is desired, registration of vital events is neither complete nor accurate, and programme resources for evaluation do not permit full-scale prospective mortality studies. Epidemiologists and health workers often either underestimate the difficulties this presents, or think it is impractical to measure a demographic impact at all (Ewbank, 1988). Options exist, however, to obtain estimates of programme impact on mortality under these circumstances.

Another limitation of using mortality indicators in these circumstances is that standard (survey) estimation methods are often not sensitive enough to detect effects of short-term changes in health inputs. Service providers, health planners, and donors cannot wait long for evidence that their efforts and funds are well-directed. And, because death is a relatively rare event even in high mortality situations, large samples of the population are sometimes needed to detect changes. For all these reasons, assessing the true impact of a health intervention on mortality can be a costly and complex undertaking.

Presented with these problems, it is not always feasible to make strong statements about causality, attributing a change in mortality to the direct effect of a programme beyond a reasonable doubt, but neither is it always necessary to do so. For some purposes, rigorously conducted, yet simple, assessments may suffice. For other purposes, very demanding data collection methods and study designs may be necessary (Habicht and Victora, 1995).

With a view toward some of the intended uses of impact evaluations, the purpose of this paper is to review the appropriate measures and data collection methods that can be employed to assess the impact of health programmes with varying degrees of certainty. In the interest of brevity, this paper will focus only on measurement of childhood mortality. All of the drawbacks mentioned above pertain in even greater measure to assessing the second stated goal of the WSC, maternal mortality reduction, and may be even more difficult to resolve.

Demographers need to be involved in evaluation of health programmes delivered on a large scale because our expertise lies in measuring mortality at the population level even in the absence of reliable registration data. The challenge for demographers is to provide affordable methods to obtain valid, reliable mortality estimates that are sensitive and timely enough to detect short-term changes in mortality, and then to communicate that expertise to the programme evaluator and the health community.

A practical framework: what determines the design of impact evaluations?

In terms of evaluating the demographic impact of a health programme, Ewbank (1986) has framed the following questions an impact evaluation needs to answer:

1. Did the expected change in mortality occur, and when?
2. Was the change observed for age groups and causes of death consistent with the expected impact of the programme?
3. Was the change observed only among (or more pronounced for) the population groups served by the programme?
4. Were there changes in other factors concurrent with the programme that may also have contributed to the mortality change?

While demographic estimation and analytical methods have developed rapidly in the last 30 years, demographers have rarely been successful in providing an entirely satisfactory means to obtain answers to these questions for programmes implemented on a large scale, within the time frame most users of evaluations demand.

With unlimited resources (both time and money) these questions can be answered with a high degree of certainty. Yet even when resources are very limited, it is almost always possible to make some assessment of the level of mortality in a population, although very recent changes can be difficult to detect. What is more difficult, however, is testing for a causal relationship between a change and the intervention. When evaluating health programmes, it is rarely possible to achieve the high degree of certainty that a causal connection exists between its activities and an observed change in mortality that can be achieved in clinical and field trials (Ewbank, 1988). The most complex designs for assessing mortality impact may not be feasible when evaluating a health programme, especially in light of the sensible maxim: "An evaluation should not cost more than the intervention it is intended to assess".

In general, the stronger the statement to be made about the impact of a programme, the more costly the study design and data collection methods that must be used (Habicht and Victora, 1995). Ruling out the influence of all non-programme factors that might contribute to a mortality reduction is a costly and time-consuming exercise that usually need not be done in the context of a programme to deliver interventions which are known to be efficacious. However, it is still important to carefully assemble and cautiously interpret the findings; any impact evaluation must be rigorous, even if less complex than the ideal model of the randomized trial.

Demographic impact evaluation should not, of course, be attempted in isolation. An important adjunct to impact evaluation is operations research to evaluate the implementation of service delivery. Evaluation of programme coverage is also necessary, to ascertain whether the target population is being reached. If the services provided are not sufficient in terms of quantity and quality, if they are not used, or if they do not cover a sufficient proportion of the target population, an impact on mortality cannot be expected.

Levels of inference

Habicht and Victora (1995) have recently elaborated a practical framework for the design of evaluations, which attempts to take into account the intended uses of the results. Their framework specifies three levels of certainty at which statements about a causal connection between the programme and an observed change in mortality can be made. These are designated the levels of adequacy, plausibility and probability. Table 1 illustrates how the framework

can be applied to impact evaluations[1]. The basic premise is that the type of decision to be taken based on the results of the evaluation should determine the level of certainty required, and therefore the complexity of the study design.

At the simplest level, an "adequacy" evaluation asks the question: Is the expected change occurring? This type of study may be undertaken to decide whether to continue support for a programme, to initiate more focused evaluations, or to provide feedback to health workers that their efforts are successful. At the level of "plausibility", the evaluation asks: Does the programme seem to be the reason for the change? The type of decision to be taken based on the results of a "plausibility" evaluation might be to expand a small-scale service delivery project to a national scale or to provide public funds for a privately-funded programme. A "probability" evaluation asks: Is the programme having an impact, beyond any reasonable doubt? This type of evaluation should be undertaken before recommending the use of a new treatment or preventive measure. For example, clinical and field trials of oral rehydration therapy were undertaken before its use was recommended as part of diarrhoeal disease control programmes. Similarly, trials of Vitamin A supplementation were conducted to assess its impact on both mortality and morbidity prior to funding of new projects on a world wide scale.

Table 1
Categories of impact evaluation according to use.

Level of certainty	Impact evaluation question	Type of decision to be taken
Adequacy	Is the expected mortality change occurring?	Continue to fund programme; initiate focused evaluations; feedback evaluation results to sustain motivation
Plausibility	Does the programme seem to be the reason for the effect?	Expand the programme to other provinces/districts
Probability	Is the programme having an effect, beyond a reasonable doubt?	Recommend new intervention for large-scale implementation/fund international initiatives to promote intervention

[1] The Habicht and Victora framework has two dimensions: the level of certainty of a causal connection, and the aspect of the programme to be evaluated - provision, use, coverage or impact of the programme. Here, we focus only on impact evaluations.

An impact evaluation need be very complex only if it is meant to answer the question of efficacy: "Can this intervention prevent deaths?". Once an intervention is shown to be effective through randomized controlled trials, programme managers, donor agencies, and other users of evaluations may choose to make a detailed evaluation of some or all aspects of programme process (provision, utilization, and coverage of the programme) rather than spending a large part of programme resources on designing and conducting complex impact evaluations. Considering the costs associated with measuring mortality impact, it may not be necessary to demonstrate the precise impact attributable to the programme in order to decide on continuation, but only to assess whether or not the expected effect is taking place. Then it may be acceptable for programme evaluations to make statements about mortality change without seeking to measure all other non-programme influences. When this is the case, evaluators may simply need to examine whether a change in mortality occurred, concurrent with the programme operation.

If it is important to answer the question "How likely is it that this programme will have the same impact elsewhere"? the complexity of an impact study may fall somewhere in between these two extremes. The design of such a study might attempt to demonstrate that any change observed was more marked in the population receiving the intervention than among a control group, and will seek to rule out at least some non-programme causes of mortality declines.

A typology of mortality measurement for impact evaluation.

Both study designs and methods for mortality data collection and estimation used to measure impact will vary with the intended purpose of the evaluation. Criteria for selecting appropriate methods will be based on their precision, resource demands and suitability of the measures they produce, and these are suggested in the following section. It is not the purpose of this paper to exhaustively review study designs for evaluating mortality impact. Rather, what follows is meant to assist in choosing appropriate measures for impact evaluation by placing methods for collecting mortality data within this framework.

Adequacy - Hypothesis: The expected changes are/are not taking place.

This type of evaluation asks the question: Is mortality declining and if so, by how much? Impact is assessed with relation to established criteria for success that the programme is expected to meet. For example, in the case of an intervention to deliver Vitamin A supplements, mortality might be expected to improve by around 10% as a result of the intervention[2]. In the absence of such criteria, the adequacy of the programme in reducing mortality may be measured simply by examining time trends over the life of the programme -

[2] Personal communication, T. Stone; for a review of efficacy trials, see: Beaton GH. et al., (1993).

has mortality declined? Have deaths from specific causes of death most likely to be affected by the programme declined? Has the age-pattern of mortality changed, if the programme aims to reduce causes of death that affect particular age groups?

Such weak inferences about the impact of the programme on mortality may be established by examining mortality trends in the intervention area, or even at the national level. No attempt is made to relate programme activities to observed changes, but this simple evaluation can provide reassurance to both programme managers and donors that their expectations are being met, and may lead to continued support for the programme. If the findings of an adequacy evaluation are negative, this first level of impact assessment can demonstrate that further evaluation is necessary to identify the cause(s) of failure. In circumstances where it is known that other factors have deteriorated, such as in a famine or conflict situation, even a finding of no change may provide evidence that the programme provided a safety net which prevented increased mortality rates (Habicht and Victora, 1995).

This simple strategy for impact evaluation may also be used to evaluate whether gains achieved in the first years of a programme have been sustained over the long term. When process evaluations are carried out routinely for programme management, this type of impact evaluation can be conducted at regular intervals, perhaps every 5 or so years.

ADEQUACY EVALUATION

Hypothesis: The expected changes are/are not taking place

Questions: Is mortality declining, and if so by how much?

Has mortality in the target age-group declined?

Have deaths from specific causes targeted by the programme declined?

Design: Time trends - national or intervention area
Comparison to expected target

Indicators:

* Under-five mortality
* Sex and age specific rates
* Proportionate causes of death
* Seasonality

Data sources: Routine data from

* Registration of vital events
* Health service data
* Sentinel surveillance data
* Completed censuses or surveys

Requirements:

* Questions specified
* Data quality assessed
* Biases and limitations of evaluation design delineated
* No post-hoc rationalization

Data collection options

The data collection options and methods of mortality estimation chosen will depend upon the available data and the time frame of the "adequacy" evaluation. At this level of inference, a statement about mortality impact can frequently rely on available, routinely-collected data. Collection and analysis can often be completed very quickly at low cost.

In almost every country the most feasible option for assessing mortality impact is to monitor national trends. In the first instance, it is best to collate data and combine the estimates to examine the trend over time from all available sources. For many countries trends in mortality will only be obtainable from a survey or census. For some, a combination of survey, census and vital registration data may be available. Putting all the estimates on a time line, together with the date of intervention activities, is a start toward understanding the overall picture of how health improves in a population.

When vital registration data and a recent census are available and can be disaggregated appropriately, mortality rates can be calculated for the target population. Data from sentinel surveillance sites in the intervention area may also be examined for trends. With such data, it is usually possible to make yearly estimates (and sometimes quarterly or seasonal estimates), but the trend should be assessed over a longer term - five years or more - to ensure that any observed decline is real and not merely reflecting year-to-year fluctuations that occur by chance. Death certification and health service reports of deaths, may also be examined for trends in notified causes of death in the intervention area. Even incomplete data can provide suggestive evidence of impact if particular causes of death are more likely to decline due to the intervention.

There is often a need for local or district-level mortality data, where more information is available on the coverage or activity level of the programme. The Preceding Birth Technique, a method of mortality estimation based on asking questions of mothers coming to health services shortly before delivery or after a recent birth may be used to estimate mortality rates on a routine basis at this level (Brass and Macrae, 1985; Hill and Macrae, 1985; Hill and Aguirre, 1990). Although the absolute value of the rates obtained in this way may be biased due to selective use of the health services, these data can provide a trend over time among users of the services. This method provides no information about the age-pattern of mortality, but records could be augmented, for example by adding more detailed questions about circumstances of the death and status with respect to specific treatments or preventive measures.

Information on the trend in mortality can also be obtained in a single-round survey, using direct (birth history) or indirect (children everborn/surviving) estimation methods. The drawback for programme evaluators is the time lag these methods entail. If previous surveys have been conducted these may provide a baseline for assessing expected changes. The most recent survey

estimates produced will refer to a time period at least two, and possibly as long as five years before the survey took place, depending upon the method of estimation[3].

Plausibility - Hypothesis: The programme appears to be having an effect.

This type of evaluation seeks to make a stronger statement: that the observed difference in mortality is apparently due to the programme. At this level, an evaluation seeks to rule out some, but not all, external influences as causes of a change or a difference in mortality rates, and may be initiated even after the start of the programme. The design of such an impact evaluation aims to detect whether the mortality reduction is more pronounced among the target population or among specific age groups most likely to be affected by the programme than among non-recipients.

Making this slightly stronger inference about the impact of a programme requires mortality to be measured in the target population and compared with mortality in a control group, with a baseline measure in the target group dated prior to the start of the intervention (before-after), or both of these. If mortality is lower among the target population (or programme recipients or a target age group) than among the control group, or if a change in mortality in the target population is observed compared to the measurement made prior to the intervention, some external causes can plausibly be ruled out. As in an adequacy evaluation, trends in notified causes of death can also be compared if these data are available from routine health statistics.

Any inferences derived from these comparisons depend on the plausibility of the assumption that the groups compared do not differ in other important ways that may affect mortality. This assumption, and any evidence to support it, should always be clearly stated when presenting and interpreting the results of a plausibility evaluation.

Plausibility statements form a continuum from weak to relatively strong, depending upon the design of the evaluation and the methods used to collect and analyze the mortality data.

[3] See David PH. (1996) *Measuring the Impact of Health Interventions: A guide to mortality measures, (draft)*, Ottawa: Micronutritient Initiative, for a more extensive review of the data requirements, strengths and limitations of these demographic methods.

PLAUSIBILITY EVALUATION

Hypothesis: The programme seems to be having an effect.

Question:

Was a change observed only among (or more pronounced for) the population served by the programme?

Design:

Intervention/control comparison
Before/after comparison
Before/after comparison among intervention/control groups

Indicators:

* Under-five mortality
* Sex and age-specific rates
* Odds ratio (exposure to intervention among deaths and survivors)

Data sources: As for "adequacy" and

* New retrospective surveys
* Multi-round surveys
* Case-control studies

Requirements: As for "adequacy" and

* Collect some data to evaluate comparability of intervention/control groups
* Exploit existing data sources for baseline and secular trend
* Sample sizes must be adequate for comparisons

Data collection options

The desired strength of the plausibility statement, the level of resources available, and the time frame for the evaluation will determine the choice of method for mortality estimation.

In the short term, countries with routine data (even if incomplete) from both intervention and control areas can assess whether an intervention is having an effect beyond external influences. It may be possible to calculate vital rates for time periods before and after the intervention, or for intervention and comparison areas after the intervention has taken place. A delay of at least a

year from the date when an impact on mortality is expected is required before a change in infant mortality can be detected.

Where a sentinel surveillance site operates or where routine health service data can be used to identify deaths, retrospective case-control studies can be carried out relatively cheaply to compare trends in intervention and control areas. Cases of deaths may be identified in health service records, and matched for important confounding factors with survivors identified from the same records or from the population. It is possible to use standard survey methods to identify recent cases of death and matched controls from a population-based sample. Deaths identified in a survey can be compared with a sample of survivors (matched for important confounding factors with the cases) and their status with regard to the intervention ascertained.

Deaths identified in health service records may also be used as cases if it is possible to find and interview a close relative (preferably the mother), or if data on the child's age, sex and receipt of the specific intervention is accurately recorded in the child's records. The case's exposure to the programme intervention should then be compared to that of at least one survivor, preferably using the same source of such data and reference period as that of the case. The odds of exposure to the intervention in the cases (deaths) are compared with the odds of exposure among the controls (survivors). This will allow a plausibility statement to be made about the likely size of the impact of the intervention.

If the cases (deaths) are identified in a survey, special attention to the phrasing of questions designed to elicit reports of recent deaths will be necessary. Retrospective ascertainment of "treatment" status (exposure to the programme) is subject to recall errors, and case control studies must be carefully designed to avoid this and other sources of bias. These studies, while cheaper than prospective surveillance, can pose special problems and require good technical resources for proper execution[4].

Over the longer term, a comparison of trends in intervention and control areas may be possible using existing census and survey data, or, if resources permit, a new cross-sectional survey can be conducted.

The full birth history is likely to be the most appropriate retrospective method for obtaining new data to evaluate impact[5], but requires careful training and is used most successfully where there is good knowledge of ages and dates. If collected in a well-conducted survey, a birth history will provide information on survival of children born during specified periods as well as age-specific risks.

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[4] See Smith P. (1987); Victora C. (1992). Also see Cutts F. et al., (1996) for a report of a mortality survey with nested case-control study to examine risk factors for child death.

[5] The children everborn/ surviving, or Brass, method is rather limited for evaluation purposes. It will provide the time trend in mortality from about 5 to 15 years prior to the survey. Although robust to reporting errors, this method smooths out trends, and will reveal only large fluctuations that may occur.

Birth history methods provide a trend from two and a half to about twelve years prior to the survey, and if data are of very high quality, can also produce trends in the age-pattern of mortality over that time. Estimates are usually calculated for 5-year bands, either for a cohort of births or true period rates. These, too, are smoothed trends, but if sample sizes are large enough, rates for shorter time periods could be calculated. The most recent estimate of infant mortality that birth histories can usually provide is dated between two and three years prior to data collection.

Short birth histories (including only the last 2 or 3 births, or births in a specified period) may also be employed to obtain an estimate of mortality within 2-3 years of the survey. Depending on the level of fertility in the population, this method may be quicker to implement than the full birth history, but also requires careful interviewing and is subject to accuracy of mother's recall of dates. The experience with this method is mixed (David, Bisharat and Kawar, 1990; Osinski, et al, nd).

Multi-round surveys can be used for the same purpose, and if well-conducted can date the estimates of mortality more precisely. However, poorly-planned multi-round surveys may yield less reliable estimates than one good cross-sectional inquiry and can suffer from other limitations (Tabutin, 1984; van de Walle, 1990; Ewbank, 1988).

Probability - Hypothesis: The programme is having an effect, beyond a reasonable doubt.

This type of evaluation asks: Is the effect real, and not due to chance, confounding factors, or bias? This type of impact study should be undertaken before recommending the use of a new treatment or preventive measure. In order to ensure that this, the strongest causal inference, can be made a special impact evaluation study must be planned before the intervention begins. Any measured change in mortality should be more marked in the intervention group than among the controls. Eligible individuals or areas must be randomly allocated either to receive the intervention or to be part of the control group. Random allocation is needed to ensure that those receiving the intervention do not differ from non-recipients in ways that may significantly affect their mortality. If possible, the investigators conducting the evaluation should be unaware of which individuals or areas are recipients (a double-blind design), but in the case of community-based service delivery programmes a double blind design is impracticable.

These elaborate study designs are better reserved for tests of the efficacy of new interventions - to answer the question "Can this intervention reduce deaths"? The research question requires this level of causal inference, but the data requirements are unlikely to be met within the resources of a programme evaluation.

Data collection options

To state that an intervention caused a change in mortality beyond all reasonable doubt requires collection of prospective surveillance or longitudinal study data to ensure detection of all deaths, and excellent control of all possible confounding factors. Recipients and non-recipients are compared, before and after the intervention.

A complete census and continuous surveillance of vital events may be used to provide precisely-dated mortality estimates before and after the intervention in intervention and control areas (or among programme acceptors and non-acceptors). Losses to follow-up must be carefully monitored in prospective studies to ensure that results are not biased by differential drop-out rates in the two groups. The follow-up period may vary, but more than one year of follow-up may be necessary to allow sufficient time for an effect on mortality to be observed and to rule out all external causes. To assess whether the intervention had an impact on specific causes of death, investigators may also plan to collect information about symptoms associated with the deaths (see, for example, Snow, 1992; Chandramohan, 1994).

Such intensive studies are usually far too costly to use for a programme evaluation, except where the programme is planned for an area already under surveillance. Careful planning may then allow randomization, but ethical considerations may require more complex designs, such as phased implementation (Smith and Morrow, 1991).

Table 2 summarizes the choices available for measuring the mortality impact of an intervention according to the level of inference required and the data collection systems available for use.

Table 2
Typology of mortality data collection and estimation methods for different types of impact evaluation.

	Data collection system:						
Level of inference:	Vital registers	Routine health records	Single-round survey	Census	Multi-round survey	Longitu-dinal survey	Surveil-lance system
Adequacy	Trends in intervention area						
Plausibility	Comparison of levels and/or trends (before-after) in intervention and control area						
Probability						Before-after comparison in intervention and control areas, with random allocation	
Estimation method (time lag for most recent estimate):							
Direct death rates (1 yr.)	X					X	X
Full birth history (2½ yrs.)			X		X		
Short birth history (2½ yrs.)			X		X		
Brass (Children ever born/surviving) (4 or more yrs.)			X	X			
Preceding birth technique		X (1½ yrs.)	X (2-2½ yrs.)				
Survival of most recent birth (1 yr)			X	X	X		

Conclusion

In summary, evaluations of impact can examine different hypotheses: that an impact on mortality has occurred, that it appears to be due to the programme, and that all other possible explanations of the decline have been ruled out. Evaluations can be designed to make statements about each hypothesis, the stronger statements requiring the more complex and expensive study designs and methods of collecting mortality data.

The difficulties inherent in attributing a mortality decline directly to an intervention mean that it is essential that programme impact evaluations measure "process" indicators, too - changes in provision and utilization of services, and changes in programme coverage, especially coverage of the target population (Habicht and Victora, 1995). Figure 1 illustrates the questions an evaluation asks at each stage of the programme cycle. Any improvements in the process indicators usually precede changes in observed impact, which may not be picked up immediately by the existing methods of mortality estimation. If the process indicators monitored as part of an evaluation point in the right direction, any statement that mortality has declined as a result of the intervention becomes more plausible and may be sufficient for most programme needs.

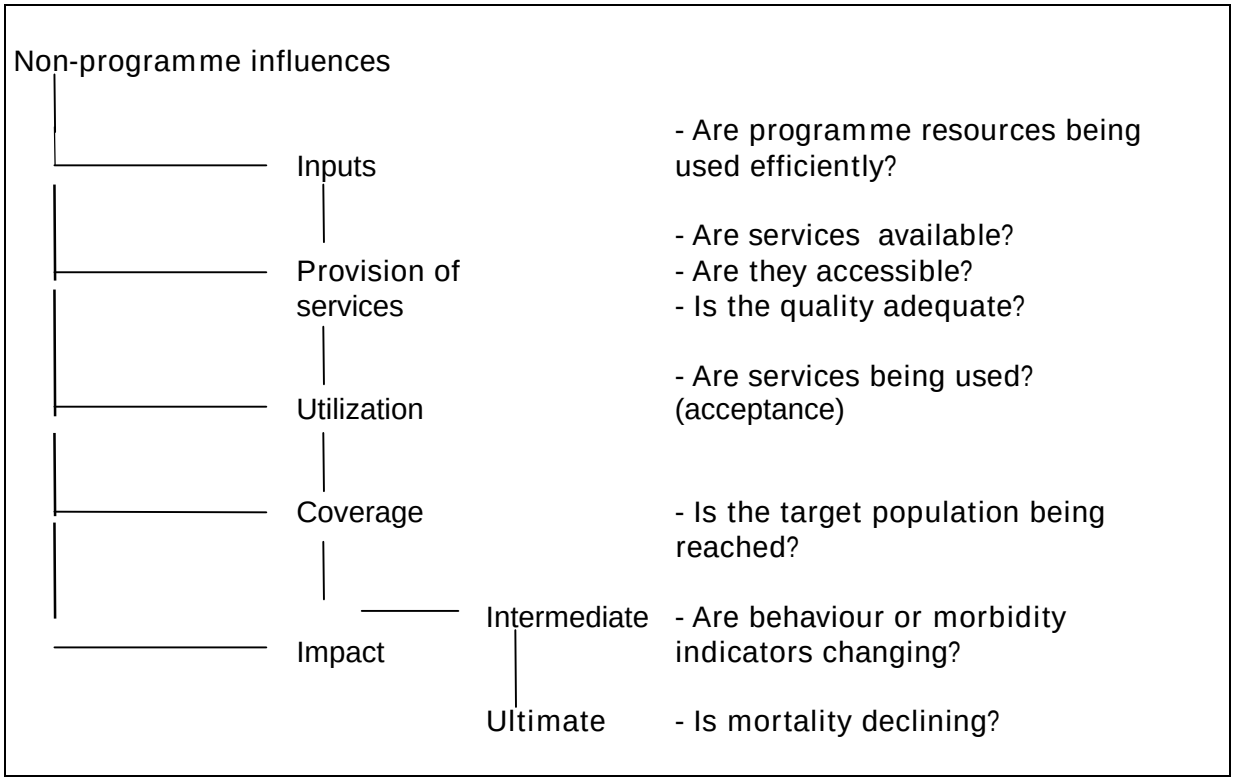

Figure 1. Programme cycle.

If a recent census, demographic, or health survey has been conducted in the study area, obtaining the data or the necessary tables to make estimates of

levels and trends in mortality using the survey estimation methods is a reasonably simple place to begin an impact evaluation. This can provide important baseline information and pre-intervention trends. Demographers can assist programme evaluators in the interpretation of secular trends in mortality.

Making use of existing sources of mortality data is almost always cheaper than collecting new data. Whatever the aim of the evaluation, every effort should be made to assemble all the available mortality data. Multiple sources of information, if of acceptable quality, are better than a single source and can lend support to any inferences made.

If vital statistics are routinely produced, working closely with the responsible government office may yield a great deal of timely information. It may be possible to ask for special tabulations and breakdowns of routine statistics so that comparison areas may be examined in relation to intervention areas. Even if these data are known to be incomplete, they may provide trend information very cheaply, provided reporting does not change.

When new survey data have been collected, results can be plotted along with trend estimates from earlier censuses and surveys to examine the general slope of mortality decline, revealing changes in the rate of decline. This also provides the evaluator with an indication of how well different estimates match up and can give an indication of how much measurement error may have occurred in the new survey. Here, again, demographers can assist programme evaluators in assessing the quality of data from different sources. Mortality estimates from different data sources can be combined to assess the timing and extent of a reduction in mortality.

It is the change in the rate of decline that indicates a programme effect, but precisely detecting a change in the rate, or a difference in the rate of change for an intervention-control comparison, may not be possible with retrospective survey methods. The large sample size requirement for such a comparison is not the only handicap; reporting errors may vary between a baseline and follow-up survey (Ewbank, 1995). Mis-dating of events is particularly serious. Whichever level of inference the evaluation requires, biases due to measurement error are likely to be the most serious ones arising from use of survey data. The collection of these data must be careful and well-supervised.

Finally, an evaluation should produce results which can be used to improve project implementation. To aid in understanding how a programme affects mortality in high-risk subgroups, analyses should aim to provide breakdowns of results for various characteristics of the areas or individuals under study, within the limitations of sample size and data availability.

For example, if a cross-sectional survey is conducted, with little extra cost additional information can be obtained about education of parents, distance from service points, or language or religious affiliation. If differentials are observed, they may provide clues to appropriate actions to improve project

operations and can suggest how to design more focused evaluations. Reaching families at greatest risk may require re-structuring of service delivery, or re-training of first-contact providers.

Of the difficulties facing programme evaluators, the most intractable may be the detection of change in mortality from one year to the next. For evaluating mortality impact within a limited project life span (say two to three years), data must be obtained from an on-going collection system: the existing vital registration system, special prospective studies or demographic surveillance, or from health service records or sentinel sites. Demographers can suggest improvements to on-going surveillance or sentinel data collection, providing advice on how to set up data bases that will allow linkages between parents and children and other members of the household.

If routinely-collected data is not available, evaluators must think in the longer term when attempting an impact evaluation. Mortality impact may be detected using survey methods but due to the time lag caused by the retrospective nature of the questions, it may not be possible to detect an impact on mortality until after the project has ended. In some cases, this may defeat the purpose of the evaluation.

Some hope still lies in the use of maternity histories, which can provide age-specific risks as well as trends in mortality indicators. Changes in the age-structure of mortality can provide important clues to programme impact (Boerma, 1986), and monitoring changes in sex-related risks and seasonal patterns of death can also provide circumstantial evidence of programme impact (Cutts et al., 1996; Rashad, 1989, 1991, for examples). However, recent experience with maternity histories in Africa, used by the USAID-sponsored CCCD programme, has proved disappointing (Ewbank, 1995). Administration of birth history questionnaires by health personnel in rapid surveys has also proved difficult (David, Bisharat and Kawar, 1991; Osinski, et al., nd).

The demographic community can contribute to improved planning and policy-making by giving advice to programme evaluators on how to improve the quality of data collected in special studies, particularly birth history data, and by helping them to make full use of census data, which can provide mortality estimates for district-level disaggregation.

Demographers have not yet provided good measurement tools for evaluating programme impact that are feasible for use within programme budgets. Indirect survey measures do not produce timely indicators of mortality change, nor are they sensitive enough to register short term trends. And their reliance on models requires assumptions that may not remain tenable over the course of health programme activities. And yet techniques robust to reporting errors are needed in most areas where special studies must be conducted to obtain mortality estimates. More work is needed to develop timely methods for detecting short-term changes in survival, with mortality indicators that are reasonably specific yet robust to error.

There are a few promising avenues. While experience with questions about deaths in the last year has been poor, Blacker's work suggests that asking the date of the last child's birth, and ascertaining this child's survival status at the time of a census or survey can produce a very recent estimate of infant mortality (Blacker, 1993). The proportion dead of births in the last two years is converted to an estimate of infant mortality. Using births in the last two years doubles the number of births available for analysis and eliminates the problem of age-heaping on 12 months for age at death, but the method has not been widely-tested.

The opportunities for testing practical applications of new techniques are available. For example, there has been a great deal of interest among the major donor agencies in methodological developments such as the Preceding Birth Technique, which can provide very recent estimates of mortality (WHO, 1994; BASICS, 1995; David, Sloggett and Blacker, 1994; David and Hill, 1992). This method is particularly attractive because it might be used within sustainable monitoring systems (Vernon and Stroh, 1993). Additional data may be collected at the same time, including information on the circumstances of any deaths identified. Such data may reveal instances of "missed opportunities", which can be useful for re-structuring and strengthening services and targeting programme activities.

The users of evaluation findings need to understand what demographic methods can offer, as well as their limitations, in order to incorporate them into the evaluation process. There is no one best method of collecting and analyzing mortality data for every purpose. The methods should be chosen realistically, with the intended uses of the evaluation and the programme resources in mind. The demographic community must make an effort to communicate our expertise and concerns to evaluators, policy-makers, donors and programme planners. We can contribute to more well-informed policy and programmatic decisions if we provide evaluators and programme managers with the information they need to choose the most appropriate methods for impact evaluations, and make a concerted attempt to meet the remaining measurement challenges they pose.

Abstract

Measures of changes in mortality rates are influential indicators of programme achievement, but obtaining mortality information is not always a straightforward task. In many settings where health programme evaluations are planned, registration of vital events is neither complete nor accurate, and programme resources for evaluation do not permit full-scale prospective mortality studies. This paper provides a typology of available options for collecting data to evaluate the impact of a health or nutrition intervention on child survival.

Evaluations of impact can examine different types of hypotheses: that a change in mortality has occurred, that it appears to be due to the programme, and

that all other possible explanations of the decline have been ruled out. Evaluations can be designed to make statements at each level, the stronger statements requiring the more expensive study designs and methods of collecting mortality data. Complex evaluations to assess a programme impact on mortality should not be carried out before ensuring that indicators of service provision, use and coverage (process indicators) are all moving in the expected direction.

The research designs required to attribute an impact on mortality to a specific intervention, eliminating the influence of all other factors, are beyond the resources of programmes meant to deliver services. Nevertheless, some assessment of the influence a programme has on mortality rates can be made in almost every setting.

No one best method of collecting and analyzing mortality data exists. The methods used should be chosen realistically, with the programme resources and the intended uses of the evaluation in mind. The challenge for demographers is to provide affordable methods to obtain valid, reliable mortality estimates that are sensitive enough to detect short-term changes in mortality.

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4

Direct and indirect estimates of mortality changes : A case study in Mozambique

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During the past century, the world has witnessed dramatic mortality changes. In Europe and in other developed countries, the mortality decline has been continuous and regular, with the exception of major political crises such as the two world wars, and of epidemics highly limited in time, such as the 1918 influenza epidemic. In developing countries, mortality changes were more contrasted. In some cases, mortality decline started late and was very rapid (China, Sri Lanka, Cuba) or less rapid (most of Latin America); in other cases it started early but was slow, though regular (Pakistan; India); in Africa it started late, and was slower than elsewhere; in Russia, it started later than in Europe, was quite rapid between 1945 and 1970, then stopped and even reversed recently (Meslé and Vallin, 1995). In some African countries, mortality is even expected to increase in the near future because of the AIDS epidemic, as exemplified by the case of Abidjan (Garenne et al., 1995), or because of major political crises, such as that described below.

Mortality changes are primarily due to public health interventions and to modern medicine, although life style, education and nutrition also play a significant role. In developing countries, small scale health interventions have obtained very rapid mortality changes, even in the absence of any significant change in income, education or other socio-economic indicators. In three Gambian villages totaling about 2,000 people, infant mortality (age 0 to 1 year) and child mortality (age 1 to 5 years) have been reduced by 80 % in a period of ten years (1974-1983) following the arrival of a full time physician and a nurse (Lamb et al., 1984). In Senegal, when compared to the baseline period (1984-1986), mortality of under-five children has been reduced by 52 % (from 329 to 159 per 1,000) within only three years (1987-1989), following a massive

intervention, including mass vaccination, and systematic treatment of diarrhea and of acute respiratory infections (Garenne et al., 1991).

One of the important methodological questions for demographers is how to evaluate rapid mortality changes and the impact of health interventions. In theory, a prospective monitoring of deaths over time and a proper registration of causes of death cover the issue, as shown in the case studies of The Gambia and Senegal (Garenne, 1994). When possible a control area can be added to improve the value of the demonstration, as in the case of Matlab, Bangladesh. However, this is not always possible outside of research sites, and in particular in places without a continuous registration of births and deaths. Often, an evaluation scheme is not built in to health projects, and one has to rely on retrospective evaluation after the project is completed.

Two methods of calculation of death rates have been proposed to conduct the retrospective evaluation of interventions : direct and indirect approaches. In direct approaches, death rates are calculated by dividing deaths by the population at risk, or by reconstructing the Lexis diagram (both are equivalent). The direct approach requires full information on the target population by age and sex, and on deaths by date, age and sex. In the indirect approach, the amount of information required is smaller. Age of the respondent (and not of the deaths) is enough to make inferences about death rates. A model, based on model life tables, allows one to convert proportions of children dead into life table estimates. For instance, in the so-called Brass method used for indirect estimation of child survival (Brass and Coale, 1968), the only information required to compute the probability of death of children is the proportion of children already dead at time of survey to women in a given age group. The indirect method can also be used to reconstruct mortality trends, assuming a linear mortality decline. More details on indirect methods can be found elsewhere (United Nations, 1983).

Indirect approaches have been used for evaluating health interventions (Ewbank, 1993), but have been severely criticized (Chen et al., 1993). In the case of child survival, they seem to present two problems: a problem of accuracy, since their confidence intervals are larger than those of direct estimates (Garenne, 1982; Garenne, Sauerborn, Borchert et al., 1995), and a problem of fitting mortality changes other than regular linear decline.

Based on a case study in Mozambique, this paper is an attempt to show the biases that characterize indirect approaches in the case of complex mortality changes, involving a reversal and rapid decline of mortality consequent on an intervention.

Data and Methods

The study was conducted in the *Maringué* district, *Sofala* province in Central Mozambique. Its aim was to evaluate previous trends in child mortality and the

impact of a child survival intervention conducted by the International Committee of the Red Cross (ICRC).

Mortality data from Mozambique are very scarce. Pioneer work based on the 1940 and 1950 censuses indicated that the central area of Mozambique had the highest levels of child mortality. After correcting for data deficiencies, q(5), that is the probability of dying between birth and the fifth birthday, (also called the death rate of under-five children), was estimated to be 440 per 1,000 around 1948 (Heisel, 1968). Further estimates indicate that mortality had declined in the whole country in the 1960s (Carvalho, 1983), and had increased afterwards (Hill, 1991). However, major deficiencies were found in the census data (Mendonça, 1982). There was no reliable registration of births and deaths in Mozambique over the past 50 years.

In order to circumvent the lack of demographic data, the study aimed at reconstructing past experience as well as recent changes in child mortality. A random cluster sample of 30 villages each with 50 women aged 15 to 60 years was selected. Altogether, 1,503 eligible women were interviewed. For each woman, a full maternity history with sex and date of birth of each child was recorded. If the child had died, age at death and cause of death, as perceived by the family, were recorded. These data contained full information both to reconstruct a Lexis diagram and therefore to compute period and cohort death rates, and to compute indirect estimates. Direct period estimates were obtained by single year of age by assuming a constant separation factor of 0.667 in each age group from age 0-1 to 4-5 years. Indirect estimates were calculated assuming a mean age at childbearing of 29 and the South Asian pattern of mortality using a standard software package (Mortpak-Lite). Further details on the survey and the computations can be found elsewhere (Garenne et al., 1996).

Results

Death rates were computed by single year of age from age 0 to 4 and for each year from 1975 to 1994. Before 1975, data had to be grouped by 5-year periods to ensure statistical validity, since the number of deaths was small. They could be compared to earlier estimates. Since all age groups were evolving the same way, only q(5), the probability of dying between age 0 and 5 will be considered thereafter.

Mortality during the colonial period

The under-five death rate was declining during the colonial period, and estimates derived from the survey were consistent with previous (corrected) estimates for the Central region (Table 1).

Table 1
Estimates of under-five mortality during the colonial period, Mozambique, Central region and *Maringué* district.

Geographical area	Period	q(5), per 1,000	Number of deaths
Central Mozambique (1)	1945-1949	440	Large
Maringué district (2)	1955-1959	373	26
idem-	1960-1964	350	58
idem-	1965-1969	245	98
idem-	1970-1974	270	175

Sources : (1) Heisel (1968); (2) Garenne et al., (1996)

Direct yearly estimates : 1975-1994

After independence (1975), the country went through a period of deep troubles. The civil war started shortly after independence, and culminated in the mid 1980s. In the late 1980s the guerrilla movement diminished its activities. The civil war formally ended in 1992 with the signing of the peace agreement. This period of civil unrest was highly visible in the changes in mortality of children (Table 2, Figure 1). Mortality fluctuated between 245 and 300 per 1,000 during the last years of colonization and the first years of independence. It started to increase dramatically in 1980 and culminated in 1986 to reach the highest value ever recorded in this area (473 per 1,000), bringing the level of mortality back to what it was 40 years before and even higher. Later, mortality went down for a few years, and reached a plateau around 374 per 1,000 in the years 1989-1991.

Table 2
Direct estimates of under-five mortality,
***Maringué* district, Mozambique, 1975-1994.**

Period	q(5), per 1,000	Number of deaths	Period	q(5), per 1,000	Number of deaths
1975	268	42	1985	449	102
1976	285	48	1986	473	115
1977	296	50	1987	443	109
1978	262	48	1988	396	100
1979	282	52	1989	365	101
1980	316	64	1990	374	109
1981	324	60	1991	380	113
1982	352	68	1992	369	110
1983	364	72	1993	324	90
1984	406	94	1994	269	83

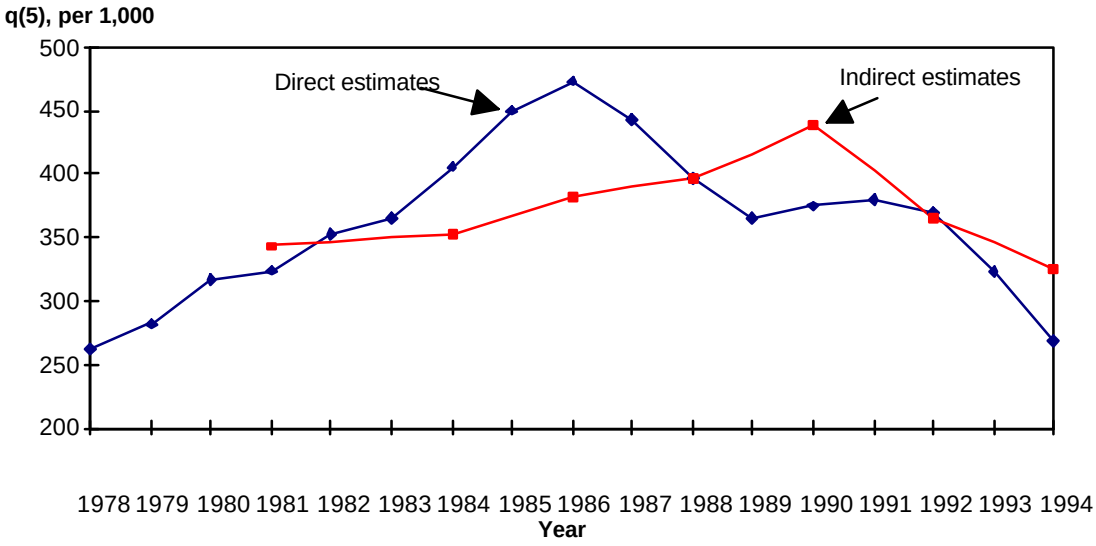

Figure 1. Mortality change in the *Maringué* district, Mozambique : 1978-1994.

Effect of the child survival intervention

Intervention of the ICRC started in late 1991, and focused on vaccination of eligible children below age 5 (BCG, measles, DPT, polio), on vaccination of

women of reproductive age (tetanus toxoid), and on vitamin A supplementation for children aged 6-59 months.

The effect of this intervention on death rates were highly visible (Table 2, Figure 1). Mortality, which was stable during the 3 years prior to intervention (1989-1991), started to decline again, and reached a (relatively) low value of 269 per 1,000 in 1994, which corresponds to a mortality decline of 28% in three years, a remarkable achievement.

Causes of death

The mortality decline during the intervention period (1992-1994) was highly significant (P = 0.017), and could not be explained by the trends in the years before 1992. It could be confirmed by the analysis of changes in mortality by causes of death. Although the information on causes of death was limited, it was considered informative for a few causes, such as measles, tetanus, diarrhea, and severe malnutrition. The analysis of changes in death rates revealed that all of the change from 1991 to 1994 was attributable to a decline in mortality from measles, tetanus, diarrhea and malnutrition, the target diseases of the intervention (Table 3). The mortality from "other and unknown " diseases did not change at all over the same period. This showed *a posteriori* that the mortality decline could reasonably be attributed to the health intervention.

Table 3
Changes in under-five death rates by cause from 1991 to 1994, (per 1,000)
Maringué **district, Mozambique.**

Cause of death	Period mortality : q(5), per 1,000				% mortality decline explained
	1991	1992	1993	1994	
Measles	88.2	94.7	35.6	11.8	68.6
Tetanus	27.1	13.1	11.9	11.8	13.7
Diarrhea & dysentery	71.2	71.9	86.1	59.2	10.8
Malnutrition	30.5	29.4	23.7	21.7	7.9
Other & unknown	162.8	160.0	166.2	163.9	-1.0
All causes	379.9	369.1	323.6	268.6	100.0

Indirect estimates

Indirect estimates were computed for women aged 15-49 years, since recent sets of parameters and current computer software do not cover the age groups 50-59, as was the case in the earlier estimates by Brass and Coale. They provide estimates of child mortality over the 13 years before the survey (Table 4).

As could have been anticipated, indirect estimates provided some kind of weighted average of direct estimates. Indirect estimates reflect only to a small extent the direct mortality changes, that is an increase during the civil war period, and a decrease thereafter. However, many discrepancies, which were essential in this context, could be noted (Figure 1) :

- First, the length of the time period covered was much shorter. Whereas direct estimates could provide yearly estimates for 20 years before the survey (1975-1994), and reasonable 5-year estimates for the previous 20 years (1955-1974), indirect estimates covered merely 13 years (January 1981-January 1994), about one third of the period covered by direct estimates.

- Second, the peak of mortality noted in the direct computations (1986) was severely displaced by 4 years (it shifted to 1990), making impossible any firm conclusion about the effects of the civil war.

- Third, the magnitude of the mortality increase during the civil war was strongly reduced. During this period, direct estimates of q(5) increased by 81 %, from 262 in 1978 to 473 per 1,000 in 1986, whereas indirect estimates increased only from 342 (January 1981) to 439 (July 1990), an increase of 28 %, that is about one third of the true increase.

- Fourth, and most important, from indirect estimates the mortality decline after 1990 appeared quite regular, and could not reasonably be attributed to the intervention. The mortality change from 1992 to 1994 (370 to 334) was in the same direction and of smaller magnitude (-10 % versus -16 %) than the change from 1990 to 1992 (439 to 370). The change from 1992 to 1994 was not even statistically significant, when the direct estimates showed the opposite : a stagnating mortality from 1989 to 1991, and a strong and significant mortality decline between 1992 and 1994. Using indirect estimates in this case could have been indeed very misleading.

Table 4
Indirect estimates of child mortality rates,
***Maringué* district, Mozambique (1994 survey).**

Age group of women	Number of women interviewed	Proportion of children dead	Age at which estimate applies (i)	Indirect child mortality estimate q(i)	Time at which estimate applies (t)	Derived estimate of q(5) at time (t)
15-19	217	0.2319	1	0.193	Jan-94	0.334
20-24	296	0.2990	2	0.290	May-92	0.370
25-29	267	0.3891	3	0.391	Jul.-90	0.439
30-34	180	0.3794	5	0.397	Sep.-88	0.397
35-39	184	0.3893	10	0.417	Oct.-86	0.385
40-44	128	0.3747	15	0.394	Jul.-84	0.353
45-49	122	0.3841	20	0.395	Jan-81	0.342
50-54	60	0.3757				
55-59	48	0.4071				

Source : from maternity histories, using the South Asian model life table, and Mortpak-lite.

Conclusion

There is nothing surprising about the discrepancies between direct and indirect estimates, even when it is known that they originated from the same data set. By definition, the indirect estimates are a weighted average of direct estimates, the weights being proportional to the number of deaths of children from women in each age group. The very marked mortality changes, accurately observed with the direct estimates, were smoothed out and even displaced with the indirect estimates.

Although indirect estimates could give a relatively good fit for a steady mortality decline, an indirect approach could never fit the complex pattern of mortality changes here. Using indirect estimates in this case would have led to an underestimation of the effect of civil war and to a wrong conclusion about the effect of the intervention. Even if these circumstances may look

exceptional, they are typical of the cases for which one wants to evaluate mortality changes, either after a crisis, or after a health intervention. In cases where mortality decline is regular and continuous, other sources of data would usually provide useful information. Therefore, indirect estimates are unlikely to be of any use to monitor dramatic mortality changes in developing countries.

Direct estimates, together with information on causes of death, remain the only way to provide useful information for monitoring mortality changes. Technical issues for the measurement of mortality using retrospective information have been discussed for a long time. Basic interview techniques for child mortality, using maternity histories, have been tested and successfully experienced for decades in developing countries, in particular with the World Fertility Surveys and the Demographic and Health Surveys. The quality of direct mortality estimates is simply the product of the quality of the field work. However, it should be remembered that retrospective information always has some minor selection biases built in.

More efforts could be devoted to the analysis of causes of death. Verbal autopsies have been successfully used in research settings (Garenne and Fontaine, 1986; Gray et al., 1991). They can provide the best information available in places where access to modern health facilities is limited and where a large proportion of deaths occur outside of hospitals. Unfortunately, their use is still rare, although it could dramatically improve the quality and quantity of information to demonstrate the effect of either a negative situation (a crisis) or a positive improvement in mortality (a health intervention).

Abstract

The paper compares direct and indirect estimates of mortality changes in *Maringué*, a district of central Mozambique. Direct estimates based on the maternity histories of 1503 women aged 15-60 years showed complex changes in q(5), the probability of dying of children from birth to their fifth birthday. During the colonial period (1955-1974), q(5) declined from 373 to 270 per 1,000. During the civil war period (1975-1991), it increased rapidly to reach a peak of 473 per 1,000 in 1986. It declined again thereafter and reached a plateau of 380 in 1991. A health intervention conducted by the International Committee of the Red Cross since 1992 reduced mortality to 269 per 1,000 in 1994. Most of the decline was attributable to vaccinations, in particular measles vaccination, and to Vitamin A supplementation.

Indirect estimates based on the same data appeared very biased. Although they did also reveal an increase in mortality, followed by a decrease, they tended to smooth out the rapid changes in mortality, and therefore to underestimate both the effect of the civil war and the effect of the intervention. Furthermore, the peak in mortality was dislocated, and pushed 4 years ahead, which made impossible any interpretation on the impact of the intervention.

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5

The potential of the demographic and health surveys (DHS) for the evaluation and monitoring of maternal and child health indicators

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The DHS Survey Program was started in 1984 by the United States Agency for International Development (USAID). The main objective of the DHS program is to provide governments of participating developing countries with highly-reliable, high-quality data on a number of issues which can be of assistance in the development of programs and the monitoring and evaluation of those programs. The main areas included in the DHS survey relate to family planning and maternal and child health. The program was a follow-on to the World Fertility Survey which took place from 1972-1984 and which was more strongly related to family planning and infant and child mortality than to maternal and child health, as is the DHS survey.

The Demographic and Health Surveys are usually national in scope and have sample sizes of women aged 15-49 years which typically are in the range of 3,000-10,000, although there is considerable variation. Another feature of the DHS program is that there is a strong attempt being made to make data comparable across countries which should aid in comparing the achievement in the areas of family planning and maternal and child health across countries.

Content of the surveys

The general content of the surveys as related to maternal and child health can best be summarized briefly in the following manner.

- A birth history which typically provides information on all children born to women in the sample, including children that have died. Information is also collected in some surveys on miscarriages, although no real attempt is being made to try to measure induced abortion rates due to the difficulty of obtaining reliable data on that topic.

- Information on whether or not the child has been delivered by caesarean section.

- Data on whether the woman has received tetanus toxoid immunizations during pregnancy.
- Prenatal care related to whether or not care was sought during pregnancy.
- Family planning. A full history of knowledge of contraceptive methods and contraceptive method use in recent periods.
- Attendance at delivery. Information on whether the birth was assisted by a trained birth attendant or not.
- Recent episodes of diarrhea in children and treatment of the disease.
- Recent episodes of fever and cough to measure upper respiratory infections.
- Age at first sexual intercourse.
- Nutritional status of children and of the mother.

In addition, some DHS surveys contain a number of optional modules including one on maternal mortality which has been applied in 20 countries. Also a module on female circumcision which has been applied so far in 8 countries, and a module on the availability of health services, which has been included so far in 40 countries. In addition, several special surveys have taken place notably in the Philippines and in Kazakstan. In Kazakstan blood was taken in order to measure anemia in women. In the Philippines, a much more extensive survey was carried out specifically related to symptoms of morbidity, as described later on in this chapter.

The contribution of the DHS to the study of reproductive health

It has to be recognized that the DHS, while making an important contribution to the study of reproductive health, has not concentrated on issues of reproductive morbidity. Other than taking the weight and height of women, the DHS does not routinely collect data on women's health status, except as related to birth-related events, and, in some countries, a small number of birth-related complications. For some morbidities, an interview-based diagnosis can be used to gain some rough estimate of prevalence. However, it is important to keep in mind that the estimates obtained by this method are for symptoms rather for actual disease. Therefore, this method works best with morbidities which have rather recognizable symptoms which are distinct from those for other morbidities or when a particular combination of symptoms is likely to be associated with a specific problem. This information is useful for estimating how many women might benefit from medical assessment.

Birth-related complications are a good candidate for studying with a survey approach because some of the most significant ones have recognizably distinct symptoms. However, this has never been a major area of DHS surveys so far, except in the specialized survey which has been carried out in the Philippines.

Another area where the DHS so far has not made a contribution to reproductive health is the area of STD diagnosis. The diagnosis of STDs needs objective data because there is such a high rate of non-symptomatic cases among women. There has historically been a problem with diagnosing many of the important STDs among women in household surveys because a pelvic exam was required to obtain the proper specimen. However, more recently new technologies have become available for diagnosing infection with gonorrhea and chlamydia in men and women through examination of urine. In addition diagnosis of syphilis in the field has been simplified through development of tests that can be done on a sample of blood obtained from a finger prick as opposed to a sample obtained through venipuncture. These new technologies, which have not been part and parcel of our DHS surveys, will be applied in a special study which will be carried out in Ethiopia to test the feasibility of using them in the field.

So what do the DHS surveys contribute to the study of maternal and reproductive health? Some of the indicators that can be obtained from DHS data include:

- Fertility. In the area of fertility, the DHS surveys provide very important information regarding issues such as age at first birth, age at last birth, and the total level of childbearing. These indicators are important for studying issues such as the percent of births which are at high risk, meaning those who occur in women in extreme age groups or at high parity.

- Information on births where the woman was seen by a trained provider for antenatal care at least once during the pregnancy.

- Percent of births where the women had their first antenatal care visit before the third trimester.

- Percent of births where the women received at least two doses of tetanus toxoid immunization.

- Percent of births where the woman was attended by a trained provider.

- Percent of births where the woman delivered in a hospital.

- Percent of deliveries done by caesarean section.

- Maternal mortality rate, ratio, and lifetime risk.

- Women’s nutritional status.

- Women's knowledge of AIDS and its risk factors.

While this information hardly provides a complete picture of reproductive health in women, it does provide some very important indicators. Notably, it sets the scene for a good overview of the general level of care that women in participating countries receive. Issues such as a large majority of women giving birth at home with no trained birth attendant, or high proportions of women who do not receive pre- or postnatal care are really indicative of the kind of circumstances under which one has to evaluate and program appropriate reproductive health interventions.

Child health

On child health, DHS surveys provide a wealth of information, particularly information related to the most important early childhood diseases which are responsible for a large proportion of the deaths occurring in young children in the developing world. Among the information collected by the DHS surveys is the following:

- Infant and child mortality. These are of course the most important outcome variables related to infant and child health. One of the important findings of the DHS has been that childhood mortality patterns in sub-Saharan Africa deviate substantially from those assumed in existing model life tables[6].

- Diarrheal disease and treatment. A large amount of information is obtained about the prevalence and particularly the treatment of diarrheal disease episodes in children under five in all DHS surveys. Of particular importance here is the attention given to the use of oral rehydration salt or appropriate home-made solutions. This information is of direct relevance to programs promoting the use of this kind of treatment of diarrheal disease.

- The treatment of fever and cough related to upper respiratory infections (ARI). Again this is an area where large efforts are in place to prevent ARI in small children and the DHS data are very useful to gage the extent of progress made in this area.

- Immunizations. DHS surveys provide a very complete picture of immunizations in small children. One of the issues which can be studied with DHS surveys is the timing and completeness of the different immunizations given to children. One of the important issues the DHS has been able to demonstrate is the quite significant drop-out rates for repeat immunizations, such as polio and DPT, even in countries with relatively high levels of immunizations. The DHS can also show the proportion of births in

[6] Sullivan Jeremiah M., Shea O. Rutstein George T. Bicego. *Infant and Child Mortality.* Demographic and Health Surveys Comparative Studies No. 15. Calverton, Maryland: Macro International Inc.

which there was a missed opportunity for the woman to receive tetanus toxoid immunization during antenatal care.

- Breast-feeding. DHS surveys have extensive information on breast-feeding and supplementary feeding. Again this is an area of great interest with large programs in place to promote breast-feeding and adequate feeding of children. One of the major contributions of the DHS program in this area has been to demonstrate the very low levels of full breast-feeding, that is to say children receiving only breast milk in the first 4-6 months of life.

- Nutritional status of small children. In DHS surveys, typically all children between ages 0-3 are weighed and measured. This provides several measurements of nutritional status of children. DHS has been able to demonstrate elevated levels of malnutrition in small children in many countries in the world.

Advantages of the DHS survey data

One of the main advantages of the DHS survey data is that these data have been collected in a comparable fashion across nations. What this means is that the methodology used in collecting the information, including questionnaires, interview procedures, training of interviewers, data processing decisions which have to be taken in the creation of variables, etc. was uniform across all the DHS surveys. This provides a high level of comparability, although it would probably be going too far to say that all the data are totally comparable, but at least a strong attempt has been made to make them as comparable as possible. Another advantage of the DHS program is that DHS surveys typically are carried out by countries about once every five years. So far 18 countries have already had two or more surveys and this number is likely to grow in the future. This means that there will be a time series of data available to look at possible improvement or deterioration in some of the indicators which are studied in a DHS survey. Therefore, these surveys will also be helpful in projecting future trends in some of these indicators.

Naturally, in issues such as fertility and infant and child mortality, each survey by itself already provides some kind of historic outlook over the developments of that indicator by allowing the calculation of that indicator for a number of years prior to the survey as well as at the time of the survey.

Another advantage of the survey program is the ready access to DHS data. DHS data are freely available to all responsible researchers for all countries participating in the program. Researchers will be provided with clean data files and complete file descriptions and can also contact DHS in case they have any problems understanding some of the data they are working with.

What are some of the challenges for DHS

One of the major challenges for DHS at this time is the increased demand for data at the sub-regional level. Many countries which have decentralized programs are requesting data for a multitude of regions or districts in their countries. This puts a real strain on sample sizes which become very large and consequently DHS surveys become more costly to implement.

A second challenge is in the area of maternal mortality. By the mere fact that the number of maternal deaths collected in a survey even as big as 10,000 households is relatively small, maternal mortality estimates will have large sampling errors. There is no guarantee that subsequent surveys actually can document increases or declines in maternal mortality at an acceptable level. In addition, one should realize that the estimates from the sisterhood method are for the 12 years prior to the survey and the direct technique, which has also been used in the DHS, basically pertains for the seven years prior to the survey. All these are issues which will make it more difficult to get reliable estimates of changes in maternal mortality for the short term. Therefore, it may be important to study some of the other indicators which have proven to be useful in monitoring and evaluating programs aimed at decreasing maternal mortality. Some of these are process indicators such as service utilization, antenatal care, place at birth, attendant at birth, while others are service based indicators of quality of services.

One of the most promising indicators which is now being explored is that of "met need for emergency obstetric care". Significant reductions in the maternal mortality ratio will not occur unless women who experience birth-related complications have received the appropriate obstetric care. In most cases the services required are only available at the district hospital level. Therefore, programs aiming at reducing maternal deaths should attempt to increase use of these facilities for women who have obstetric complications. The ideal indicator for this intervention would be a change in the percent of hospital deliveries among the women having complications. However, this population-based indicator is difficult to use because the prevalence of these complications in the community is also relatively low. Therefore, a hybrid indicator of met need has been developed which has a population-based denominator and a facility-based numerator to indicate the proportion of women experiencing complications in the community who are being treated within facilities equipped to manage major complications. The denominator is the proportion of births in the population where major obstetric complications were experienced. Surveys such as the Safe Motherhood Survey conducted in the Philippines are attempting to get a better idea of the magnitude of these problems.

In the area of reproductive health, it is particularly difficult to obtain good indicators on the prevalence of STDs. As mentioned before, STDs are very difficult to measure and can really only be measured by laboratory exam. Thus, the need for these data will impose particular challenges on surveys. Interviews

will have to be complemented by the taking of blood, urine, laboratory exams, etc. This, combined with the need for cold chains which can be used in the field, the need to probably send the samples abroad for test results, etc. make this a very costly and time consuming operation. Clearly, the feasibility of this type of effort must be evaluated.

Special DHS surveys

Philippines

In the Philippines, DHS carried out what was called at the time a Safe Motherhood survey. This safe motherhood survey was particularly geared to identifying morbidities and complications related to pregnancy and child birth. The study was based on a survey of a subsample of women interviewed in the DHS in the Philippines. Prior to the development of the Safe Motherhood Survey questionnaire for the Philippines, a hospital-based validation study was carried out in the Philippines, the objective of which was to quantify how well women recognize and report on obstetric complications. In addition, qualitative research was conducted to identify the most appropriate wording of questions to be included in the questionnaire.

In some ways, the Philippines may not have been the best country to do this survey because it is relatively developed in terms of health and other characteristics of the population. Therefore, some of the morbidities identified really were not very prevalent in the population, making it more difficult to do detailed analysis on some of these complications or morbidities. Nonetheless, the survey showed that women are able to identify symptoms of diseases related to childbearing and pregnancy and the results lead to some important policy changes in the Philippine health care delivery system.

Ethiopia

In Ethiopia, a survey similar to the one in the Philippines is in the planning stages. A major difference with the Philippines is that the Ethiopia survey will include the study of prevalence of diseases such as chlamydia, gonorrhea, and syphilis in the general population of women. This will be done by taking a urine sample and a blood specimen by fingerstick. Testing for syphilis will be on the spot, but the specimens for diagnosis of chlamydia and gonorrhea will have to be done abroad. The Ethiopia survey will not be national in scope, but will take place in the southern region of Ethiopia, which is a region where there are strong programs related to family planning and reproductive health.

Nonetheless, the Ethiopia experience should provide an important benchmark for future studies in the areas of reproductive health and morbidities.

Participating countries

The DHS program is truly a worldwide program. Most of the surveys have taken place in Africa, but a large number of surveys have taken place in Asia and Latin America as well. In addition, a survey in India was also done by Macro International in collaboration with the East-West Center and Indian counterparts, although that survey was not formally a part of the DHS program. Nonetheless, it's hoped that these data will also become available shortly to interested researchers. The full list of countries and the years in which surveys were carried out or are planned follows (Table 1).

Table 1
Listing of DHS surveys by year of fieldwork
(Plans for DHS-III as of July 1, 1995).

REGION / COUNTRY	DHS-I	DHS-II	DHS-III
Sub-Saharan Africa			
Botswana	1988	-	-
Benin	-	-	1996
Burkina Faso	-	1992/93	-
Burundi	1987	-	
Cameroon	-	1991	
Central African Republic	-	-	1994/95
Côte d'Ivoire	-	-	1994
Eritrea	-	-	1995
Ethiopia	-	-	1995/96
Ghana	1988	-	1993
Kenya	1989	-	1993
Liberia	1986	-	-
Madagascar*	-	1992	-
Malawi	-	1992	1996
Mali	1987	-	1995/96
Mozambique	-	-	1995/96
Namibia	-	1992	-
Niger	-	1992	-
Nigeria	-	1990	1996?
Ondo State, Nigeria	1986/87	-	-
Rwanda	-	1992	-
Senegal*	1986	1992/93	-
South Africa	-	-	1996?
Sudan	1989/90	-	-

Tanzania*	-	1991/92	(Interim) 1994, 1996
Togo	1988	-	-
Uganda	1988/89	-	1995
Zambia	-	1992	1996
Zimbabwe	1988/89	-	1994
Asia/Near East/North Africa			
Bangladesh	-	-	1993-94/1996
Egypt	1988/89	1992	1995
Indonesia	1987	1991	1994
Jordan	-	1990	1996
REGION/COUNTRY	**DHS-I**	**DHS-II**	**DHS-III**
Kazakhstan	-	-	1995
Kyrgystan	-	-	1996?
Morocco*	1987	1992	(Panel) 1995
Nepal	(KAP-GAP) 1987	-	1996
Pakistan	-	1990/91	-
Philippines	-	-	1993
Sri Lanka	1987	-	-
Thailand	1987	-	-
Tunisia	1988	-	-
Turkey	-	-	1993
Uzbekistan	-	-	1996
Yemen	-	1991/92	-
Latin America/ Caribbean			
Bolivia	1989	-	1993/94
Brazil	1986	1991 (NE)	1996
Colombia	1986	1990	1995
Dominican Republic	1986	1991	1996
Ecuador	1987	-	-
El Salvador	1985	-	-
Guatemala	1987	-	1995
Haiti	-	-	1994
Mexico	1987	-	?
Paraguay	-	1990	-
Peru	1986	1991/92	1996
Trinidad and Tobago	1987	-	-

* These countries have surveys planned for DHS-IV, as the fieldwork should take place in 1997, which is the end year of DHS-III.

Publications

DHS survey results are published extensively by the program. The major publications are:

- Preliminary reports. This is generally published within 3 months from the end of fieldwork.
- Final reports. Published within one year from the end of fieldwork.
- Summary reports. Geared towards policy makers, this report is currently published at the same time as the final report.
- A series of Comparative Studies. These are topics specific and provide information for a large number of countries in each report.
- A series of Comparative Analyses. These are also topic specific and are more analytic in scope than the comparative studies, which are descriptive.
- Working papers
- Occasional papers
- Methodological reports.
- The semi-annual Newsletter provides general information about DHS and updates the public about new developments.

In addition, basic documentation, such as questionnaires and manuals, have been published during each round of the DHS.

DHS publication are widely distributed and can be obtained free of charge as long as copies remain.

Conclusion

The DHS data are an excellent resource for evaluating maternal and child health indicators, particularly the latter. DHS data provide a solid basis for evaluating progress towards goals set in terms of child health indicators. Maternal health data are more scarce and refer mainly to a limited number of issues regarding pre- and post-natal care.

The DHS data base will cover over 90 surveys in more than 50 countries. The comparative nature of the data provides another important incentive for their use in evaluation and monitoring.

6

Household surveys to evaluate reproductive health programs

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Survey programs since 1972 have documented the reproductive revolution spreading across much of the developing world (Robey et al., 1992; Morris et al., 1981; Kendall, 1979). These survey programs have also revolutionized the use of population-based household surveys with appropriate sample designs to collect accurate data on fertility, contraceptive use and non-use and health and reproductive behavior that impact on childhood mortality. These data have been used to establish baseline indicators and to evaluate impact of health and family planning programs over time. The innovative use of the calendar has led to reliable and comparative data on contraceptive continuation and failure rates (Moreno and Goldman, 1991). In many countries without adequate vital registration systems and/or program service statistics, the results have been used as official data by Ministries of Health at the national and regional level.

The World Fertility Survey (WFS) was the first worldwide program to collect comparable national survey statistics on fertility and family planning. The Demographic and Health Survey (DHS) program followed the WFS and Contraceptive Prevalence Survey (CPS) projects, both conducted until the mid-1980's. In addition, Reproductive Health Surveys (RHS), provided technical assistance through AID's Participating Agency Service Agreement (PASA) with the Centers for Disease Control and Prevention (CDC), continue a series of surveys begun in 1975, mostly in Latin America, whose focus and methods are like those of the DHS and the CPS projects.

As outlined by Vaessen (1991), national family planning and health surveys provide accurate, objective information that can help policy-makers and program officials make better decisions and/or reallocate resources. They are efficient and unobtrusive if the time of interview can be controlled. They interview only a very small percentage of the population of interest but, by using probability sampling techniques, are representative of the entire group. Also, unlike program statistics, surveys cover non-users as well as users of services.

The AID-sponsored survey programs have become the standard world-wide even as data needs and questionnaire content have expanded from family planning to infant and maternal health to reproductive health. There are now new information needs to support a greater program accountability based on data that document change. The documentation of change may not only be at the national level but also at the sub-national level, for special populations and/or to evaluate specific projects. Special populations may include young adults and groups targeted for STD/HIV prevention. Additional indicators such as maternal morbidity and maternal mortality have important implications for sample size.

Issues

Let us look at some of the issues related to data collection by population-based household surveys. Six areas are of interest: length of interview, sample size, comparability of survey results, survey content, technical assistance costs and timing of repeat surveys.

Length of interview has become a serious problem as demands for information have increased. Both DHS and the Centers for Disease Control and Prevention (CDC) have discovered that long interviews (greater than 45 minutes on the average) lead to both interviewer and respondent fatigue and may affect quality of data. Quality of data related to long survey instruments continues to be a subject of serious discussions at demographic forums. In Paraguay, the interview time in the national reproductive health survey pretest shifted from 25.6 minutes when the respondent was nulliparous or primiparous to a maximum of 61.2 minutes!

In the old days, if we just wanted to measure contraceptive prevalence for three domains within a country, we needed about 3,000 women to obtain estimates within four percentage points in each domain (with a 95% confidence interval). However, if you want to compare prevalence every 3 or 4 years to measure program impact, an interval in which you may expect a 4 or 5 percentage point increase, sample size and costs obviously have to increase if you want to establish a significant difference among population sub-groups.

If you want a reliable estimate for infant mortality or maternal mortality, sample size requirements can jump to 9,000 women. Obviously, although contraceptive prevalence and other health indicators can be estimated at sub-national levels, maternal mortality and infant mortality may usually only be estimated at the national level and, at best, for urban and rural areas within a country.

Changes in survey content for special population groups or to evaluate specific projects call for great flexibility. Should male surveys include the husbands of women selected in the sample or should they be an independent sample? If you

need information on unmarried males and their sexual activity and use of condoms, you need an independent sample (NFPB-Jamaica, 1995).

There has also been increasing interest in education and service programs for young adults to reduce unintended pregnancies in younger women. Since 1985, Young Adult Reproductive Health Survey (YARHS) have collected information about the sexual experience and contraceptive use of married and unmarried young people ages 15-24, both men and women (Morris, 1993). These household surveys have interviewed representative samples of youth in Jamaica, the Dominican Republic and Costa Rica and in 10 cities of five other Latin American countries. The YARHS are helping policy makers become aware of the extent of unprotected premarital sexual activity and unintended pregnancy among urban youth (Yinger et al., 1992). The results point to the need for better sex and reproductive health education in and out of schools as well as for innovative family planning services that provide access to contraceptive information and supplies for youth who are at risk of unintended pregnancy. In addition, several reproductive health surveys in Latin America have included a young adult module for women 15-24 years of age.

Maternal mortality

Since the mid-1980's, surveys have collected data on maternal and child health care in addition to family planning. Data have been collected on pre-natal care, delivery, post-partum care and breast-feeding, and well-baby care, including immunizations and prevalence and treatment of diarrhea and acute respiratory infections. It is now recognized that maternal mortality is the health indicator that demonstrates one of the greatest differentials between developed and developing countries. However, maternal mortality is often underestimated in developing countries. The World Health Organization (WHO) estimates that 500,000 women die every year during pregnancy, childbirth, or abortion, leaving 1 million children orphaned, many of whom die or survive in poor health.

The International Decade of Women, 1975-1985, helped focus attention on the health problems of women. Studies done during this time raised alarm about the magnitude of maternal mortality and led to a "call to action" by the WHO at the International Safe Motherhood conference held in Nairobi in 1987 (Mahler, 1987).

Documenting a reduction in maternal mortality may be difficult due to the significant under-registration of maternal deaths. Lack of awareness of its magnitude stems in part from the fact that maternal deaths are often simply not reported. Even in the United States, with a well-developed vital registration system maternal mortality was shown to be underestimated by 37 percent (Koonin et al., 1988). In Honduras, a study showed that the number of maternal deaths was 4.4 times higher than officially reported (Castellanos et

al., 1990).

This degree of under-reporting has highlighted the need for better methods of assessing the true magnitude of maternal mortality. The development and use of instruments which can reliably measure maternal mortality are critical in assessing whether WHO and its member states are meeting their desired goals. Recently, the method of sibling survivorship has been applied to large household-based health surveys to measure maternal mortality. This has allowed a more reliable, population-based estimation of national maternal mortality ratios than that provided by official statistics.

The Safe Motherhood Initiative, launched in 1987, has led to an increase in studies about the magnitude and determinants of maternal mortality with population-based surveys utilizing the sisterhood method (Graham et al., 1989; Trussel and Rodriguez, 1990). The basic idea of the sisterhood method is to take a sample of women, inquire how many sisters she has, and of these, how many have died during pregnancy, childbirth, or the puerperium.

Maternal mortality estimates from three recent surveys in Ecuador, El Salvador, and Romania are derived from the sisterhood method. Respondents were asked whether each sister, if she has sisters, is still alive. If the sister is still alive, it is only necessary to know her current age; if she has died, additional questions are included to determine how long ago she died, her age at death, and in order to classify deaths as maternal whether the death occurred during pregnancy, childbirth or 6 weeks postpartum.

With these questions asked about sisters it is possible to estimate maternal mortality rates, defined here as annual maternal deaths per 100,000 women ages 15 to 49. The rates can be estimated for specific windows of time during the period before the survey. The width of the time period can be wider or narrower depending on the sample size of the survey. The information on maternal mortality obtained for the sisters can be combined with information on past trends in fertility obtained from the respondents to estimate maternal mortality ratios, which are defined as maternal deaths per 100,000 live births.

Table 1 shows results obtained from the maternal mortality module in the 1994 Ecuador Reproductive Health Survey. The upper panel gives results disaggregated by age for the 14-year period, 1981-1994, and the second panel gives overall results for two 7-year periods of time; 1981-1987 and 1988-1994. In this survey, 13,582 women were interviewed and they provided information on 39,583 sisters. Among this group of sisters there were 205 reported maternal deaths.

The first column presents maternal mortality rates, expressed as annual maternal deaths per 100,000 women 15-49, and shows that the rate increases with age. The middle column gives the estimated maternal mortality ratios, expressed as maternal deaths per 100,000 live births. The last column gives fertility rates, expressed as annual births per 1,000 women in the age group. The maternal mortality rate is affected by both the maternal mortality ratio,

which is an indicator of the obstetric risk accruing to a given pregnancy, and by the fertility rate which indicates the number of times, on average, that a woman is exposed to that obstetric risk.

Table 1
Maternal mortality results from the 1994 Ecuador reproductive health survey. Period 1981-1994.

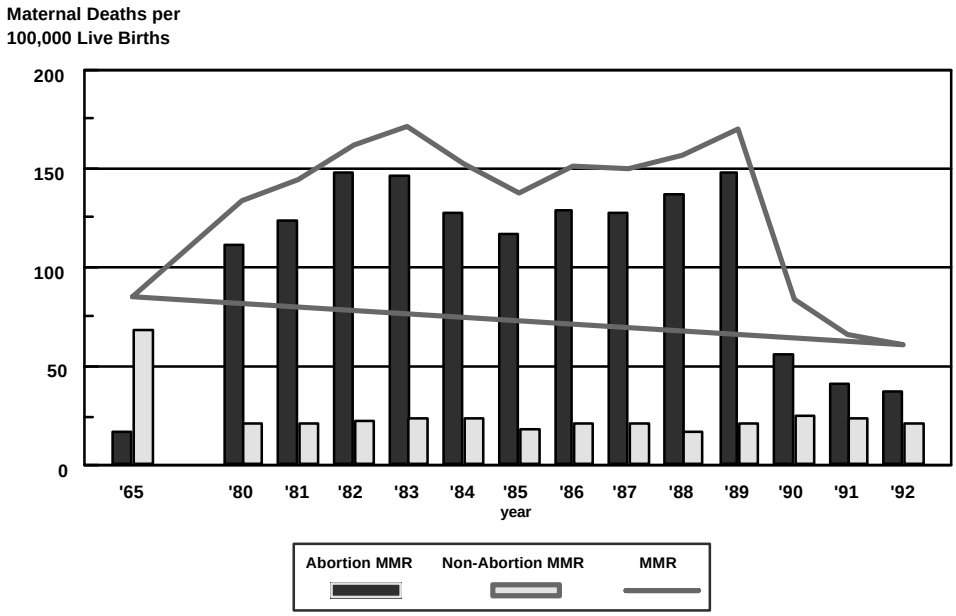
Age group of sisters	Maternal Mortality Rate*	Maternal Mortality Ratio**	General Fertility Rate (per 1,000 women)
15-24	20.9	146	143
25-34	31.8	184	173
35-49	35.2	438	80
Totals (15-49)	28.1	220	127
Totals(1981-1987)	40.3	302	143
Totals(1988-1994)	18.8	159	118

* Per 100,000 women

** Per 100,000 live births

Comparing the two periods, 1981-1987 and 1988-1994, it can be seen that the maternal mortality ratio was estimated to have dropped by 47 percent from 302 to 159, and that when this is combined with the decrease in fertility from 143 to 118 births per 1,000 women, the result is an even more pronounced decline in the maternal mortality rate from 40.3 to 18.8 maternal deaths per 100,000 women.

Even with the maternal mortality decline estimated from the survey, the rates estimated by vital statistics are lower. In 1993, the most recent year with data available, the maternal mortality ratio estimated from vital statistics was 120 maternal deaths per 100,000 live births. If we compare this with the figure of 159 estimated by the survey for the most recent period, this would indicate that approximately 25 percent of maternal deaths are not registered in vital statistics.



Source: Romania Reproductive Health Survey, 1993 - Final Report

Figure 1. Abortion and nonabortion maternal mortality rates Romania 1965, 1980-1992.

Finally, reproductive health surveillance in Romania has shown the dramatic effects on the levels of maternal mortality of outlawing legal, safe abortions (Figure 1). In the first 10 years after restrictions on abortions were enacted in 1966, a five-fold increase in abortion related deaths was recorded and 99 percent of these abortions were classified as illegal. From 1980 to 1989, the abortion related maternal mortality ratio (MMR) fluctuated between 112 and 148 maternal deaths per 100,000 live births, a level 8 times higher than before the restrictive legislation was enacted. In December 1989, the new Government abolished the laws restricting abortion and contraceptive use. The effect of switching from the use of illegal, unsafe abortions to legal abortions was reflected in the drop of the MMR, beginning in 1990. After many years of high rates of maternal mortality, more than 85 percent abortion-related, the MMR decreased between 1989 and 1992 from 170 to 60 per 100,000 live births, a decrease entirely due to the 60 percent decline in the abortion-related deaths. In 1993, the MMR declined to 53 per 100,000 live births.

Maternal morbidity

Maternal mortality has been referred to as the tip of the iceberg. Millions of women suffer acute and chronic morbidities as a result of pregnancy and childbirth. It is estimated that there are over 100 acute morbidity episodes for every maternal death (Koblinsky et al., 1993). An understanding of maternal morbidity is important because of its relationship to maternal mortality, maternal disability and to perinatal morbidity and mortality. Most studies of

maternal morbidity are hospital-based. Since many women in developing countries deliver at home such studies are not representative of all births[7]. Because of this paucity of information, a WHO working group emphasized the need for population-based studies on maternal morbidity (WHO, 1990).

CDC first added a maternal morbidity module, as well as a maternal mortality module, to the reproductive health surveys conducted in 1993 and 1994, in El Salvador and Ecuador, respectively (ADS, 1994; CEPAR, 1994). These modules were repeated in Paraguay in 1995 and Honduras in 1996 with some modification based on the experience gained in El Salvador and Ecuador. Selected results will be presented here for the two recently conducted national reproductive health surveys which included modules on maternal morbidity in El Salvador and Ecuador. These modules obtained information from women about problems they suffered during pregnancy, childbirth and the puerperium.

Both of these surveys used a three stage probability sample with a first stage selection of census sectors with probability proportional to the number of households in each sector, a second stage selection of households and a third stage selection of one woman of reproductive age, 15-49 years old, in each household. Women who reported a pregnancy which terminated in the 2 to 3 years prior to the survey were asked about the occurrence of specific symptoms and problems during and after their last pregnancy, among which the leading causes of maternal mortality: hemorrhage, infection, hypertensive disorders and prolonged labor.

The total number of women who responded to these questions was 1,945 in El Salvador and 4,290 in Ecuador. In Ecuador several symptoms and signs, primarily those during the antenatal period, were more likely to be reported by women who received medical care. It is unclear whether this is due to the fact that women sought care for these problems or became aware of these problems after receiving care. Bleeding associated with loss of consciousness was lower among hospitalized women but the rate of convulsions was higher, and it still has to be investigated whether referrals explain the higher hospital convulsion rate.

In Ecuador, a validation study has been carried out which compares the self-reported morbidity during the national reproductive health survey by a sub-group of women who delivered in a hospital with the morbidity reported by health personnel in their hospital records (Lozada et al., 1995). Some of the preliminary findings of this validation study are included in the next section of this paper.

In El Salvador, the percentage of women reporting maternal morbidity was high. The incidence of important causes of maternal morbidity included postpartum bleeding (35 percent), post-partum fever (15 percent), prolonged

[7] Also, women who deliver at home and die during childbirth are often not registered and contribute toward the underenumeration of maternal mortality reports.

labor (15 percent), loss of consciousness (11 percent), possible preeclampsia (8 percent), and convulsions (2 percent). The prevalence of antenatal morbidity was higher among women who received prenatal care and raised questions about the interpretation of some self-reported maternal morbidities. The prevalence of morbidity during labor and delivery, on the other hand, was higher among women who delivered at home, when compared with those who delivered in the hospital. Studies such as this are a step toward understanding and preventing maternal morbidity and its sequelae.

Health service utilization in El Salvador improved slightly in the 5-year periods between 1983-1988 and 1988-1993. While 71 percent of women had at least one prenatal visit during their last pregnancy only 56 percent delivered in a hospital. While 36 percent of women were assisted during childbirth by a traditional birth attendant (TBA), 5 percent delivered at home by themselves, without any assistance at all.

Health service utilization is promoted as an important way to improve maternal health. It is therefore desirable to assess the impact of health service utilization on maternal outcomes. While it is not possible to assess its impact on maternal mortality using this type of survey methodology, it is theoretically possible to assess its impact on the prevalence of maternal morbidity. However, this study revealed difficulties in the interpretation of self-reported maternal morbidity information with respect to health service utilization. We found, for instance, that all of the antenatal morbidities which we measured were higher among women who received prenatal care than among those who did not. It is unlikely that prenatal care increases the prevalence of antenatal morbidity. Rather, women who are experiencing problems, such as antenatal bleeding, are more likely to visit a clinic to receive treatment. Another explanation for this finding is that prenatal care increases a woman's awareness of complications she may be experiencing which might not otherwise be apparent. The prevalence of self-reported anemia is more than double among women who received prenatal care than among those who did not. This is probably due to the fact that during their visit they had their hemoglobin checked and were told they were anemic. Unless a woman's hemoglobin drops very low she will not be aware that she is anemic.

Because of these contradictions, it is probably more appropriate to look at other indicators of maternal health to assess the effectiveness of antenatal health service utilization. These include outcomes of the pregnancy and the perinatal period such as stillbirth, neonatal death and birth weight. Unfortunately, results of FESAL-93 are limited by the fact that only 48.5 percent of women knew their infant's birth weight. In addition, the small sample size did not permit an assessment of the impact of antenatal care on perinatal morbidity.

Morbidity during childbirth is probably most closely linked with maternal mortality in developing countries. Given that many of these complications are difficult to prevent, efforts to improve the treatment of obstetric emergencies

during labor and delivery are a cornerstone of the WHO's recommendations to reduce maternal mortality.

Hospital delivery is more consistently associated with a lower prevalence of morbidity during childbirth than is prenatal care. With the exception of convulsions, all of the morbidities studied here are more prevalent among women who delivered outside the hospital. There are different ways to interpret this finding. On the one hand it is likely that hospital delivery prevents the occurrence of some of these morbidities (severe bleeding with loss of consciousness, labor > 24 hours, fever). On the other hand, women with complications may develop the complication at home and be referred as quickly as possible to a hospital where the delivery occurs. This referral process tends to increase the prevalence of complications among women who deliver in the hospital. Under ideal circumstances, all women with complications would deliver in the hospital. Nevertheless, in El Salvador, the prevalence is higher among women who do not deliver in the hospital suggesting that the referral process is not functioning properly.

Complications during childbirth occur among all groups of women. Results of FESAL-93 show little difference, for example, in the prevalence of intense bleeding during childbirth based on area of residence or level of education. However, striking differences are noted in the development of life-threatening bleeding which was defined as bleeding associated with loss of consciousness. Whereas intense bleeding is reported by 28 percent of women with 10 or more years of education and by 30 percent of women with no education, a minimal difference, bleeding associated with loss of consciousness is reported by only 6 percent of women with 10 or more years of education compared with 28 percent of women with no education, a greater than four-fold difference. A similar picture is observed when women from the Metropolitan area (10 percent with life-threatening bleeding) are compared with women from rural areas (25 percent). Hemorrhage is one of the most common causes of maternal mortality. The results observed in FESAL-93 highlight the differences in the likelihood of developing a life-threatening morbidity for different population groups and the need to resolve some of these differences if maternal mortality is to be reduced.

Results on maternal morbidity in the Ecuador survey are, in general, similar to El Salvador, thus contributing to the consistency of self-reported morbidity in the region. However, larger sample size and the validation study (see next section) make the Ecuador data set more attractive for subsequent multivariate analysis. Descriptive findings are presented in detail in the survey report (CEPAR and CDC, 1994). A brief summary of findings are presented here.

About half of women reported dizziness and almost half reported swollen feet. One-fourth reported both anemia and bleeding (25 percent moderate to severe bleeding). Severe bleeding was associated with perinatal morbidity, premature births and low birth weight. Of 2,806 women (70 percent of total sample) who had their blood pressure measured, one in four had high blood pressure with

about two-thirds categorized as probable pre-eclampsia.

The four most common morbidities reported during childbirth were intense bleeding (30 percent), premature rupture of the membrane (27 percent), prolonged birth (22 percent), and fever (22 percent). The intense bleeding and premature rupture was reported in a significantly greater proportion of home deliveries. Forty percent of women received antibiotics during the birth or post-partum period. Two-thirds of women with a caesarean delivery received antibiotics. In the post-partum period, at least one-fourth of women reported intense bleeding and/or pain during urination. Another 16 percent reported foul vaginal discharge and 14 percent reported mastitis.

Validation study: Ecuador

A WHO working group on maternal morbidity has stressed the importance of studies to validate self-reported information. The survey in Ecuador provided an opportunity to validate survey findings by comparing women's reports of maternal morbidity to information obtained from medical records (Lozada et al., 1995).

The validation study included the women who answered questions from the maternal morbidity module and who received care for an abortion or delivery in a public hospital or maternity in the urban areas of Quito, Guayaquil, Cuenca and Machala. All women who delivered in these hospitals were included regardless of their area of residence. Only records from public hospitals were abstracted because of the ease of access of these records and the greater difficulty in obtaining information from private hospitals and clinics. These four cities were selected because of their size and the large number of women attended in their hospitals. Other cities were not included due to economic constraints.

A total of 736 women met the requirements mentioned above to be included in the validation study. Of these, 41 women were not included because data about the date of birth or abortion and/or city or hospital of birth was missing, leaving a total of 695 women. Of the 695 medical records solicited, 528 (76 percent) were located. However, this percentage varied depending on the outcome of the pregnancy (abortion or birth). Only 41 percent of the records pertaining to an abortion were located compared with 78 percent of those related to a birth. Since the percentage of abortion records located was so low it was not possible to validate the information related to abortion morbidity. All subsequent results are limited to births which are defined as pregnancies greater than or equal to 6 months gestation.

The inability to locate 22 percent of the medical records could result in a bias if record loss was not random and certain groups of women were more likely to have "lost" records. However, no important differences in the demographic

characteristics were observed (age, residence, education, or socioeconomic status) for these two groups of women. There were also no important differences observed in the morbidity findings for women whose records were and were not located.

An immediate and disturbing finding of the study was the poor quality of the medical records in the hospitals and maternities. There were 10 variables being studied in which more than 20 percent of the records had "no data" or data missing. These variables were eliminated from the validation study. They included contraceptive advice after delivery (79 percent), gestation at first prenatal visit (76 percent), vaccination against tetanus (75 percent), number of prenatal visits (55 percent), placenta delivered completely (38 percent), placenta delivered spontaneously (36 percent), anemia or low iron during pregnancy (30 percent), received prenatal care (26 percent), and hemorrhage during childbirth (24 percent).

For other variables, the percentage of agreement ranged from 53 to 99 percent. Low agreement (less than 67 percent) was found for parity (55 percent), ankle edema (53 percent), headache (56 percent), number of gestations (65 percent) dysuria (63 percent), membranes artificially ruptured (63 percent), and oxytocic used (64 percent).

Data quality was assessed both objectively and subjectively. Objectively, the percentage of records with no data for each of the variables of interest was analyzed. We found that for some variables more than 50 percent of the records had no information (contraceptive advice after delivery, gestational age at first prenatal visit, tetanus vaccine, number of prenatal visits). It was decided that any variable which did not have information in at least 76 percent of the records would be excluded from analysis. In addition to those mentioned above, this criterion also excluded the questions about whether iron was taken during pregnancy and whether the woman was anemic. Surprisingly, there was also insufficient information about the type of placental delivery (spontaneous or manual) and whether the placenta was complete.

The objective assessment, however, does not present a complete picture of the quality of the medical records. Although most records were actually located, there was disappointment over the poor quality of many of the medical records. It was found that information was often inconsistent. For instance, the number of gestations, abortions, live births and still births would vary from one part of many of the records to another. Some of the health workers would include the present pregnancy in the gravidity count and others would not. There are checkboxes for antenatal problems on the forms, but we suspect that these were not filled out correctly and were often left blank. It was found that women with hypertension during delivery who received phenobarbital (given for preeclampsia) were discharged as normal deliveries.

The general impression is that the low quality of medical records means that for many variables they cannot be viewed as the gold standard. If the medical record is not a gold standard it cannot be used to assess the predictive value

(true positive or true negative) of the interviewee's responses. In fact, for some responses we have more confidence in the self-reported information than in that obtained from the medical record.

A good example is the sex of the child. We would expect a very high degree of agreement (near 100 percent) for this information but we found it to be only 93 percent. While there may always be errors during the survey in checking boxes or in typing in data, generally we would consider the mother to be the gold standard on this question. Thus, this percent agreement (93 percent) could be considered the best that can be expected.

Conclusion

There have been significant developments in population-based surveys collecting demographic and health data over the last 20 years, including question wording and sequence, field work methodology, and perhaps most important, the turnaround of data using specially designed data entry/edit software. Surveys have provided accurate, objective information that can help policy-makers and program managers to make better decisions. Also, unlike service statistics, surveys cover non-users as well as users of public sector services. More recently, the subject matter of these surveys has been extended from the traditional demographic, family planning and maternal and child health to other reproductive health topics such as maternal mortality and morbidity.

The sisterhood method is an indirect technique used to estimate maternal mortality in developing countries where maternal deaths are often poorly registered in official statistics. It has been used successfully in many population-based surveys. The major advantages include its minimal data requirements and analytical simplicity, as well as its lower sample size requirements relative to other estimation procedures. Nevertheless, any population-based survey involves considerable financial and personnel resources and may not have the sample size necessary for sub-national estimates. Another limitation is that this method estimates maternal mortality for a period of about 10 years before the study. Thus, guidelines need to be developed for a more efficient, low cost approach to estimating maternal mortality at sub-national levels.

The collection of maternal morbidity data is a more recent development and may have the greater potential to provide service providers with information on which they can develop intervention strategies to prevent maternal mortality. The consistency of responses on morbidity during pregnancy in several Latin American surveys has been encouraging but definitive validation studies are needed.

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7

The relevance of mortality as an outcome measure of evaluation studies :

Illustration using Safe Motherhood Programmes

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Mortality measures are popular indicators of programme achievements. They are immediately meaningful to data users, and health care providers, donor agencies and policy makers are more likely to use them as the sole basis for decision-making than they are to use process indicators (Graham and Filippi, 1994). The fact that mortality indicators are amenable to comparison across programmes of different natures, relating for example the impact on child mortality of a nutrition programme with that of a vaccination programme, constitutes one of their strongest qualities (Graham, 1989). This is reinforced by considerable demographic experience in the measurement of mortality using routine information systems or survey methods. Moreover, new developments relevant to programme evaluation are still taking place with, for example, recent advancements in verbal autopsy techniques (Chandramohan et al., 1994).

It is important to recognize, however, that depending on the disease entity and the nature of the intervention, mortality may not be a suitable indicator for demonstrating effectiveness at the programme level. Demonstrating impact is a process of comparison over time and across populations. It implies the existence of feasible programme targets, that programme inputs have been delivered, and that outcomes can be measured before and after the interventions (Graham et al., 1996). The choice of the type of outcome and the specific measure itself is thus driven by two main considerations:

- the conceptual framework, with specification of programme goals and causal pathways between interventions and ultimate outcomes of interest. At the

programme level, one of the major issues to be addressed is whether the interventions will directly affect mortality, and to what degree.

- the accuracy and ease of measurement of the preferred outcomes: in other words, whether it is desirable and feasible to measure mortality in the context of specific interventions, and given the study design requirements.

This paper uses maternal death, a rare and sensitive event for which the efficacy of most community-based intervention programmes is still unclear, to illustrate these points and to evaluate the usefulness of mortality as an outcome indicator for Safe Motherhood Programme assessment.

Conceptual issues

In a recent report on the mortality impact of a communicable disease programme, Ewbank (1993) defines three main levels of evaluation: (i) at the first stage, the efficacy of new interventions is established; (ii) their performance is then evaluated in a context approximating routine service delivery; (iii) their demographic impact on health outcomes can finally be demonstrated in "real world conditions" (Chen et al., 1993). All these 3 levels of evaluation are currently taking place in maternal health. Whether, from a conceptual point of view, mortality is the legitimate end-point of demographic evaluation needs careful consideration, however.

Maternal mortality indicators have been instrumental in putting maternal health on the international health agenda. Of all public health indicators, maternal mortality stands out as the parameter showing the largest difference in rates and risks between North and South. These differences have convinced those working in public health that the majority of maternal deaths occurring in the world today are preventable. What can be achieved in settings with poor infrastructure is still unclear, however. Most of the evidence on the effectiveness of specific interventions originates from clinical trials conducted in developed countries (Chalmers et al., 1989), and from studies of secular trends in mortality interpreted in the historical context of health services and technologies (Loudon, 1992). Conventional wisdom is being challenged with indications that the potential of prenatal care for averting maternal death has not been systematically assessed despite widespread confidence in its effectiveness (Rooney, 1992). Published examples of demographic evaluation of Safe Motherhood Programmes in developing countries are few (Greenwood et al., 1990; Fauveau et al., 1991), and their main findings are being questioned due to lack of consistency between observed mortality and expected impact (Graham and Filippi, 1994). Current programme strategies to avert deaths are thus educated guesses; in the short term, they focus on the upgrading of family planning services and obstetric emergency services and in the long term on women's status enhancement. In their simplest form, their goal is to save lives by ensuring that women reach the appropriate level of health services in adequate time to avert death once a problem has occurred.

One of the major challenges of programme evaluation relates to the

understanding of the causal framework which sets out the linkages between programme inputs, direct and intermediate outputs (or processes), health effects and goals (Figure 1). The dearth of reliable evidence on the efficacy and effectiveness of interventions aimed at maternal health, such as prenatal care, leaves considerable uncertainty as to the nature, strength and stability of many of these linkages (Graham and Filippi, 1994; WHO, 1994). To confuse matters further, maternal health is clearly multi-factorial, and significant changes detectable at a population level are largely dependent on the functioning of the whole social and economic system; even within specific programmes the interaction between external elements and individual interventions is often difficult to define precisely. An example of a conceptual framework for Safe Motherhood programme assessment can be found in Figure 2. The pathway to maternal death can be interrupted by helping women to avoid pregnancy through family planning; by reducing the incidence of complications through preventive measures such as iron supplementation or malaria prophylaxis; and by reducing case-fatality once a complication has occurred.

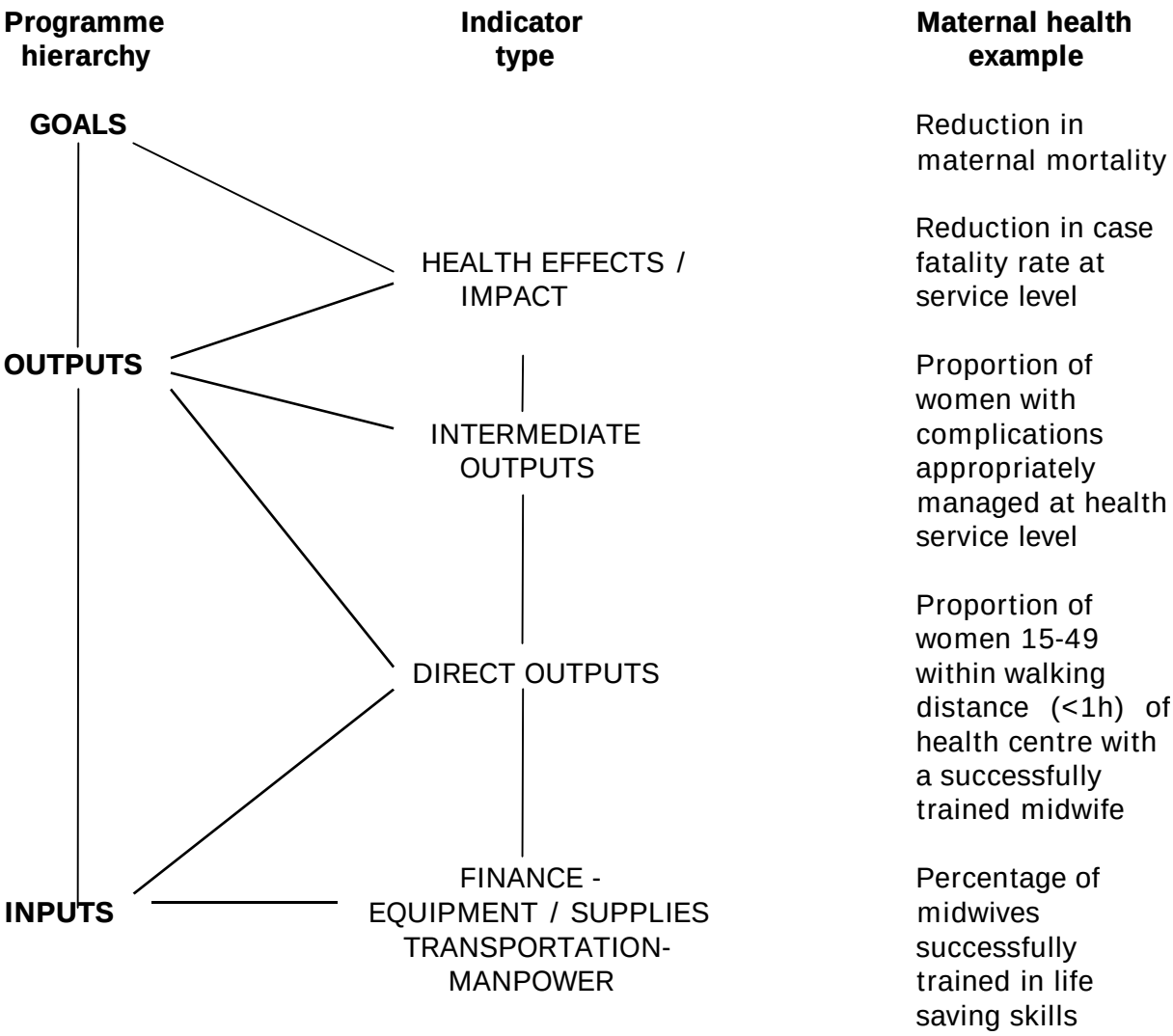

Figure 1. Type of indicators according to logical framework approach to programme hierarchy. Source: adapted from Graham and Filippi (1994).

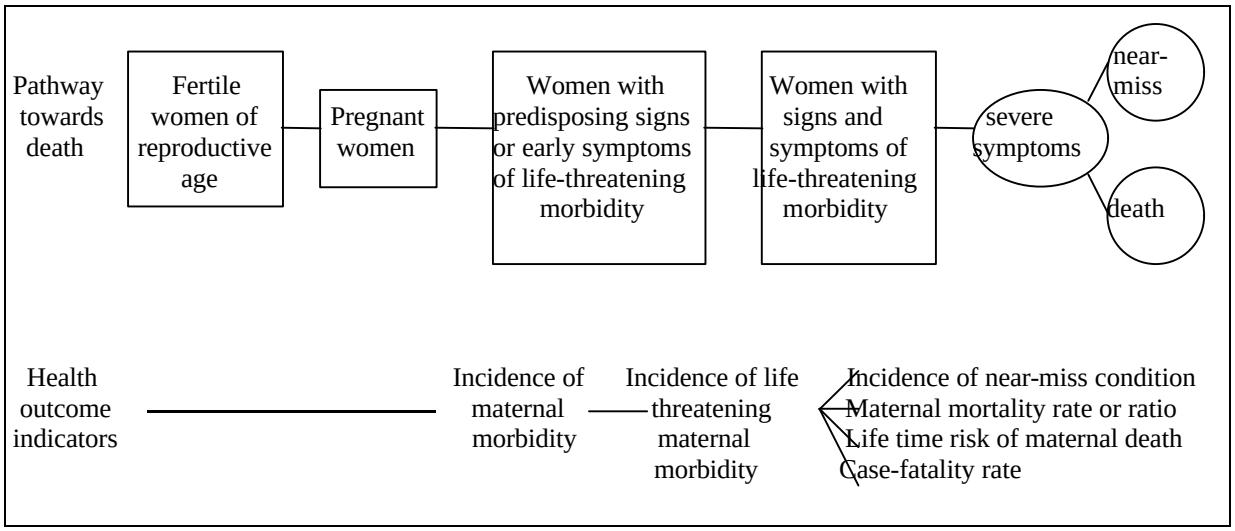

Figure 2. Conceptual framework for evaluation of Safe Motherhood Programmes and corresponding health outcome indicators. Source: adapted from Filippi (1995).

Improvements in overall health status are not necessarily followed by concomitant changes in mortality (Ewbank, 1984; Filippi, 1995). This has been most clearly demonstrated in the field of child health with the example of high dose measles vaccine averting cases without any overall impact on mortality (Ewbank, 1993). With respect to Safe Motherhood, conventional prenatal care programmes can improve positive health outcomes without substantial influence on the occurrence of death (WHO, 1994). Likewise, amelioration of case-fatality rates for specific complications does not imply that individuals have ceased to suffer from these complications. In brief, morbidity and other health outcomes may be affected by interventions more directly or to a different degree than mortality. It is therefore important to go beyond mortality measurement, in particular for those interventions for which the magnitude and mechanisms for efficacy have been insufficiently demonstrated in controlled trials.

Measurement issues

Many health programmes in developing countries are designed to reduce mortality. However, depending on the disease entity and the intervention, a considerable time lag may occur before mortality changes become measurable. Among health planners and programme administrators, there is a natural eagerness to demonstrate changes in health outcomes after a short length of time, sometimes as little as one year or even a few months. One of the most important qualities required of assessment indicators is the ability to reliably detect changes over a short time scale.

In maternal health, significant methodological improvements have been made in obtaining community-based information on baseline levels of mortality. In

particular, the application of the sisterhood method has enabled estimates of maternal mortality to be derived for the first time in several developing country populations (David et al., 1991; Graham et al., 1989; Wirawan and Linnan, 1994). Numerous studies have also been conducted using more direct approaches or multiple sources of information to derive community-based estimates of maternal mortality and to identify their determinants (for example, Kwast et al., 1986; Toure et al., 1992; Walker et al., 1986). Likewise, considerable progress has been achieved in developing verbal autopsy instruments for ascertaining medical causes of maternal deaths which have proved useful in obstetric care audit and programme management (Egypt Ministry of Health, 1994; Ronsmans and Campbell, 1994; Shahidullah, 1995). However, owing to the sensitivity and rarity of maternal deaths, the resource implications for judging progress of Safe Motherhood Programmes on the basis of mortality indicators alone are major (Maine et al., 1992; WHO, 1994).

There are several factors which may affect the performance of mortality as an indicator of changes:

- the level of mortality
- the instruments and approaches for data collection
- the degree of specificity of the information requested by the programme evaluation
- the study design requirements in terms of comparison groups

Mortality level

Health programmes typically target specific population subgroups and sometimes specific causes or groups of causes of deaths (Ewbank, 1984). In the case of safe motherhood, the targeted sub-groups are pregnant women or women of reproductive age and the mortality is pregnancy-related. Women in West Africa face a life time risk of maternal death of about 1 in 18 but the maternal mortality ratio and the maternal mortality rate may seem rather low (760 per 100,000 live births and 154 per 100,000 women) compared to other public health indicators such as infant mortality (WHO, 1991). This intimates high random annual fluctuations in number of deaths even in a fairly large population. In a prospective evaluation study conducted in The Gambia, for example, 2,586 women from a total population of 13,780 were followed during pregnancy and 35 of these women died of maternal causes during the 4 year study period. This small number of deaths affected the statistical significance of differences in change between the two intervention groups, and hence the study conclusions, although there did appear to be a sharper drop in maternal mortality in the intervention area (Greenwood et al., 1990).

Data collection

Finding maternal deaths in sufficient numbers to test for statistically significant differences and to allow disaggregation by key co-variates such as age and parity, is also affected by the performance of data collection tools.

Whatever the approach, there are some important difficulties in identifying pregnancy-related deaths, and in particular those related to early pregnancy and induced abortion. Recent WHO calculations using demographic models show that numbers of maternal deaths have been systematically underestimated by at least one third in countries where routine cause-of-death statistics are poorly documented (Coghlan, 1996). One innovative approach to gathering information on maternal mortality is the sisterhood method, an indirect technique, which uses the proportions of adult sisters dying during pregnancy, childbirth or the puerperium reported by adults during a census or survey to derive a variety of indicators of pregnancy-related mortality. One of its major strengths is its reliance on a relatively small number of respondents to report over several years on the survival of the larger pool of their adult sisters. Maine and colleagues (1992) have demonstrated its superiority over "direct" survey approaches in terms of efficiency for deriving stable baseline figures of maternal mortality. Important characteristics of the sisterhood method are that it provides retrospective estimates located approximately 12 years prior to data collection and that it is built around the assumption of a standard age distribution of maternal mortality. While it is theoretically possible to calculate trends using information from single round sisterhood surveys (Wong, 1993), this has not been put into practice, because of the huge increase in sample size requirements.

Cause-specific data

Safe Motherhood Programmes address a variety of maternal health problems and complications rather than single disease entities. Two approaches can be adopted for the evaluation of this type of integrated programme: the first focuses on individual components which may lead to examination of differentials and trends in cause-specific mortality over time, and the second on the evaluation of the demographic impact of the programme in its entirety. An important issue is that the sum of disease components is not necessarily equal to the overall impact as there may be synergy or cancellation of effects (Ewbank, 1984). The choice of the approach is largely related to the degree of confidence in the efficacy of the interventions. *A priori*, when the effectiveness of an intervention is not yet established, it would be best to try to document what is happening for a single disease entity. One of the problems related to the collection of reliable cause-of-death statistics, however, is that they are hard to obtain. Verbal autopsy instruments for adult deaths are still at the validation stage (Chandramohan et al., 1994), and given the sample size requirements to monitor changes for each group of diseases, this is certainly not the most convenient strategy, at least for maternal health.

Study design

Design issues involved in demonstrating changes are presented in Table 1. A crucial but often neglected factor affecting study designs for monitoring progress is the need to control for artifactual changes by drawing comparisons between time periods, populations, and population sub-groups or by, at a very minimum, documenting external changes. This has important sample-size implications, as adequate numbers need to be reached in each of the comparison groups. Most evaluation studies, especially those focusing on health services, find it impractical to conduct randomized double blind controlled trials at the individual or community level (Ewbank, 1993; Kirkwood and Morrow, 1989). One of the methodological difficulties which then faces demographic evaluation relates to finding large enough comparable areas, in other words those which can be matched on a number of important demographic and socio-economic characteristics, so that the causal relationship between mortality and interventions can be inferred.

Table 1
Study design issues in demonstrating change in health indicators

Design needs to be able to answer the following key questions:
• Did the change occur after the introduction of the programme? • Was the change observed in the indicator consistent with the expected results of the programme? • Was the change observed only among, or more pronounced for, population subgroups served by the programme? • Were there any other changes closely related to the health indicators which could have influenced them?
Design needs to consider:
• Degree of specification requested for information on health outcome indicators • Method and frequency of data collection • Time-lag before detectable change can be expected
Principal types of design:
• Simple before/after design without separate control. • Before/after design with control based on existing routine statistics • Before/after design with control areas, and *ad hoc* data collection • Stepped or phased design with natural comparisons within programme area • Randomized control trial at individual or communal level
Design problems:
• Confounding and intervening factors • Hawthorne effect (change as a consequence of the monitoring process) • "Spill-over effect" (changes in control population owing to proximity to the programme area) • Ethical considerations. • Comparable controls

Source: adapted from Graham and Filippi, 1994

Conclusions and recommendations

The goals of a health programme and the routes to achieving them have a profound effect on the selection of indicators. If the links between programme inputs and health effects are well established, indicators of direct and intermediate outputs may be acceptable markers of progress. One of the major questions facing the investigator when demographic impact has been poorly established relates to whether the inability to demonstrate change is related to the performance of the indicator or the interventions. Mortality indicators do not always form a strong foundation for short term evaluation, in particular when disaggregation of mortality information is needed.

In maternal health, mortality-based indicators have played an effective advocacy role, drawing attention to the seriousness of the problem. The challenge now is to measure the impact and effectiveness of interventions designed to resolve this problem. Although a strong lobby exists for monitoring action on the basis of process indicators alone (Maine et al., 1992; Tinker and Koblinsky, 1993), the need remains for alternative outcome indicators sensitive enough to reflect changes in the state of maternal health and for which information can be disaggregated at cause specific level. There are two main reasons for this. First, the link between programme inputs and health effects still needs to be established for many interventions, making it hazardous to deduce the existence of an impact on the basis of process indicators alone (Chalmers et al., 1989; Rooney, 1992). Secondly, little information exists on maternal health outcomes apart from deaths, and these other outcomes may respond to interventions in a different way than mortality.

With a larger number of cases and episodes, morbidity indicators could reflect changes in a shorter period and for less monetary and field work effort (Chen et al., 1993). Differentiating between type of morbidity and degree of severity or long term impairment could also facilitate prioritisation of health problems. In particular, there is a strong conceptual argument for focusing on severe morbidity (Filippi, 1995). This argument relates to the rationale behind a large number of Safe Motherhood Programmes: cutting down the burden of life-threatening conditions and mortality rather than improving positive health. Using indicators which focus on the most severe clinical manifestations of illness preceding death, in other words "near-miss death" morbidity (Stones et al., 1991; Filippi, 1995), seems appropriate because of the close relationship to mortality, and because these serious morbidities lie within the action framework of the majority of Safe Motherhood Programmes.

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8

Contribution of the case-control method to health program evaluation

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The general purpose of evaluation is the comparison of different groups of individuals with respect to the rate of occurrence of a particular outcome. The main difficulty in this undertaking is the non-comparability of the groups concerned as regards a number of factors likely to influence the outcome. Randomized trials are considered to be the ideal type of design in evaluation research, as they enable the avoidance of most types of biases in the comparison, but they have to be set up before the program is implemented and may prove too costly.

When a program has been in operation for a period of time, and when this program does not cover the entire population evenly, then the question is: is evaluation still feasible, and what are the alternatives to randomization? There are in fact alternative designs, and while they are certainly less conclusive they can nonetheless provide valuable clues. In particular, there is the case-control design which is rarely used by demographers, yet which is potentially very informative when properly planned and interpreted (Greenland, Watson and Neutra, 1981; Rhoads and Mills, 1984; Baker and Curbow, 1991; Selby, 1994).

In this chapter, the application of the case-control method to the evaluation of the demographic impact of health programs is presented and illustrated. The specific strengths and weaknesses of this type of study are highlighted, and the solutions to common problems of ordinary case-control research are discussed.

Background

Case-control studies have at times been called by other names, including: retrospective studies, case-referent studies, case-comparison studies, case-compeer studies, and trohoc studies. The term case-control did not come into general use until the 1950s, and case-control studies are now by far the type of epidemiological study most frequently undertaken, as a less expensive and less intrusive approach than the cohort and community study techniques favored in the early days of the discipline.

The first case-control studies to be carried out examined the relationship between smoking and lung cancer, and for this purpose a series of lung cancer cases were compared with a series of non-cases of similar age, sex and socio-economic status. The main finding to emerge was that of a much higher proportion of smokers in cases than in non-cases; based on the observed difference, an estimate of the risk of lung cancer in smokers versus non smokers was derived.

More generally, in a case-control study, persons with a given disease or condition (designated as the " cases ") and similar persons without the disease or condition (designated as the " controls ") are selected. By comparing the members of the two groups on their present or past characteristics, behavior or experience, one can examine the association of these characteristics with the condition under study. The statistical expression of this comparison is an estimation of the risk of disease given exposure to such or such a factor, relative to the risk of disease given no exposure, known as the " relative risk ", that is obtained using appropriate statistical techniques.

How does this concept of relative risk fit in the framework of health program evaluation? If the condition under study is " death from a specific group of causes " (for example death from breast cancer in women aged 35 to 54), and if the characteristic of interest is " exposure to a health program " (for example mammographic screening), then the relative risk can be viewed as: the ratio of the cause-specific death rate in those individuals exposed to the program (women who have undergone regular mammographic screening) to the cause-specific death rate in those individuals not exposed to the program (women who have not had mammographic screening).

Program evaluation entails the statistical testing of the null hypothesis that the program does not affect the cause-specific death rate, against the alternative hypothesis that the program does reduce the cause-specific death rate. Under the alternative hypothesis, cases differ from the controls in their histories of exposure to the health program, with a greater proportion exposed in controls than in cases, resulting in a relative risk estimate significantly lower than 1. If this is so, then it can be concluded that the study results support the alternative hypothesis, and therefore that the program is successful in preventing deaths from the condition of interest, at the significance level adopted for the test. Based on the magnitude of the relative risk, the reduction in risk of death associated with exposure to the health program can then be estimated.

A step-by-step approach to implementing this design to the evaluation of the impact of health programs on mortality is presented below, using the example of a published case-control study (Horwitz and Feinstein, 1981) to illustrate and clarify each of the practical stages considered.

Definition and selection of cases

The proper constitution of the group of cases is essential when conducting a case-control study. It is particularly important that cases be homogeneous with respect to the condition under study, and for this purpose objective criteria of eligibility have to be specified for inclusion of cases in the study.

So as to ensure homogeneity of diagnostic criteria or certification rules for cause of death, it is usual to choose newly detected occurrences of the condition of interest for the series of case. This is the reason why cases or deaths generally enter the study as they are diagnosed or certified until the required sample size is reached, unless the study is dealing with very rare conditions, when it may be necessary to include conditions identified in the recent past. In addition, a sampling procedure is not usually needed, as case-control studies make use of all eligible cases appearing during a particular period of time. Potential cases may be identified from a number of different sources: hospital registries and other medical care institutions, disease registries, occupational sites, and in the community.

The particular case-control study considered here concerns the administration of anticoagulants to patients suffering from myocardial infarction. At the time the findings of this study were published, the benefits of anticoagulants in reducing mortality in the hospital management of these patients were controversial despite six randomized trials, of which one had shown a significant mortality reduction, and the other five had found negative results, possibly due to insufficient sample size. At that stage, a case-control approach was envisaged, and cases were selected from among the following group: patients who were hospitalized in the coronary or intensive care unit of the Yale-New Haven Hospital, and who died in the hospital with a diagnosis of acute myocardial infarction between January 1, 1974 and October 31, 1978.

Definition and selection of controls

Choosing the cases is to solve only half of the problem since by definition a case-control study is comparative, which poses the question of the selection of controls. As the number of eligible controls is typically greater than the number of eligible cases, sampling is more likely to be necessary for controls than for cases. Choice of the most appropriate control group is one of the most difficult and controversial aspects of study design, and it is probably far more difficult than the choice of the case group.

In experimental designs, the “ control ” group is the one which is not treated, and subjects from the same source population are assigned by random allocation methods to either the experimental group or to the control group. With a sufficient group size (at least 40 to 50 subjects per group), the random allocation ensures that the two groups are comparable in terms of age, sex, and the usual socio-demographic variables, and that the only difference between them is exposure to treatment.

In case-control studies, “ controls ” are actually persons without the disease, and comparability of the cases and the controls may be ensured either at the design stage or at the analysis stage, the former being more frequent in practice than the latter. At the design stage, the procedure which is used is referred to as "matching", which consists of selecting a comparison group with a parallel distribution on co-factors to the case group. Two types of matching may be used:

- individual matching: a control subject is chosen for each case subject with the same relevant attributes (age, sex, occupation, etc), which leads to the constitution of a series of matched pairs;

- frequency matching: the comparison group of subjects is chosen so as to parallel the case group in terms of overall distribution on matching factors. This type of matching involves the calculation of the observed number of cases within each level of the factors to be matched on, and then the selection of the appropriate number of controls from the pool of potential controls, in order to fill the quota for each category.

Frequency matching is more economical than individual matching, but in certain circumstances, such as the choice of neighborhood controls, individual matching is the only workable approach. At the analysis stage, an adjustment for the co-factors may be done, using post-stratification or regression analysis.

The four most commonly used control groups are: probability samples of the population from which the cases came; persons seeking medical care at the same institutions as the cases for conditions believed to be unrelated to the cases’ diagnosis; visitors in hospital settings, or; neighbors of the cases.

The choice of which control group to use is generally dictated by the source of the cases, the relative costs of obtaining the various types of controls, and the facilities available to the investigator carrying out the study. The use of multiple control groups is often considered to be helpful in avoiding selection bias: one group is generally selected from the same source of care as the cases, and another group drawn randomly in the population or chosen from the same neighborhood to control for socio-economic differences (Ibrahim, 1985).

In the case-control study on anticoagulants and myocardial infarction, the controls were selected from among the patients who were hospitalized in the coronary or intensive care unit of the Yale-New Haven Hospital, and who were discharged between January 1, 1974 and October 31, 1978. From the 2,229 survivors, one patient was matched as a control to each fatality according to nearest date of hospitalization, age (within 4 years), gender and race.

Power considerations

The number of cases and controls to be included in the study is a statistical problem of sample size determination for the comparison of proportions. The

larger the numbers included, the greater the power of the study in detecting differences between cases and controls in terms of their prior exposure to the health program being tested.

In order to calculate the minimum size required, the following parameters have to be considered: a rough estimate of the proportion of individuals in the population who have been exposed to the intervention under study; the minimum reduction in mortality risk which the investigators is interested in (20 %, 30 %), and the level of alpha error (risk of rejecting a null hypothesis which is true, usually set at 5 %) and the level of beta error (risk of accepting a null hypothesis which is really false, usually set at 10 to 20 %), and the number of controls per case. Once these parameters are fixed, the minimum sample size can be calculated using the appropriate formula (Schlesselmann, 1982).

In the study on anticoagulants and myocardial infarction, previously published data had suggested that anticoagulants would have been prescribed for 30 % of the fatalities and 50 % of the survivors. To get a power of 80 % at the 5 % significance level, it was found that at least 112 fatalities and an equal number of matched survivors would be required to demonstrate anticoagulant efficacy. To compensate for an expected loss of 25 % of the assembled patients who would be excluded by the clinical trial criteria for eligibility, the cases were 151 fatalities randomly selected as cases from the 234 patients who died.

Data collection

Part of the information needed in a case-control study will come from various types of records, such as: medical records, hospital charts, or death certificates. Other data will be obtained by interviewing subjects, or, in the case of deaths, from the relatives, through the mail or telephone or in person. The primary research instruments in a case-control study are therefore record abstract forms and questionnaires. In addition, approval of a number of committees and individuals will have to be obtained when trying to access the study subjects and their records, and research staff who will interview subjects or abstract records have to be trained.

In the study on anticoagulants and myocardial infarction, the following data were extracted from each patient's medical record by specially trained research assistants: contraindications (gastrointestinal bleeding, intracranial hemorrhage) which usually prohibit anticoagulants, and would have disqualified patients as possible candidates for a randomized trial; clinical conditions regarded as strong indications for anticoagulant use: thrombophlebitis, recent pulmonary embolism. In addition, information was obtained on clinical and paraclinical examinations made in the coronary care unit or intensive care unit, to allow a clinical stratification of the patients according to indexes of infarct severity.

Data analysis

Of basic concern here is the proportion of cases versus controls who have been exposed to or enrolled in the health program being evaluated. If the alternative hypothesis being tested by the study is met (“ exposure to the program results in a mortality reduction ”), then subjects exposed to the program would have a lower death rate than subjects not exposed. The ratio of the death rate in exposed subjects to the death rate in subjects not exposed is referred to as the relative risk (RR), and we expect this statistic to be significantly lower than 1 under the alternative hypothesis, that is if the program is successful in preventing the condition of interest.

Because subjects in a case control study are selected on the basis not of their exposure but of their health status, it is not possible to obtain a direct estimate of the relative risk. It is however possible to estimate the relative risk indirectly if cases and controls are assumed to be representative of persons with and without the disease in the basic population from which the cases derived, and if the disease is rare in the population.

Assuming that we have chosen study cases and controls so as to represent all cases and all noncases in the population being investigated, we can summarize the study results in tabular form:

Table 1
Distribution of cases and controls by exposure status to health program in the study sample.

Exposure to Health Program	Cases	Controls	Total
Yes	a	b	a+b
No	c	d	c+d
Total	a+c	b+d	a+b+c+d

It has to be pointed out that frequently b+d is chosen to equal c+d, that is the total number of controls equals the total number of cases, and for this reason the ratio a/a+b does not estimate the risk of disease for those with the risk factor. The key to understanding how the data in this table can be used to estimate the relative risk is in recognizing that a+c is a sample of total cases and b+d is a separate sample of non-cases. Therefore although the relationship of a to b or of a to a+b is not meaningful, the relationship of a to c provides an estimate of how all cases are divided into those with and without the risk factor. Similarly, the relationship of b to d provides an estimate of how all non-cases are divided into those with and without the risk factor.

The table below cross classifies the total population from which the cases and controls were selected according to their health status and exposure to the risk factor.

Table 2
Distribution of cases and non-cases by exposure status to health program in the population.

Exposure to Health Program	Cases	Non-cases	Total
Yes	A	B	A+B
No	C	D	C+D
Total	A+C	B+D	A+B+C+D

Based on this table, the relative risk of being sick for those with compared to those without the risk factor is:

(A/A+B)/(C/C+D)

For conditions which are uncommon, and fortunately most diseases and causes of death fit this requirement, A+B can be satisfactorily approximated by B. Similarly C+D can usually be approximated by D. By making these substitutions we obtain:

(A/A+B)/(C/C+D)=(A/B)/(C/D)=(A/C)/(B/D)

This is precisely the ratio of: A/C, that is between the probabilities of having and not having the factor for those who are cases, and; B/D, between the probabilities of having and not having the factor for those who are non cases; which reduces to AD/BC. This ratio is commonly called the odds ratio, which can reliably be derived from the study data as ad/bc, provided the assumptions of representativity and rarity are both satisfied.

How do we interpret the odds ratio value? In fact the odds ratio should not be taken at face value, but compared to the theoretical value of 1 using a significance test. An odds ratio value significantly lower than 1 is a strong argument in favor of a protective effect of the program. Various methods of statistical analysis are available for examining results of case-control studies. These include logistic regression models which allow: adjustments for confounding factors; assessment of individual and joint effects of two or more variables, and; tests for dose response, various matched analyses, etc.

In the study on anticoagulants and myocardial infarction, the patients with strong contraindications for anticoagulant use and those with strong indications for anticoagulant use, who would have been excluded in a therapeutic trial, were removed from the sample to avoid selection bias. Based on the smaller sample thus constituted, the odds ratio between use of anticoagulants on fatalities and their use on survivors was 0.6, indicating no significant difference in the history of anticoagulant use between fatalities and survivors.

The next step in the analysis consisted of removing the effects of any further

selection bias which might occur if the use of anticoagulants is determined by the clinical severity of the infarction. Previous non-experimental studies had indeed been criticized for neglecting the selection bias which occurs when the decision to use or withhold anticoagulant treatment is determined by the clinical severity of the myocardial infarction. For this purpose the patients were in two groups: high-risk group, with clinical signs or symptoms of heart failure, and low-risk group, with no such signs. For the high-risk patients, the use of anticoagulants was associated with a protective odds ratio of 0.38, significant at the 5 % level.

Based on these figures, the authors concluded that anti-coagulants seem to be worthless in the hospital management of patients with a mild clinical presentation, and beneficial whenever severe infarcts have to be dealt with. In addition, they explained why previous randomized clinical trials had produced contradictory results: either because high-risk patients had tended to be excluded from the trials, or because low-risk patients predominated, which contributed to obscure the efficacy of anticoagulants in more severe infarctions. By applying in this observational study the same type of admission criteria that would have been imposed in a randomized clinical trial, the authors come up with a modified case-control method, which constitutes a valuable strategy for assessing medical therapies that cannot be tested with randomized trials.

Applications of the case-control design to program evaluation in the health field

There are several arguments in favor of the future use of the case control method in the evaluation of programs already in operation.

- it is a very efficient design for the study of rare conditions, and of uncommon outcomes such as death;

- it can be carried out over a much shorter period than a cohort study, which requires a large sample size to capture a rare outcome such as death; in case-control studies the number of people under investigation can be greatly reduced if all the fatalities are collected, while only a small proportion of the survivors are needed. As a result, in comparison with cohort studies, the case-control method allows a smaller sample size, economizes on subjects, time and on the costs associated with data collection, personnel and data processing;

- using a case-control study with a limited sample size, it is possible to collect a large amount of information on each subject, which is not feasible in large scale prospective cohort studies;

- it can be easily replicated. Not only are trials more expensive to duplicate, but ethical problems arising from preliminary results may prevent further use of this strategy. When a program or treatment is already in widespread

use, or when its efficacy is strongly suspected, then a randomized trial may not be feasible.

Despite their usefulness and wide applicability, certain potential problems and limitations may be associated with case-control studies, and these have to be considered:

- the method is not applicable to the evaluation of new health program interventions, because the cases and controls would have had no opportunity for antecedent exposure to the program;

- one possible bias is the non-randomized assignment of a health program or preventive measure being evaluated: in screening for breast cancer, for example, women with a family history of breast cancer would be preferentially prescribed a mammography;

- to ensure homogeneity, cases and controls should only be compared if they are similar with respect to known risk factors. In order to classify subjects with respect to pertinent risk factors for the outcome under study, a substantial amount of information has to be collected to permit stratification. This is feasible in a case-control study generally based on a relatively small sample size, but quite impractical in a large-scale prospective cohort study;

- they are subject to recall bias, being dependent on patients' or informants' recall of a drug exposure that occurred long ago. Typically, controls may not have the same recall of past events as cases, since the subjects who have a condition may be more sensitive to the possible importance of past events. This bias ceases to be a problem when evidence for exposure is documented in medical records, and these are the situations for which the case-control technique is the most suited.

In recent years, the case-control method has become increasingly popular as an efficient and relatively inexpensive method for evaluating a number of different types of health interventions. These include:

- evaluation of immunization programs: for example, case-control studies of the BCG vaccine have been conducted in Columbia (Shapiro, Cook, Evans et al., 1985), in Malawi (Fine, Ponnighaus, Maine et al., 1986) and in Canada (Young and Hershfield, 1986);

- evaluation of screening programs: this is one of the areas where the case-control method has been most effectively used in program evaluation. For example, there have been case-control studies of the cervical smear as a screening device for invasive cervical cancer (Clarke and Anderson, 1979);

- evaluation of medical treatment programs: one famous example is the study of post-menopausal estrogen treatment which supported the hypothesis that therapy provides protection against osteoporotic fractures (Hutchinson, Polansky and Feinstein, 1979).

Conclusion

Although the case-control study clearly cannot be a substitute for experimental designs or for cohort surveys when a strong causal statement is imperative, it can be used as a very efficient tool when more controlled methods are not applicable, either for budgetary or ethical reasons. A further advantage is that it can easily be replicated, and an accumulation of concordant results across studies certainly contributes to strengthen the argument either in favor or against the effectiveness of a program.

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9

Measles vaccination and child mortality in Burkina Faso *

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The demographic evaluation of vaccination programmes is rarely done, the most common form of evaluation consists of measuring vaccination coverage, whereas the objective is to reduce morbidity or mortality, especially for measles which is the main life-threatening pathology for African children who have not been vaccinated. Before the vaccine was available, half of the deaths of children between the ages of one and five, in 1957, in the valley of the Senegal river was attributed to measles (Boutillier, Cantrelle et al, 1962). Although the benefits of vaccination are obvious, evaluation is difficult, since there is often a lack of data. For example, in Burundi, based on DHS surveys, because of a lack of information on the vaccination status of dead children, the study used the vaccination status of children who were close to the deceased, so the lack of association found between vaccination and mortality is therefore not surprising (Dunn and Yumkella, 1990). In Senegal, Desgrées Du Loû and Pison (1995) found a relation between a reduction in mortality and an increase in vaccinations against measles, but although the conclusion is plausible, individual links could not be studied because of the lack of information on the vaccination status of each child before 1992, "in the absence of a vaccination card, this status is reconstructed from statements made by the mothers as to the number of vaccination sessions the child took part in, and not from information on the type of vaccination". However, Garenne and Cantrelle (1986), by comparing children vaccinated against measles with others not vaccinated in a neighbouring area show a reduction of 20% of mortality between the ages of one and ten years.

Child mortality in Burkina Faso remains high; in rural areas approximately one quarter of children die before their fifth birthday. With the objective of reducing mortality an integrated programme financed by UNICEF concerns the province of Yatenga. To evaluate this programme in terms of its impact on child mortality, a multi-round survey was started in 1986 in the neighbourhood of Gourcy. A neighbouring area not included in the UNICEF programme but

* Translated from French by Paul Belle.

benefiting from the usual health interventions served as a control area in the Passoré province near Yako (Duboz and Vaugelade, 1992).

One of the priorities of the UNICEF programme is the vaccination of children. The comparison between the two areas will concern in the first place the coverage of vaccination against measles, which of all vaccinations is the one which has potentially the greatest impact on child survivorship. Indeed, measles is widespread and its lethality is relatively high. Comparisons between the areas will then concern child mortality rates, and lastly a comparison will be made between mortality rates of children according to their vaccination status.

Methodology

In each of the two areas a sample of 10,000 people, representing 1,500 children under five years of age, was constructed by a random selection of villages which were then extensively surveyed, except for villages of more than 1,500 inhabitants which were divided into two groups of whole neighbourhoods. This precaution is necessary in a multi-round survey to avoid any deterioration of the sample over time. The interviews were held every six months and the information was entered on individual cards with an A5 format. A questionnaire on deaths used the technique of verbal autopsies, by concentrating on a limited number of symptoms which were translated into the language of the respondents to avoid variations due to interpretations of the interviewer-translator (Bonnet, 1988).

In addition to the usual demographic factors, the variables recorded concern vaccinations and the nutritional status evaluated by measuring the brachial perimeter. Vaccinations are known based on the vaccination cards distributed upon vaccination. There is therefore a bias, since a vaccinated child whose card has been lost is considered as not having been vaccinated, given that the parents' statements cannot be relied on since they do not know which vaccinations their children have had.

Vaccination coverage against measles

The global vaccination coverage rate against measles for the two areas increased from 56% to 66% between 1987 and 1992. In spite of the special programme in Yatenga, the coverage rates remained lower than those in Passoré. Variations in coverage rate between villages do not point to different changes according to village groups (Tables 1 and 2). The explanation for the delay in Yatenga might be explained by differences in attitudes towards vaccination between the different populations.

Table 1
Coverage of vaccination against measles (per cent)
in children aged 1 to 9 in 1987.

Area	Yatenga	Passoré	Total
Villages most vaccinated	57	58	57
Villages least vaccinated	51	54	52
Total	54	57	56

Table 2
Coverage of vaccination against measles (per cent)
in children aged 1 to 9 in 1992.

Area	Yatenga	Passoré	Total
Villages most vaccinated	66	71	69
Villages least vaccinated	58	62	60
Total	63	69	66

Mortality rate according to vaccination coverage

To compare mortality according to vaccination coverage in each of the provinces, the village sample was divided into two groups according to the proportion of vaccinated children of under ten years of age. The survivorship rate at five is the same as for the four sub-groups (Table 3), 774 for 1,000 births. There is no apparent difference between the groups of villages, which is not surprising since the vaccination coverage rates are very similar.

Table 3
Number of survivors at age 5 for 1,000 births
by area and by vaccination coverage (1986-1991).

Vaccination coverage	Yatenga	Passoré
Villages least vaccinated	777	772
Villages most vaccinated	775	773

The vaccination coverage increased during the period, the survivorship rate at

five by year increased noticeably, from approximately 750 per 1,000 for the 1986-1988 period to 800 per 1,000 for the 1989-1991 period (Table 4), although the change is not regular (Figure 1).

Table 4

Number of survivors at age 5 for 1,000 births by year (1986-1991).

Year	Number of survivors at age 5 for 1,000 births
1986	744
1987	754
1988	738
1989	778
1990	813
1991	785

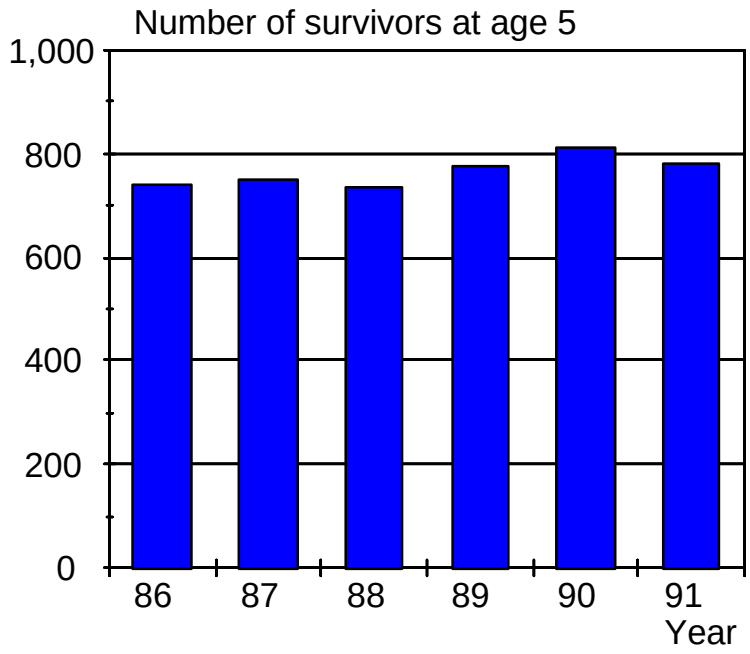

Figure 1. Number of survivors at age 5 for 1,000 births by year of death.

Child mortality rate according to vaccination status

The mortality rate according to vaccination status was estimated by reconstructing hypothetical cohorts. For the non-vaccinated, entry is done at birth or at the time of immigration, exit can be done at death, emigration or vaccination; for vaccinated children, input can be done at vaccination or at immigration if the child is vaccinated when immigrating, and exit can be done at death or emigration. The vaccination used is the first one after the age of six months, which is the age at which vaccination starts to be more efficient (37% at 6-8 months) and it increases with age at vaccination (89% from 9 months, Hull et al., 1983), and 97% at ten months (Garenne et al., 1993). The survivorship table for vaccinated children therefore starts at 6 months, but the small numbers of children vaccinated between six months and a year leads to comparing vaccinated and non-vaccinated children from the age of one year.

Reduction in mortality reaches 50% at three years and 44% at ten years of age (Table 5 and Figure 2). It is higher than the 20% found by Garenne and Cantrelle (1986) in Senegal. It is of the same order as the reduction in mortality evaluated in Bangladesh, according to the time lapse since vaccination (Koenig, 1990), because the children are vaccinated young the effect is much stronger the cumulated risk of death three years after vaccination is reduced by 40% (38 per 1,000 compared to 63 per 1,000).

Table 5
Survivorship table for 1,000 births and 1,000 one-year-old children according to vaccination status for measles (1986-1991).

Age	Total	Non-vaccinated	Vaccinated	Non-vaccinated	Vaccinated
S_0	1,000	1,000			
$S_{0,5}$	942	942	1,000		
S_1	905	902	997	1,000	1,000
S_2	849	812	970	905	973
S_3	801	741	932	832	936
S_4	777	718	900	806	904
S_5	761	704	882	790	885
S_7	738	682	868	765	871
S_{10}	726	668	856	750	859

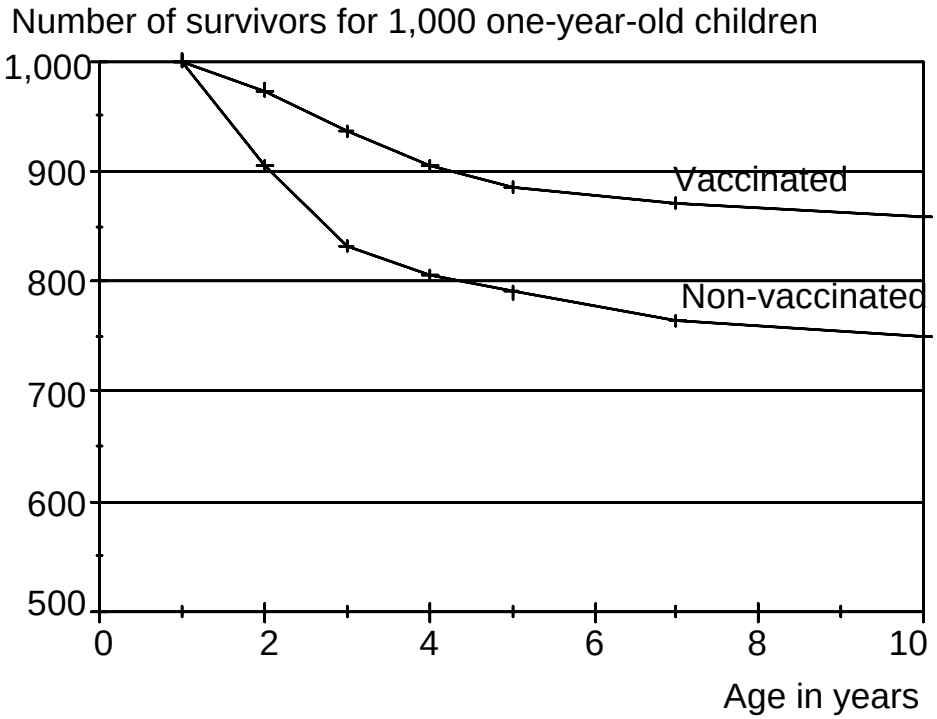

Figure 2. Rate of survivorship from one to ten years of age according to vaccination status.

The low mortality rate of children vaccinated at a very young age seems abnormal. Is it due to an error in the survey, in the code or an input error? Children vaccinated at 18 months and who are therefore alive at that age may have been mistakenly noted as having been vaccinated at six months, such that the risk of death between 6 and 18 months would then be nil. Another explanation, whose effect would be weaker, is linked to the fact that children suffering from bad health are not brought in for vaccination and would in any case be refused by the health worker, with the result that the children who are not vaccinated would have a greater risk of dying. Notwithstanding errors in the survey or the analysis of results, the comparison between vaccinated and non-vaccinated children is therefore subject to a bias which may partly explain the increased survivorship of vaccinated children.

Conclusion

The evaluation of health programmes is difficult because one is far from an experimental situation: in a diachronic comparison one may dissociate the effect of the programme from global changes; in a synchronic comparison, neighbouring areas which may be considered as having similar results can never be compared as much as one might wish. The effects of many variables which play a role cannot be ignored, and there is always a certain element of risk involved when isolating the effect of a variable which is never independent

from the other variables.

In the case of measles, for example, at a certain level of vaccination coverage non-vaccinated children would be indirectly protected by vaccinated children due to the limiting of the number of multiple cases whose lethality is greater than that of isolated cases (Aaby et al., 1986). The effect here would be to reduce the difference in mortality between vaccinated and non-vaccinated children.

Inversely, it seems that vaccination against measles has a stimulative effect on the immune system and confers a wider protection, which would explain why vaccination has a greater effect than simply that of suppressing measles. Another explanation for part of this greater effect may be linked to differences in behaviour. However, studies of behavioural patterns are only feasible on a small scale, and for this reason cannot generate conclusive evidence (Bonnet et al., 1991). The quality of the relation between the mother and the child can differ from one child to the next (Somda, 1994), causing mothers not to have all their children vaccinated. And attitudes which lead parents to have some of their children vaccinated and others not, may well be linked to other attitudes which have other effects on children's health. However, it is not certain that an understanding of these mechanisms would result in more efficient preventive action.

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10

The evaluation of health programmes based on death registers from the local health office of Antananarivo, Madagascar, 1984-1994 *

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What is the present situation regarding mortality, in other words the health situation, and the changes it is undergoing in big African cities? Is it getting worse or improving? Reliable chronological series of registrations are rare in Africa; and even rarer are registrations that include the cause of death. Several have been analyzed over periods of varying length: Dakar 1964-71 and 1950-1978. Saint Louis 1930-1988, Bamako 1974-1985, Abidjan, Libreville 1962-1972, Brazzaville 1974-1975 (Cantrelle, Diop, Silva, 1986; Fargues, Nassour, 1988; Diop, 1990; Dittgen, 1979; Garenne et al., 1995; Antoine, Cantrelle, Sodter, 1976; Duboz, Herry, 1976; Toto, 1986).

In the Madagascan capital, Antananarivo, formerly Tananarive, civil registration dates back a long way. Epidemiological monitoring, especially of the plague, justified it. These civil registries were created in their current form in 1973 by Professor Randrianarivo, Director of the Bureau Municipal d'Hygiène (BMH) of Antananarivo-ville.

In 1993, the decision was taken to make a first trial at exploiting them over the period of one year to check the validity of registration. Following the positive result, the series covering the previous ten years were used to find out about changes in the health of the population and to evaluate the effects of health

* Translated from French by Paul Belle.

programmes[8].

General situation

The city of Antananarivo, the administrative, political, economic and cultural capital of Madagascar, lies in the heart of the central plateau of the island at an altitude of 1,350-1,750 metres.

It covers a rectangular area of 80 square km which is drained by two rivers. The areas of marshland and valleys of the lower part of the city are surrounded by hills where the inhabitants of the higher part of the city live.

The climate in the area is a tropical high-altitude climate with two seasons: one dry and cool from April to August, the other hot and humid from November to March. Between the two seasons there is a period when the weather is hot and dry during September and October.

For the period from 1983 to 1991, the average annual temperature was 19° with a maximum of 28° and a minimum of approximately 11°. The average annual hygrometry is approximately 74%. Average annual rainfall reaches 1,267 mm with 135 days of rain.

The administrative area or Fivondronana of Antananarivo-ville is divided into six "Firaisana" or wards, each with its own civil registry bureau. These Firaisanas are divided into Fokontanys or neighbourhoods. There is a total of 192 of them.

The Direction des Affaires Sociales et Culturelles (Bureau of Social and Cultural affairs) is among the administrative structures of the city and the Bureau Municipal d'Hygiène is under the authority of this bureau.

In the 1993 census, the population of city was estimated at 676,980 inhabitants, which represented a population density of 8,679 inhabitants per square km.

It should be added that during the 80s the economic situation in Madagascar suffered deterioration and reached a trough in 1986. GNP per capita fell from $ 330 in 1984 to $ 190 in 1988, and rose again in 1994 to $ 230.

[8] After a first visit to the BMH during a mission in 1990, P. Cantrelle initiated the task in 1993 in the framework of a UNICEF project, analysing the data with D. Waltisperger. The coding, the data input and the checking were undertaken by SSSD, under the supervision of Dr. Ralijaona. The UNICEF Bureau of Madagascar provide a technical support as well as funding and management.

Year of reference	GNP per capita ($)
1984	260
1985	240
1986	230
1987	210
1988	190
1989	230
1990	230
1991	210
1992	230

Health policies and programmes

From the middle of the seventies until the beginning of the 90s the Health Department directed its activities in such a manner so that its medical services should benefit the greatest number of inhabitants. In addition, Madagascar, a member of WHO, has approved "The Charter for Health Development in the African Region" and implemented the policy for "Primary Health Care" (Law dated April 18th, 1982). One of the objectives in the 1986-1990 quinquennial plan was to improve the state of the population's health by ensuring more regular supplies of pharmaceutical products, by extending actions in the field of nutrition, especially that of the mother and the child, support of interventions in rural areas and the intensification of the fight against the major endemic diseases.

At the national level a series of programmes has been elaborated among which the principal ones are as follows:

- The Expanded Programme for Immunization (EPI).
- The national programme against diarrheal diseases.
- The integrated programme for Maternal and Child Health Care and Family Planning. This programme has two objectives in common with the preceding programmes: EPI and the fight against diarrhoeic diseases. Other objectives include reducing maternal mortality and morbidity due to complications during pregnancy and labour, abortions and malaria, and reducing mortality due to acute respiratory infections.
- The curative programme against tuberculosis.
- The programme against malaria.
- The programme against the plague.

At the same time the Ministry for Health has set up programmes called "Service" Programmes, such as the adoption of a list and the supplying of essential drugs.

The capital has benefited from these different programmes in addition to the medical assistance provided in the following health infrastructures: 4 hospitals and 3 specialized establishments; 12 free health centres; 1 general clinic and 1 medical centre; and the Bureau Municipal d'Hygiène.

In the private sector there are the following facilities: 4 private clinics and maternity clinics; 16 Company Medical Services; 9 church infirmaries and free health centres; 17 different infirmaries and health centres; 4 different social centres; and surgeries.

During the period of economic crisis, deficiencies in the public service drove people to using private medical centres that were better equipped.

Method and data description

Death registration procedure

The death registration procedure, established since the plague epidemic of 1921, seems to provide sufficiently complete registration. The cemeteries are guarded and burial cannot be carried out without a burial permit. This permit is delivered by the civil registration bureau (Firaisana) upon presentation of a death certificate issued by the BMH. If the death occurred at home, then a BMH agent is informed, goes to the home of the deceased and makes a certificate based on information supplied by the family and the medical documents available. If the death occurred at the hospital, then the family presents the death certificate made out by the hospital to the BMH. Whether deaths occur at home or in hospital they are registered in the same BMH registry as and when they are reported.

The time allowed for recording civil registration information is 12 days. The great majority of deaths are declared in less than three days following the death. The coding and the input of information is carried out by SSSD staff under the management of the department head. The total cost in personnel for this specific operation, is 1,500 French Francs or 300 US $ on average, per year of death registration covered.

Causes of death certification

Although knowing the cause of death is not a problem in obvious cases: accidents, maternal deaths, measles, diarrhoea, etc., in other cases, like malaria and tuberculosis, the diagnostic is often far from accurate and the figures reported only have a value as an indication.

In general the cause reported is the initial or the principal cause. The code used is that of the WHO International Classification of Diseases (ICD-9), with four figure numbers (WHO, 1977). Two possibilities were provided for, the first concerns the main cause of death and the second the associated causes. In the case of a trauma, the first is reserved according to localization (i.e. fracture of the skull), the second for the cause or the aetiology (i.e. road accident). The cause is registered with a detailed code and classifications under 41 different headings. The details are supplied in the annex.

It would appear that for deaths occurring in hospitals information about the cause is of better quality than for deaths at home. However, both sources are classified here. Finally, it may be noted that the same person, a physician, was responsible for the coding of the cause of death, thereby guaranteeing the consistency of the series.

Geographical coverage

The BMH does not cover the 6th *Arrondissement* (Firaisana d'Ambohimanarina). Under the 1st Republic this area was an autonomous urban district which was not under BMH control. Under the 2nd Republic (1975-1991) the area was attached to Fivondronana in Antananarivo-Ville but its situation with the BMH remained the same. This area represents 10.2 % of the population, and is not included in the present study.

Completeness of death registration

The completeness of coverage has been verified in different ways:

- The rate of registration of deaths has been evaluated with the Brass technique. It gives a favourable result.

- The death rate recorded by the BMH was compared with that of the civil registry. The numbers are very similar. This indicates that there is no substantial under-registration of one list compared to the other.

- The numbers of deaths registered by the BMH having occurred in hospital have been compared with hospital statistics and have shown no major discrepancy.

- Finally, age-specific deaths in days during the first week, in weeks during the

first month and in months for the first year seem consistent and contradict the hypothesis of a under-registration of deaths of young children.

Reference population

- The results only concern nationals. As the number of deaths of foreigners was low (81 in 1990), they were not included in the current statistics.

- The population at risk has been established by separating deaths of resident from deaths of non-residents. The number of cases without any details concerning place of residence is negligible. The indicators only concern the resident population, which corresponds to approximately 80% of registered cases.

It should be added that for the residents of Antananarivo the absence of information on the neighbourhood is minimal, for example: in 1992, 24 out of 5,675. The degree of precision achieved by the Fokontany within an *Arrondissement* in Antananarivo is remarkable.

- The size of the reference population is that of the census of August 1993[9]. To obtain the average population for previous years an estimation was made based on the intercensal growth rates between 1975 and 1993, which gives an average annual rate of 27.4 per thousand for men and 28.4 for women.

Results

Trends in mortality from all causes

Precision regarding age at death in most cases makes comparisons in time more reliable. Life tables have been calculated for four periods covering the whole series.

[9] Recensement général de la population et des habitats 1993. Résultats Préliminaires. Décembre 1993 (Forthcoming). Recensement général de la population et des habitats 1975. Données démographiques en milieu urbain. Institut National de la Statistique et des Recherches Economiques.

Table 1
Mortality trends over the study period, based on registration of deaths in Antananarivo-ville (BMH), 1984-94.

Probabilities of dying	1984-85	1986-87	1988-89	1990-91	1992-94	Difference 85-93 (%)
Males						
1q0	93.0	76.0	77.5	64.6	55.7	-40.1
4q1	123.3	105.0	79.3	62.8	61.7	-50.0
5q0	204.8	173.0	151.1	123.4	113.9	-44.4
35q15	274.4	312.1	208.9	201.7	192.4	-29.9
1q0/4q1	0.75	0.72	0.98	1.03	0.90	
Life expectancy at birth	46.0	45.4	52.0	54.5	55.4	+20.4
Females						
1q0	73.4	66.7	67.3	52.1	49.1	-33.1
4q1	123.2	100.7	84.1	62.6	58.0	-52.9
5q0	187.5	160.7	145.7	111.4	104.3	-44.4
35q15	161.8	188.4	172.8	134.6	134.8	-16.7
1q0/4q1	0.60	0.66	0.80	0.83	0.85	
Life expectancy at birth	52.6	52.3	55.2	59.9	60.4	+14.8

The fall in child mortality between the ages of 1 and 4 years is very marked, 50% in approximately eight years, more so than infant mortality (37%). The ratio of infant mortality (1q0) to juvenile mortality (4q1) is quite low, as is the case in general in Sub-Saharan Africa, and tends towards 1. This fast transition phase is typical of the region.

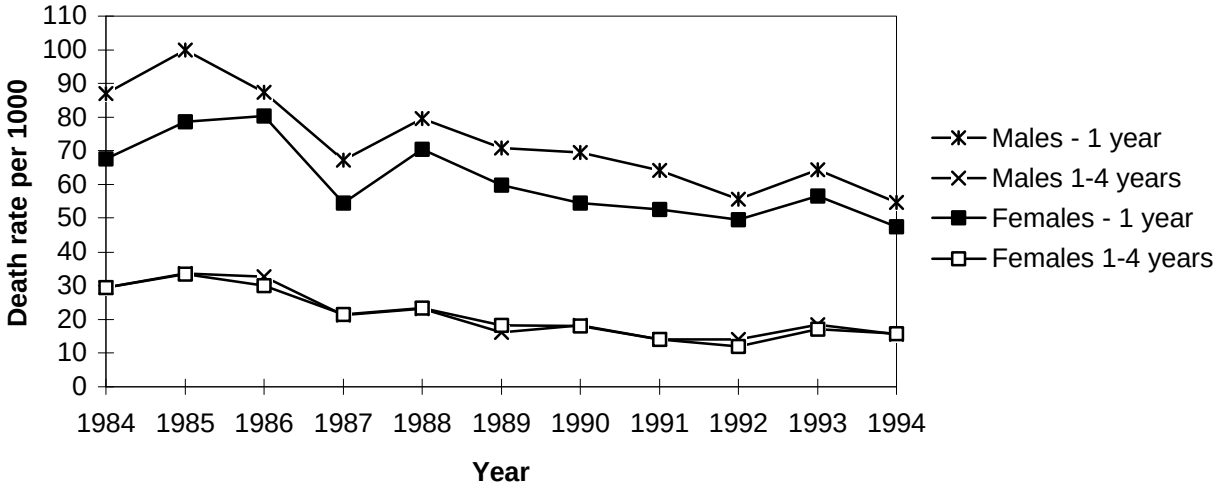

Figure 1. Changes in child death rates.

Less marked among adults, 15-49 years, there remains, nonetheless, an apparent fall, more than 20%; more so among men, whose mortality rate used to be higher, than among women (a 30% decrease versus a 17% decrease).

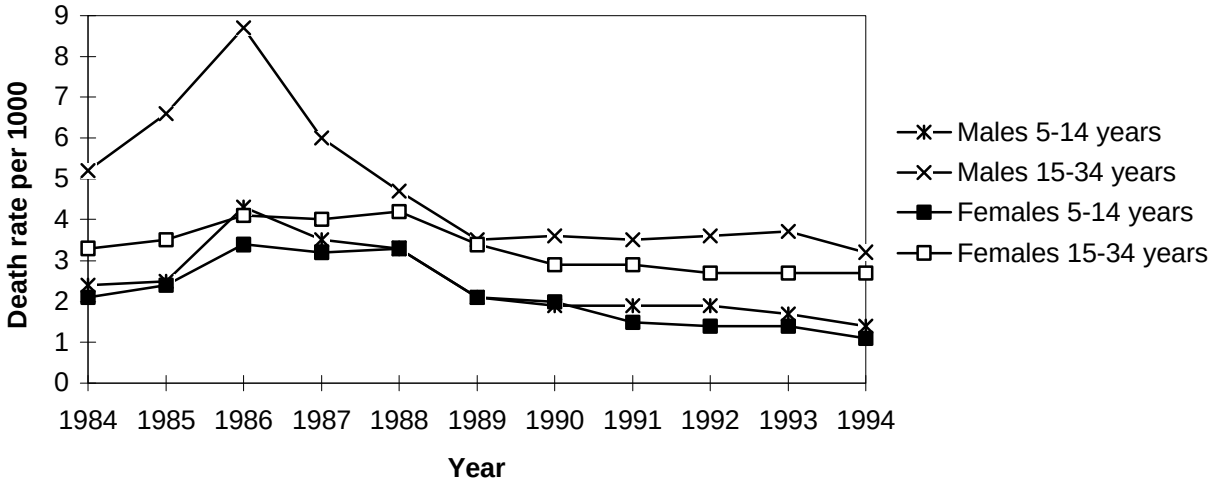

Figure 2. Changes in young adults death rates.

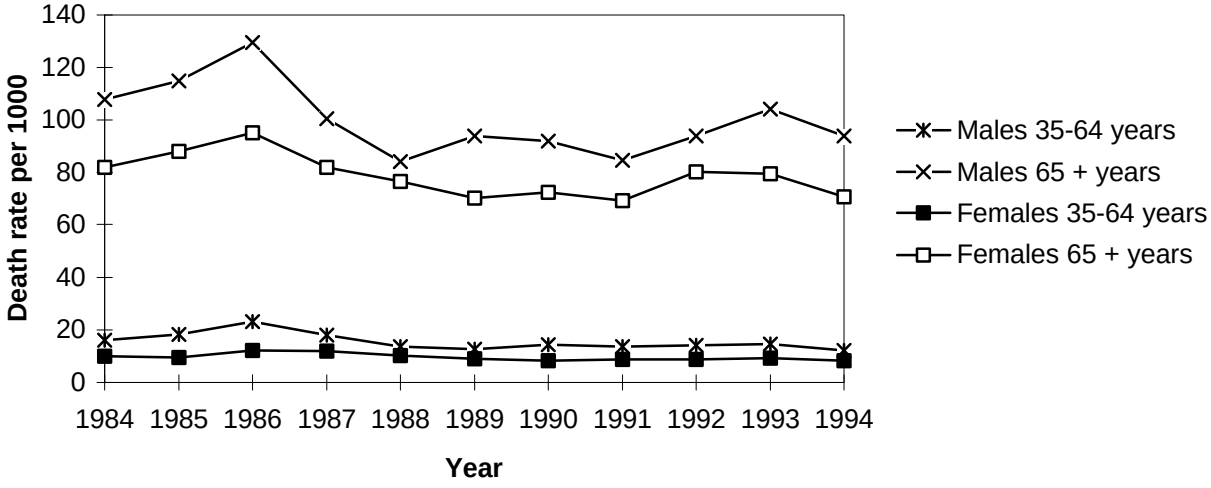

Figure 3. Changes in adults death rates.

In 1986, a fertility survey was carried out in the Madagascan capital (Rabetsitonta, 1988) which also provided information about mortality of children under five (5q0). The retrospective information collected in this survey showed that 5q0 had constantly increased since 1977-80, and the level estimated for 1984-85 was close to that obtained with death registration. The fall observed after 1986 probably corresponds to the improved economic situation during this period.

The curve of cumulated deaths, on the Bourgeois-Pichat logarithmic scale, makes it possible to situate the critical period in childhood, between the two points of inflection of the curve, between 7 and 25 months.

Does knowing the causes of death make it possible to explain this change? A general table with 41 headings is presented for each year (Table 2), as well as more detailed information corresponding to specific programmes. The codes are listed in the annex.

Table 2
Numbers of cause-specific deaths (not including stillbirths), resident nationals,

Antananarivo-ville (BMH), 1984-94.

Cause of death	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1.Diarrhoea	735	885	1290	855	753	613	703	576	485	597	599
2.Other infectious intestinal diseases	95	102	131	129	79	73	70	65	73	47	38
3.Tuberculosis	174	226	199	149	79	107	149	119	159	152	127
4.Plague	1	0	0	0	0	0	12	12	12	17	7
5.Diphtheria	12	7	5	3	4	1	3	3	0	3	1
6.Whooping cough	53	68	32	20	16	14	15	5	4	13	8
7.Tetanus	17	20	11	12	11	8	10	7	6	8	5
8.Poliomyelitis	0	1	1	0	0	0	0	0	1	0	0
9. Measles	354	447	124	11	185	52	30	32	7	85	11
10.Viral hepatitis	9	11	20	22	19	3	13	16	15	13	11
11.Malaria	58	84	172	288	701	378	224	198	233	216	163
12.Other infectious and parasitic diseases	86	88	67	69	52	54	43	52	38	55	48
13.Tumours	172	212	190	185	219	241	237	237	242	241	276
14.Endocrine and diabetic diseases	75	45	44	54	49	62	47	72	51	69	64
15.Malnutrition	515	671	1313	890	472	383	425	306	315	384	376
16.Diseases of the Metabolism	74	96	112	80	73	42	55	60	32	43	44
17.Diseases of the blood	32	24	10	29	25	17	32	25	14	24	28
18.Mental disorders, including alcoholism	37	60	43	42	48	54	73	73	82	84	54
19.Nervous system	150	134	122	94	86	107	93	91	110	139	117
20.Ear infections, including otitis	2	1	3	6	4	3	6	1	3	3	5
21.Hypertensive diseases	99	90	76	80	70	78	74	91	98	112	59
22.Ischemic heart diseases	29	22	25	22	30	33	39	27	58	56	45
23.Cardiac insufficiency	341	382	418	358	271	320	320	369	355	423	446
24.Cerebro vascular diseases	390	339	341	405	333	344	392	392	442	501	446

Cause of death	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
25.Other diseases of the circulatory system	281	339	356	231	220	186	205	227	207	179	142
26.Pneumonia, Bronchial Pneumonia and flu, or Acute Respiratory Infections (ARI)	519	847	609	646	593	534	616	558	531	670	599
27.Other diseases of the respiratory system	159	173	155	118	120	119	129	124	115	125	139
28.Diseases of the digestive system	450	273	413	267	253	242	297	246	296	302	258
29.Diseases of the genital and urinary organs	134	116	144	123	114	128	118	90	125	139	98
30.Pregnancies ending in abortion	30	38	26	43	46	38	37	36	34	45	39
31.Complications linked to pregnancy	17	10	23	19	36	12	7	6	10	14	11
32.Complications during labour	13	7	17	13	10	7	15	8	13	16	18
33.Complications following labour	11	15	13	4	13	8	10	10	14	7	7
34.Diseases of the skin, of the muscles	18	15	15	11	16	14	28	11	22	11	9
35.Prematurity, insufficient weight at birth	108	117	141	100	144	137	136	100	86	99	87
36.Hypoxia	30	35	48	31	48	43	44	66	43	56	35
37.Neonatal tetanus	9	11	7	14	16	19	21	8	10	7	6
38.Congenital & perinatal diseases	322	343	317	215	232	299	206	215	227	263	201
39.Senility	65	87	132	155	172	125	105	158	142	112	70
40.Other indeterminate diseases	363	480	550	427	475	343	301	250	331	380	336
41.Traumas	294	312	429	282	272	286	296	369	388	411	408
All causes	6334	7233	8144	6504	6377	5527	5637	5314	5432	6123	5458

The plague

The old programme against the plague is maintained because of the need for vigilance. Massive administrations of insecticides are made annually[10]. For the period from 1984 to 1994, they were carried out during the following periods:

Year	Month of campaign	Number of deaths caused by the plague
1984	J F M A M O N D	1
1985	J F M A M S O N D	-
1986	J F M A M J S O N D	-

[10] Memo issued by the Department of Insect Control of the city of Antananarivo.

1987	J F M A M J J A O N D	-
1988	J F M A M J J A S O N D	-
1989	J F J A S O N D	-
1990	J F N D	12
1991	J F M A M J J A S O	12
1992		12
1993	S O N D	17
1994	J F M A M J J A	7

In 1992 there was a total lack of products, and in 1993-1994, "the rate of refusal for insect pest control in homes was 50% because of the unpleasant smell of the new products used".

It should be noted that the period from 1984 to 1989 during which there was only one death caused by the plague contrasts with the period from 1990 to 1994 during which there were 60 deaths. Even if the impact on the mortality rate is small, one can see here the effect of a deficiency in a health programme.

Diseases targeted by the EPI

Several phases followed each other:

- 1976-1981: beginning of the EPI with vaccination against diphtheria, tetanus, whooping cough and tuberculosis.
- 1982: introduction of the vaccination against polio and tetanus of pregnant women.
- 1985: introduction of the measles vaccination.
- 1987-1991: plan for the acceleration of the EPI against the six target diseases.

Among childhood diseases, such as measles, whooping cough and diphtheria, there is a relatively short time lapse between the vaccination and the risk of contagion, therefore the effects of the vaccination programme are soon felt.

The number of vaccinations carried out per year is available for the BCG, vaccination against measles and anti-tetanus injections of pregnant women in the *Circonscription Médicale (CM)* (Medical Area)[11]. This district stretches beyond the capital itself which represented 65% of the population of the CM in the 1993 census.

Table 3
The number of deaths for each target disease of the EPI, by year, resident nationals, Antananarivo (BMH), 1984-94.

[11]Annual reports issued by the Ministry of Health Vaccination Department from 1988 to 1994.

Year	DIPHT.	WHOO. COUGH.	POLIO.	MEAS.	TETANUS		TUBER.
					Neonatal	Others	
1984	12	53	-	354	9	17	174
1985	7	68	1	447	11	20	226
1986	5	32	1	124	7	11	199
1987	3	20	-	11	14	12	149
1988	4	16	-	185	16	11	79
1989	1	14	-	52	19	8	107
1990	3	15	-	30	21	10	149
1991	3	5	-	32	8	7	119
1992	-	4	1	7	10	6	159
1993	3	13	-	85	7	8	152
1994	1	8	-	11	6	5	127

Measles

For measles, one injection is enough, from the age of 9 months. The results are spectacular, with an almost tenfold reduction in the number of deaths from measles. The same observation had been made in other countries, notably in Senegal. But it is obvious that vaccination coverage has not reached its full efficiency since there are still some deaths (Table 4). Deaths from measles occur on the average at age 2 (1.9 years in 1984-85; 1.8 years in 1986-87; 2.3 years in 1988-94).

Table 4
Number of antimorbillous vaccinations and the number of deaths caused by measles, by year, resident nationals, Antananarivo-ville (BMH), 1984-94.

Year	Number of vaccinations (Medical Area)			Number of deaths		
	at 0 year	at 1 year and over	Both	at 0 year	at 1 year and over	All ages
1983	-	-	-			
1984	367	-	367	62	292	354
1985	5 152	-	5 152	88	359	447
1986	6 464	27 525	33 989	21	103	124
1987	11 781	20 537	32 318	4	7	11
1988	16 228	20 302	36 530	31	154	185
1989	15 173	14 414	26 587	10	42	52
1990	27 814	24 637	52 451	5	25	30
1991	16 941	10 322	27 263	7	32	32
1992	22 466	12 602	35 068	3	4	7
1993	25 118	7 654	32 772	13	72	85
1994	26 402	6 381	32 783	3	8	11

Whooping Cough

Complete vaccination requires three injections, as with diphtheria, tetanus and polio. The fall in the number of deaths from whooping cough gradually reaches the same proportion as that due to measles from the intensification of the EPI, 1987-1991.

Poliomyelitis

Death statistics do not appear to be significant for the evaluation of a programme. A more significant measure would be the prevalence of motor deficiencies.

Tetanus

Vaccination concerns two different categories of the population:

1) Children with D. T. COQ Vaccine: the risk of contagion is less immediate than for the previous diseases. However, a definite reduction of deaths has been noted which can be attributed to vaccination.

2) Pregnant women with only the anti-tetanus vaccination with the objective of avoiding neonatal tetanus of infants. Two injections are needed to ensure immunity, therefore the figures taken into account are those of the second injection (Table 5).

Table 5
Number of anti-tetanus vaccinations among pregnant women and the number of deaths caused by neonatal tetanus, by year, resident nationals, Antananarivo-ville (BMH), 1984-94.

Year	Number of second injections (Medical Area)	Number of deaths from neonatal tetanus
1983	5 446	
1984	9 403	9
1985	9 569	11
1986	8 970	7
1987	12 379	14
1988	17 283	16
1989	11 707	19
1990	16 323	21
1991	7 400	8
1992	10 265	10
1993	9 606	7
1994	9 323	6

The apparent lack of improvement would indicate that vaccination coverage of pregnant women, following prenatal consultations, remains insufficient.

Tuberculosis

There are two combined actions directed against tuberculosis which correspond to different programmes. BCG vaccination was developed within the EPI, at the beginning, 1976-1981, and was extended in the accelerated phase of EPI, 1987-1991(Table 6). The under 1 year population targeted was 31,178 children in 1984 and 40,956 in 1990. The vaccination coverage of the BCG therefore substantially improved, rising from 39% in 1984 to 99% in 1990. During the period covered, the improvement should benefit a greater number of children. The curative programme against tuberculosis is entrusted to another department. It is intended to ensure complete treatment of all infectious cases detected, most of which are among the adult population.

Table 6
Number of BCG injections (CM) and number of deaths caused by tuberculosis,
by year and by age, national residents, Antananarivo-ville (BMH), 1984-94.

Year	Number of vaccinations		Number of deaths (Capital)						
	at 0 year	at 1 year and over	at 0 year	at 1-4 years	at 5-14 years	at 15-34 years	at 35-64 years	at 65+ years	at all ages
1983	9 202	16 223							
1984	12 113	21 513	3	10	3	81	68	9	174
1985	11 333	17 174	2	17	11	87	88	21	226
1986	14 210	17 045	3	5	5	101	71	14	199
1987	18 970	47 736	4	12	10	67	49	7	149
1988	33 189	30 959	4	2	4	32	28	9	79
1989	25 327	20 675	4	5	10	37	38	13	107
1990	40 464	40 282	6	6	7	45	71	14	149
1991	23 865	10 866	3	9	7	41	52	7	119
1992	33 029	8 766	5	5	12	52	67	18	159
1993	34 243	9 132	7	7	5	55	60	18	152
1994	37 355	5 435	7	11	5	42	55	7	127

Diarrhoea

Diarrhoea is the single most important cause of death, accounting for approximately 10% of the total, and the proportion exceeds 30% in the 1-4-

year age group. The proportion in relation to all deaths due to diarrhoea for all ages remains fairly stable at approximately 50% (Table 7).

Table 7
Number of deaths caused by diarrhoea, by year, resident nationals, Antananarivo-ville (BMH) 1984-94.

Year	at all ages	at 1-4 ans	% 1-4	Population 1-4 years	Rate in 1-4 year (per 1,000)
1984	735	373	50.7	48 311	7.7
1985	885	421	47.6	49 467	8.5
1986	1 290	576	44.7	50 651	11.4
1987	855	338	39.5	51 843	6.5
1988	757	350	46.2	53 105	6.6
1989	613	336	54.8	54 376	6.2
1990	703	387	55.0	55 678	7.0
1991	576	268	46.5	57 011	4.7
1992	485	227	46.8	58 376	3.9
1993	597	318	53.3	59 973	5.3
1994	599	298	49.7	61 204	4.9

The rate of mortality from diarrhoea in the 1-4-year age group reached a maximum of 11 per thousand in 1986, at the worst of the economic crisis. It dropped the following year to 7 per 1,000. The programme against diarrhoeic diseases started afterwards, in 1988-1989. However, this is a national programme and information on the capital would be needed, especially since the programme has been combined with the existing Maternal and Child Health Programme. It would then be possible to evaluate to what extent the significant decrease observed from 1991 is linked to the programme.

Acute respiratory infections

Acute respiratory infections make up the third cause of death for the 1-4-years age group, with a proportion a little below 20%. The Department of Maternal and Child Health (Service de Santé Maternelle et Infantile - SMI) was in charge of reducing mortality due to ARI in the 1-4-year age group, and the improvement from 1990 is noticeable (Table 8). The relation with the action carried out by the SMI remains to be demonstrated.

Table 8
Number of deaths caused by acute respiratory infection, by age and by year, resident nationals, Antananarivo-ville (BMH), 1984-94.

Year	at all ages	at 0 years	at 1-4 years	Rate in 1-4 year (per 1,000)
1984	519	170	159	3.3
1985	847	261	264	5.3
1986	609	166	155	3.1
1987	646	191	148	3.0
1988	595	242	172	2.9
1989	534	194	127	2.3
1990	616	239	141	2.5
1991	558	225	121	2.1
1992	531	192	125	2.1
1993	670	245	169	2.8
1994	599	206	140	2.3

Malnutrition

Malnutrition is the second cause of death for the 1-4-year age group with a proportion nearing 20%. This information is all the more remarkable in that malnutrition appears here as a major cause whereas it is often masked by other declared causes.

In the 1-4-year age group the mortality rate due to malnutrition reached a peak of 10 per thousand in 1986 at the worst of the economic crisis, as for diarrhoeic diseases (Table 9). Although nutritional surveillance is the responsibility of the Department of Maternal and Infant Health and of the free clinics, improvements in diets are more linked to nutritional rehabilitation in health care centres for the most serious cases and more generally to improved food intake. In addition to economic indicators information about volume of food distribution to children would be useful to explain the improvement observed since 1990.

Table 9
Number of deaths caused by malnutrition by year, resident nationals, Antananarivo-ville (BMH), 1984-94.

Year	at all ages	at 1-4 years	Rate in 1-4 year (per 1,000)
1984	515	331	6.9
1985	671	339	6.9
1986	1 313	488	9.6
1987	890	356	6.9

1988	474	269	5.1
1989	383	238	4.4
1990	425	255	4.6
1991	306	191	3.4
1992	315	204	3.5
1993	385	255	4.3
1994	376	269	4.4

It should be noted that three causes: diarrhoea, acute respiratory diseases and malnutrition make up approximately 70% of the causes of death for the 1-4-year age group. Although the programmes mentioned are essentially preventive actions, deaths are also avoided through curative training, and these have to be considered in evaluation.

Malaria

"The discovery of chloroquine and DDT made it possible, from 1949 to set up a programme for the eradication of malaria based on chemoprophylaxis at pre-school and school ages, the active screening of malaria sufferers and of the carriers of the parasites, the spraying of residual insecticides in homes. In the highlands of Madagascar the results were quickly felt". "In Antananarivo between 1946 and 1951, the malarial mortality rate dropped from 6 to 0.4 per thousand. The proportion of deaths caused by malaria went from 20% to 5%". In 1957 malaria was thought to be eradicated. "Active measures against malaria were gradually reduced from 1962 to 1964. From 1975, the disease took over the control area of the highland regions", so that a new epidemic developed over the period from 1985 to 1988 in Antananarivo Province, culminating in 1988 as the cause of almost 16% of deaths (Blanchy, Rakotonjanabelo, Ranaivoson, Rajaonarivelo, 1993).

For the total of deaths in Antananarivo-ville (Table 10), the evolution is similar. Deaths caused by malaria were at 1% in 1984 and reached 11% in 1988. The malarial death rate went from 0.12 per thousand in 1984 to a high of 1.34 in 1988, in fact, ten times higher. These rates should be compared with those estimated by Mouchet and Baudon for the highland region (Mouchet, Baudon, 1988): 0.07 per thousand in 1984; 1.10 in 1985; 1.30 in 1986; 1.90 in 1987.

In 1988, after the 1985-1988 epidemic which caused many deaths, a new programme against malaria was set up which integrated preventive measures and treatment in the short and medium term:

- advanced chemoprophylaxis using chloroquine, available through local and school dispensers;
- the spraying of homes with insecticide (DTT) in areas where there is an epidemiological risk;
- the chemoprophylaxis of pregnant women.

However, since 1990, the malarial death rate has remained higher than in 1984, at between 0.3 and 0.4 per thousand, the proportion remaining at 3% of deaths in 1994.

Table 10
Number of deaths caused by malaria, by year, national residents, Antananarivo-ville (BMH), 1984-94.

Year	Number of deaths caused by malaria		Population (all ages)	Mortality rate from malaria (per 1,000)
	at all ages	at 5 years and over		
1984	58	53	467 202	0.12
1985	84	72	480 505	0.17
1986	172	139	494 261	0.35
1987	288	259	508 489	0.57
1988	701	610	523 208	1.34
1989	378	332	538 437	0.70
1990	224	207	554 198	0.40
1991	198	178	570 511	0.35
1992	233	208	587 400	0.40
1993	216	188	604 888	0.36
1994	163	147	622 999	0.26

Maternal deaths

One of the objectives of the integrated Maternal and Child Health and Family Planning Programme is to reduce maternal mortality and morbidity due to complications during pregnancy and childbirth, to abortions and malaria.

The maternal mortality rate is obtained by comparing the number of maternal deaths in resident women with that of the births. This ratio has been calculated over the four-year period of 1990-1993 for which the number of births was available (92,306), 300 maternal deaths for 100,000 live births.

It should be pointed out here that an estimate including non-residents would introduce errors into the results. In fact, maternal deaths of non-residents make up a substantial proportion, 38% for the 1990-1992 period (122/317), because of the role played by health training in the maternity clinics in the capital. This is illustrated by the proportion of women who are referred to the hospital due to a difficult labor (54 %). The proportion of deaths following an abortion is much lower.

Another illustration of changes is the ratio between maternal deaths and all deaths of women from 15 to 49, which has varied little, between 10% and 14%

(Table 11). But the proportion of deaths following abortion, apparently for the most part induced and illegal, is higher among the youngest women, and has increased, exceeding half in recent years (Table 12). This observation is an indication of the need to reinforce the action of the programme in this direction.

Table 11

Numbers of maternal deaths (MD) of resident women based on death registration, Antananarivo-ville (BMH), 1984-1994

Year	Abortions	Complications during pregnancy	Complications during labour	Complications following labour	All MD	All female deaths 15-49	% MD	% Abort. MD
1984	30	17	13	11	71	541	13.1	42.3
1985	38	10	7	15	70	548	12.7	54.3
1986	26	23	17	13	79	680	11.5	32.9
1987	43	19	13	4	79	723	10.9	54.4
1988	46	36	10	13	105	734	14.3	43.8
1989	38	12	7	8	65	659	9.9	58.5
1990	37	7	15	10	69	559	12.3	53.6
1991	36	6	8	10	60	587	10.2	60.0
1992	34	10	13	14	71	596	11.9	47.9
1993	45	14	16	7	82	617	13.3	54.8
1994	39	11	18	7	75	627	12.0	52.0

Table 12

Categories of maternal deaths (MD) of resident women by age based on death registration, Antananarivo-ville (BMH), 1984-1994 (percentages)

	Abortions	Complications following pregnancy	Complications during labour	Complications following labour	Number of MD	% of abortions	
						1984-88	1989-94
15-19	60.4	12.5	13.4	13.4	96	56.4	63.2
20-24	60.1	19.1	11.2	9.6	188	61.5	58.8
25-34	47.6	21.5	17.1	13.7	357	41.7	53.7
35-49	40.0	23.1	21.3	15.6	160	31.6	48.1

Conclusion

The reliability of the data provided by the death registers of the Madagascan

capital has been established. There is, therefore, a body of remarkably reliable data, analysis of which reflects the impact of health programmes, their insufficiency or even their absence.

The Expanded Programme for Immunization (EPI) aimed at eradicating measles, diphtheria, tetanus, whooping-cough, poliomyelitis and tuberculosis contributed to reducing mortality caused by measles and whooping cough during the accelerated phase of the programme. On the other hand, the impact on tetanus and tuberculosis was less obvious. In the latter case, in addition to preventive action, curative action should be taken into account for evaluation purposes. The efforts of the Maternal and Child Health Department have been encouraged by a drop in the number of deaths caused by diarrhoeal illnesses, malnutrition and acute respiratory diseases.

The temporary insufficiency of a programme can also translate into a negative effect, as in the fight against the plague. In the same way, the absence of a programme can result in an epidemic, as was the case with the malaria epidemic of 1985-1988.

Data providing indicators for the monitoring of programmes, act as a gauge for the whole of the capital, but also at the level of the *arrondissement* and the neighbourhood. One example was that of maternal health.

Given the results, the objective is now to go back over the series until 1980, and especially to perpetuate it by including it within a set of indicators. But also to extend the experience to centres in the other Provinces and to test the same approach in rural sectors.

A strategy based on the complementarity of both approaches, periodic snapshots of the national level and chronological series, has proved to be more adapted to needs. Indeed, the Demographic Health Surveys (DHS) - single-round surveys, representative at a national level - have provided, since 1975 almost all of the data on mortality. However, for a given year, the number of countries chosen is limited, and whichever country is studied, at the national level few reference points in time are available. Here again, this concerns only child mortality (and maternal mortality in some surveys) without causes of death.

More information about the health status of developing countries requires the implementation of a permanent system for the registration of births and deaths. Many African capitals already have such systems. It is true that such a registration system cannot provide a representative picture of the country. But this shortcoming is compensated by substantial advantages: it concerns all age groups and includes cause of death. The data are quickly available: with a monthly registration input one may even refer to real-time availability. The cost of exploiting such data is extremely low, compared to that of a survey.

It may be wondered why such data are not used systematically since they represent a reliable source of information. It is true that for a long time the

prevailing dogma was that of preferring national statistics, even if they are unreliable or only partly reliable, to chronological series that were reliable but limited to part of the country. In other words preference was given to an international centralized vision to the detriment of the country's own needs.

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Annex

CODES FOR CAUSES OF DEATH

N° of the heading	Cause of death	Code
1.	Diarrhoea	009
2.	Other infectious intestinal diseases	001->008
3.	Tuberculosis	010->018
4.	Plague	020
5.	Diphtheria	032
6.	Whooping cough	033
7.	Tetanus	037
8.	Poliomyelitis	045
9.	Measles	055
10.	Viral hepatitis	070
11.	Malaria	084
12.	Other infectious and parasitic diseases	021->139
13.	Tumours	140->239
14.	Endocrine and diabetic diseases	240->259
15.	Malnutrition	260->269
16.	Diseases of the metabolism	270->279
17.	Diseases of the blood	280->289
18.	Mental disorders, including alcoholism	290->319
19.	Diseases of the nervous system	320->379
20.	Ear infections, including otitis	380->389
21.	Hypertensive diseases	401->409
22.	Ischemic heart diseases	410->414
23.	Cardiac insufficiency	428
24.	Cerebral vascular diseases	430->438
25.	Other diseases of the circulatory system	390->459
26.	Pneumonia, bronchial pneumonia and flu, or acute respiratory infections (ARI)	480->487
27.	Other diseases of the respiratory system	460->519
28.	Diseases of the digestive system	520->579
29.	Diseases of the genital and urinary organs	580->629
30.	Pregnancies ending in abortion	630->639
31.	Complications linked to pregnancy	640->648
32.	Complications during labour	650->669
33.	Complications following labour	670->679
34.	Diseases of the skin, of the muscles	680->739
35.	Prematurity, insufficient weight at birth	765
36.	Hypoxia	768
37:	Neonatal tetanus	771.3

38.	Congenital and perinatal diseases	740->779
39.	Senility	797
40.	Other indeterminate diseases	780->799
41.	Traumas	800->999

11

Impact of birth care practices on neonatal mortality in Matlab, Bangladesh.

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Bangladesh has had remarkable success in bringing down its fertility and infant and child mortality in the last two decades (Mitra, Ali, Islam et al., 1994; ICDDR,B, 1996; Cleland, Phillips, Amin and Kamal, 1994). However, maternal and infant mortality remain high. The health and maternal and child health and family planning (MCH-FP) agencies of the Government and Non-Government Organizations (NGO) have been trying various innovative and low-cost interventions for reducing maternal and infant mortality. For example, traditional birth attendants (TBAs) were given short-term training on safe pregnancy termination with the expectation that it would reduce neonatal and maternal mortality (The Fourth Five Year Plan, 1990; Duby, 1989). Related to the birth care practices, some agencies distributed a "safe delivery kit" (SDK) containing a sterile blade, some thread and gauze, antiseptic liquid, a soap, and a plastic sheet to be used in deliveries either by a TBA or relatives of the mothers (Kabir, 1989). The impact of these simple technologies on neonatal and maternal mortality has not been systematically measured. Additionally, villagers use different methods of cutting and dressing of the umbilical cord, the effects of which are not well documented in Bangladesh.

The objective of this paper is to examine if neonatal mortality was differentially associated with different types of birth care practices. We used longitudinal information from the Demographic Surveillance System (DSS) of Matlab, Bangladesh which registers in complete detail the number of births, deaths, migrations, and marital events in a population of about 200,000. Information on birth care practices was collected using a specially designed birth registration form during 1989-91.

Background

The onset of demographic transition in Bangladesh has been well documented. Despite the country's unfavorable economic conditions, low literacy, and the predominantly traditional and agrarian nature of the society, contraceptive use has risen to nearly 50 percent, and immunization of children and married women of reproductive age (MWRA) has risen to over 80 percent. Use of oral rehydration saline (ORS) for treating diarrhoea, a common disease of children, has become widespread. Health care services that positively influence child survival are increasingly available. Many health and MCH-FP agencies disseminate information on ways to reduce fertility, morbidity, and mortality

and provide MCH-FP services. Birth spacing and limitation have become common; the total fertility rate (TFR) has declined from nearly 7.0 in the 1970s to 3.5 in the early 1990s. Infant mortality has declined from over 150 per 1,000 live births in the 1970s to below 100 in the early 1990s. The annual child mortality rate has fallen from over 25 per 1,000 in the early 1970s to about 10 per 1,000 at the present time (Mitra, Ali, Islam, et al., 1994; ICDDR,B, 1978, 1991, 1994). Though there have been remarkable reductions, these demographic parameters indicate that further substantial reductions are necessary.

Maternal mortality in Bangladesh is extremely high, although there has been some improvement in the recent past. Maternal mortality ratio was over 6 per 1,000 live births in the 1970s and has come down to below 4 per 1,000 live births (ICDDR,B, 1994). It is difficult to reduce maternal mortality without widespread use of medical technologies that can handle complicated deliveries. Comprehensive emergency obstetric care has been unavailable in Bangladesh, and several projects are currently undertaking operations research to find an affordable way of reducing maternal mortality in Bangladesh.

Neonatal mortality in Bangladesh is also high, about 60 per 1,000 live births. Low birth weight, lack of proper antenatal care, unhygienic birth care practices, inadequate management of obstetric complications, and poor management of common neonatal illnesses, are believed to be the primary causes of high neonatal mortality (Kamal, Streatfield and Rahman, 1993; Simmons, Smucker and Misra, 1978; Upadhay, 1974; Akbar, 1992; Islam, Rahman, Aziz, et al., 1982).

An understanding of the mechanisms of high maternal and neonatal mortality in Bangladesh will be enhanced by a discussion of the overall situation of the country, and especially of the health care practices related to pregnancy and delivery. Over 80 percent of the population live in the rural areas, in a largely subsistent agricultural economy. The rural lifestyle is largely governed by traditional norms and beliefs. The land is basically low-lying and road communication between villages and towns is limited. In much of the country, boats are the primary mode of transportation, at least during the monsoon. Health centers that can manage complicated deliveries, a major cause of maternal and neonatal mortalities, are found only in towns. The lowest level centre, capable of handling difficult deliveries is known as the Thana Health Complex (THC) and covers on an average, 250,000 people including about 50,000 MWRA. Distance and the lack of convenient transportation to these centers are a major hindrance to the optimal utilization of services at THCs. There are 478 THC in Bangladesh but the quality and the range of services are poor. In most of the THCs only basic obstetric care is available; a few complications can be managed at this level. However, the full potential of the THCs cannot be used because of the lack or inadequacy of appropriate resources and because of management weakness.

There is a Health and Family Welfare Centre (H&FWC) for about 25,000 people including about 6,000 MWRA. An H&FWC is managed by one male Medical

Assistant (MA) and one Female Welfare Visitor (FWV). The latter provides basic health care services, antenatal care, immunization, and the supply and side-effect management of contraceptives. The MA usually provides curative services to general patients like children and adult males. Although, the FWV is supposed to conduct deliveries, virtually no deliveries are conducted in H&FWCs. The FWV can screen complicated pregnancies at the H&FWC and refer the cases to the THC, but in practice such referrals are very rare. The FWV also conducts Satellite Clinics (SCs) at eight spots spread over the catchment area of the H&FWC, where she provides antenatal and postnatal services, and contraceptive supplies and side effect management. She can also refer clients to the THC.

A Family Welfare Assistant (FWA) visits each MWRA at her home every two months to provide counsel on contraceptive use, antenatal and postnatal care, immunization, and the use of ORS for diarrhoea and to supply contraceptives. The FWA advises pregnant mothers to visit the SC for antenatal and postnatal care and the H&FWC for antenatal and postnatal care in the case of complicated deliveries. However, the use of antenatal care services has remained low in the country. The FWA also advises pregnant mothers to use the services of a trained TBA at the time of delivery.

About 19 out of 20 births are delivered at home in Bangladesh (Mitra, Ali, Islam et al., 1994). Over 60 percent are attended by TBAs, about 30 percent by relatives, and about 10 percent by a doctor or nurse or trained midwives. The common practice is to call for a TBA when labor pains start. TBAs are usually older women with no formal education, and live in the neighborhood. They do not have any training on delivery (Khan, 1986; Akhter Halida, 1995; Islam, Shahid, Haque, Mostafa, 1986). They conduct deliveries at the home of the clients, where relatives like mothers-in-law, mothers, or other older women assist the TBA in conducting the deliveries (Bhatia, 1981). The relatives provide emotional support to the client and her family members.

TBAs pay little attention to cleanliness of the place of delivery, clothing, and equipment and materials to cut and dress the umbilical cord. They use whatever is available at the time of delivery (Akhter Halida, 1995; Bhatia, 1981; Tanjina, Parveen and Juncker, 1993). For example, TBAs use a razor blade, not necessarily new, to cut the umbilical cord. In the case of a complicated delivery they are helpless and simply wait and see what happens. It is the relatives who have to make a decision to call medical personnel. Someone like a FWV or an untrained village doctor is called to assist in complicated deliveries. Sometimes, a physician is also called for, depending on the socioeconomic status of the family. The most effective solution to handling complicated deliveries is to take the pregnant mother to the THC, which has physicians and adequate medical technology. Many complicated deliveries can be handled at the THC and the clients with more complicated deliveries can be sent to hospitals at higher levels where Caesarean sections are performed.

But this does not happen because, for a range of reasons associated with culture, economy, and communication, home deliveries are favored. The

problem is compounded by a lack of properly managed resources at the THC and other health centers (Anonymous, 1992). Given that most deliveries are at home, a TBA is convenient for delivery. Wealthier people can afford to bring a FWV or a physician to the home. Taking a pregnant women outside her home for delivery requires a major decision that, culturally, can only be made by male members. In many cases, however, a mother-in-law plays an important role in allowing a daughter-in-law to be taken outside the home for treatment in case of illness or for delivery. Once decided, the transportation of a pregnant women outside the home is made difficult by the poor roads and the limited availability of transportation. Once the pregnant mother is brought to a health center, the availability of proper and timely intervention is also difficult. All these factors mean that few deliveries are conducted at health centers.

In these circumstances an appealing solution to the problem of ensuring safe deliveries is to train TBAs to conduct safe deliveries at home. The Government is providing TBAs with three weeks of training spread over a period of three months. They are trained in the basics of pregnancy and safe delivery and are advised to visit pregnant mothers to provide antenatal care and to counsel them to use a trained TBA for delivery.

The TBAs are also trained to motivate pregnant mothers to visit the SC or H&FWC to receive an antenatal check-up by the FWV. The trained TBAs are also supposed to advise pregnant mothers to go to the FWV or THC for assistance in case of any complications. This training of TBAs has been completed in most parts of the country. There is one trained TBA for about 500 mothers in the villages. The trained TBAs are initially supplied with safe delivery kits (SDKs), and are also encouraged to sell SDKs to pregnant mothers (Kabir, 1989). In Matlab, Bangladesh, the MCH-FP project of the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) delivers SDKs to pregnant mothers. The purpose of this program is to reduce maternal and neonatal mortality.

Although there have been studies on the utilization of trained TBAs and SDKs (Tanjina, et al., 1993; BRAC, 1989; Ahmad, Nazrul, Chowdhury, et al., 1989; Hossain, 1992) no systematic studies have been conducted to see if these activities have any impact on mortality, particularly maternal and neonatal mortality. It is difficult to make an assessment of such a program in relation to maternal mortality because of the lack of data. Studies need a large number of cases of pregnancy terminations, since maternal death is a rare event even though maternal mortality is very high in Bangladesh.

There is a practice of placing some concoctions on the umbilical cord just after or a few days after the birth (Islam, Rahman, et al., 1982). These materials are usually in the form of powder-medicated or non-medicated. The non-medicated powder includes ash or burnt soil or sometime burnt ash of cow-dung (Islam, Rahman, et al., 1982). The impact of such practices on neonatal mortality remains to be systematically studied. There are certain unobserved behavior patterns affecting pregnancy care, delivery care or neonatal care. This behavior

may be related to demographic and socioeconomic conditions. Socioeconomic and demographic differentials of neonatal mortality can partially be associated with unobserved behavior. No studies have so far explored such possibilities.

In this study, we examined differential risks associated with various types of birth practices on neonatal mortality. Types of birth attendants and methods of cutting and dressing of the umbilical cord received focus as birth care practices of the analysis. The analysis considers different segments of the neonatal period because certain birth care practices influence particular ages more than others. The analysis is carried out in two areas with different exposures to various public health interventions. Effects of other variables that affect both birth care practices and neonatal mortality, are controlled for in the analysis.

Methods and Procedures

The Area

Matlab is a rural riverine thana (sub-district) located about 35 miles south of Dhaka, the capital of Bangladesh. The area is largely inaccessible except by river transportation. Subsistence-level rice cultivation and fishing dominate the economy. Literacy, particularly among women, is still relatively low. Social institutions are predominantly traditional although the influence of modernization is increasing through access to radio and personal commercial contact with urban areas.

The Maternal and Child Health and Family Planning (MCH-FP) Project has provided a series of health and family planning interventions in an area of Matlab since 1977 (Phillips et al., 1982; Phillips et al., 1984; Bhatia et al., 1980).The area is known as the "treatment area". Contraceptive use has been widespread; most of the children and mothers have received immunization; and basic maternal and child health care services are available (Koenig, Rob, Khan et al., 1992).

Infant and childhood mortality have declined to below 70 and 90 per 1,000 live births in 1993 (ICDDR,B, 1996). However, neonatal mortality is still high, over 40 per 1,000 live births. In the neighboring comparison area such mortalities are below 100 and about 140 for infant and childhood mortality respectively and about 65 for neonatal mortality per 1,000 live births. There are 0.6 and 4.3 deaths per 1,000 live births due to tetanus during 4-14 days of life in the treatment and comparison areas, respectively.

Since 1988, the Matlab MCH-FP Project has initiated an intervention program on birth care practices. TBAs were trained in 1988 and SDKs are distributed among pregnant mothers. Mothers and relatives are advised to use a SDK or a clean and new blade to cut the umbilical cord and to use clean thread to tie it. Moreover, they are advised to contact a trained TBA for deliveries, especially in complicated deliveries. The TBAs are advised to refer complicated cases to the

midwives located at the maternity sub-centers of the project. Complicated cases that cannot be handled by the sub-centres are referred to the Matlab THC or to the higher level hospital where medically assisted deliveries including Caesarean sections can be performed. However, the proportion of deliveries that take place at the Matlab THC or higher level hospitals is small (Juncker, Uddin and Das, 1996).

In the neighboring comparison area, MCH-FP and other health services are provided by the regular Government program. Figure 1 shows neonatal, post-neonatal, maternal mortality, and TFR in the treatment and comparison areas (ICDDR,B, 1994; ICDDR,B, 1996).

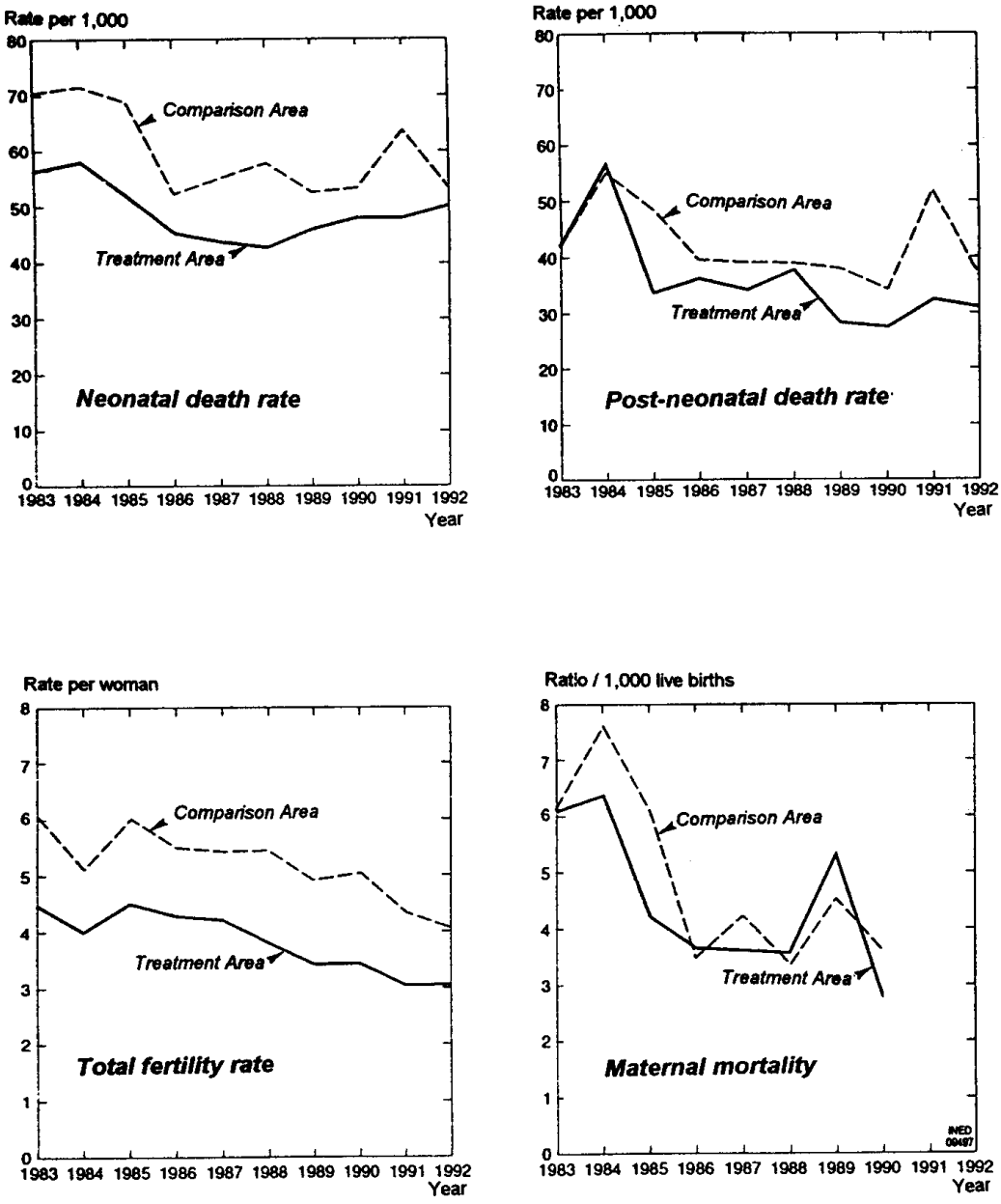

Figure 1. Neonatal, Post-neonatal and Maternal Mortality and Total Fertility Rate in Matlab, 1983-91.

Data and analysis

Information is obtained from the DSS, which has been registering vital events since 1966 in both the Matlab treatment and comparison areas. Births, deaths, marital events, and migrations are registered by Health Assistants who make routine visits at each household once a month. A birth registration form contains information on the type of birth attendant, method of cutting and dressing of umbilical cord. The form also includes information on gestational age, complications of delivery, duration of labor pain and presentation of the baby.

There were 19,191 live births (8,548 in the treatment area and 10,643 in the comparison area during 1989-91. Of these live births, 999 died in the neonatal period within 28 days of birth. The neonatal period was divided into three age groups: Early neonatal (0-3 days), mid-neonatal (4-14 days), and late neonatal (15-28 days). Factors associated with mortality at different age groups differ. Mortality during 0-3 days is much more influenced by the maternal condition during pregnancy or at birth or by delivery complications than in late stages of infancy. Tetanus neonatarum, associated with unhygienic birth care practices, is much more likely to develop during 4-14 days of life. Mortality after two weeks of life is more likely to be associated with other exogenous factors such as weaning practices or infectious diseases.

The probability of dying in each neonatal period was compared for various groups of each independent variable. The net effect of each variable was estimated by using logistic regression where adjustments were made for the effects of control variables. The different variables and their categories appear in Tables 3 and 4.

The analyses were done separately for the treatment and comparison areas, because the level and pattern of neonatal mortality are markedly different in the two areas. The treatment area has experienced a substantial lower mortality due to various interventions that have been in place from the end of 1977. The separate analyses will allow examination of the roles of various birth care practices and interventions on neonatal mortality since the areas differ in these aspects.

Results

Cause-specific probabilities of neonatal mortality by area are shown in Table 1. The treatment area has about 15 percent lower neonatal mortality than the comparison area but the difference is attributable to the lower mortality during 4-14 and 15-28 days. The probability of dying 0-3 days is nearly the same in both areas, with nearly equal distribution of causes of death. The probability of dying in 4-14 and 15-28 days is about 25 percent lower in the treatment area than in the comparison area, indicating the influence of various interventions in

the former area. Lower 4-14 day mortality in the treatment area is explained by its lower tetanus mortality compared to the comparison area. Tetanus has almost been eliminated in the treatment area, probably due to universal TT coverage of women. These positive findings indicate a limitation of comparing birth care practices that cause or prevent neonatal tetanus. For example, since there is no tetanus mortality in the treatment area, we will be unable to measure the beneficial impact of the use of SDK on 4-14 day mortality.

Table 1
Number of Births and Deaths, and Cause-specific Probability of Dying (per 1,000 Live Births) by Age and Area.

	Treatment area (n= 8,548)			Comparison area (n= 10,643)		
	Age at death (days)			Age at death (days)		
	0-3	4-14	15-28	0-3	4-14	15-28
Number of deaths	224	116	62	292	194	111
Probability (all causes)	26.1	14.0	8.0	27.0	18.9	11.1
Neonatal tetanus	0.0	0.6	0.0	0.0	4.3	0.0
Light for date	16.3	8.0	3.3	13.9	8.8	3.5
Complications at birth	2.7	0.4	0.0	3.6	0.9	0.1
ARI	0.5	2.5	1.2	0.0	2.4	3.2
Diarrhoea	0.0	0.0	1.3	0.0	0.0	0.8
Others	6.6	2.5	2.2	9.5	2.5	3.5

Untrained TBAs delivered 90 and 99 percent of live births, respectively, in the treatment and comparison areas (Table 2). Trained TBA delivered only eight and one percent of live births, respectively, in the treatment and comparison areas. Very few live births were delivered in hospital. In 84 percent of deliveries umbilical cords were cut using a SDK in the treatment area. SDKs were not used in the comparison area, where SDKs were not provided. However, 87 percent of umbilical cords in the comparison area were cut with new blades. Old blades were used in 4 and 12 percent of cases in the treatment and comparison areas, respectively. Hospital treatment was used in 155 and 49 cases in the treatment and comparison areas, respectively. The umbilical cord was tied with thread in 35 and 44 percent of cases in the treatment and comparison areas, respectively. Some kind of powder, medicated or non-medicated material, was used in the remaining cases.

Table 2
Distribution of Live Births by Birth Attendant, Method of Cutting and Dressing of Umbilical Cord.

Variables	Treatment area		Comparison area	
	Number	percent	Number	Percent
Birth attendant				
Untrained TBA	7,730[a]	90	10,519[b]	99
Trained TBA	704[c]	8	98[d]	1
Hospital	113	1	26	0
Cord Cutting				
SDK	7,140	84	---	---
New blade	939	11	9,254	87
Old blade	313[e]	4	1,238[f]	12
Hospital method	155	2	49	0
Cord Cutting				
Thread only	3,009	35	4,669	44
Thread and medicated materials	4,509	53	562	5
Thread and non-medicated materials	1,030[g]	12	5,412[h]	51

[a] Includes mother-in-law or relatives (n=304), self (n=33)
[b] Includes mother-in-law or relatives (n=36), self (n=24)
[c] Trained midwife (n=395), ICDDR,B midwife (n=120), and trained TBA (n=125), and Government TBA (n=64)
[d] Trained midwife (n=34), ICDDR,B midwife (n=10), and Government TBA (n=64)
[e] Old blade (n=213) and bamboo split (n=100)
[f] Old blade (n=316) and bamboo split (n=922)
[g] see appendix
[h] see appendix

Table 3 and Table 4 show the probabilities of dying in three sub-periods of neonatal period in the treatment and comparison areas. There are significant variations in probabilities according to different categories of birth care practice variables as shown in Table 5. In Table 5, we show odds ratios (OR) of the three birth care practice variables. The net ORs show the association between mortality and the variables under consideration when the effects of other variables are controlled. The gross ORs represent the association between mortality and the variable without controls. As expected, gross ORs, generally provide larger and more significant effects than net ORs.

Table 3
Number of Births and Deaths, and Probability of Dying in Different Ages of Neonatal Period According to Categories of Independent Variables in the Treatment Area.

	Live births		Total deaths	Probability per 1,000		
	Number	%		0-3	4-14	15-28
Birth attendant						
TBA	7,730	90	347	24	14	8
Trained TBA	704	8	46	45	13	7
Hospital	113	1	9	62	19	0
Cord cutting						
SDK	7,140	84	231	15	11	7
New blade	939	11	84	59	23	10
Old blade	313	4	60	128	55	19
Hospital method	155	2	27	154	7	15
Cord dressing						
Thread only	3,009	35	215	45	19	8
Thread and medicated materials	4,509	53	133	14	10	6
Thread and non-medicated materials	1,030	12	54	24	16	12
Maternal age						
<20	735	9	55	45	24	7
20-34	7,062	83	307	24	13	7
35+	751	9	40	31	10	14
Gestation period						
<8 months	336	4	176	375	162	91
8 months	808	9	63	33	35	12
9 months	7,382	87	160	9	7	5
Labour duration						
<24 hours	8,118	95	344	22	13	8
24+ hours	430	5	58	98	36	5
Delivery complications						
No	8,154	95	328	21	13	7
Yes	394	5	74	134	44	18
Presentation of baby						
Normal	8,449	99	372	23	14	7
Abnormal	94	1	30	277	44	15
Maternal education						
None	5,532	65	265	27	14	7
1-5 years	2,000	23	101	28	13	10
6 years+	1,014	12	36	19	13	3
Religion						
Muslim	7,189	84	334	27	13	7
Hindu	1,359	16	68	23	19	9

Table 4
Number of Births and Deaths, and Probability of Dying in Different Ages of Neonatal Period According to Categories of Independent Variables in the Comparison Area.

	Live births		Total deaths	Probability per 1,000		
	Number	%		0-3	4-14	15-28
Birth attendant						
TBA	10,519	99	582	27	19	11
Trained TBA	98	1	11	61	43	11
Hospital	26	0	4	115	0	43
Cord cutting						
New blade	9,254	87	467	24	16	10
Old blade	1,238	12	109	40	35	15
Hospital method	49	0	11	204	26	0
Cord dressing						
Thread only	4,669	44	426	55	25	14
Thread and medicated materials	562	5	23	20	13	9
Thread and non-medicated materials	5,412	51	148	5	14	9
Maternal age						
<20	833	8	85	49	40	16
20-34	8,604	81	449	26	16	11
35+	1,206	11	63	26	20	7
Gestation period						
<8 months	279	3	168	391	259	119
8 months	4,328	41	233	24	21	11
9 months	6,030	57	190	13	10	9
Labour duration						
<24 hours	10,263	96	535	24	19	11
24+ hours	380	4	62	126	24	18
Delivery complications						
No	10,322	97	517	22	18	11
Yes	321	3	80	193	46	24
Presentation of baby						
Normal	10,566	99	571	26	19	11
Abnormal	73	1	26	301	39	41
Maternal education						
None	7,371	69	441	29	19	12
1-5 years	2,252	21	112	22	21	7
6 years +	1,018	10	44	25	10	8
Religion						
Muslim	9,644	91	530	28	17	11
Hindu	999	9	67	25	32	12

Table 5
Gross and Net Odds Ratios (OR) Related to Birth Care Practice Variables by Neonatal Age and Area.
Treatment area

Variables	Age at death							
	0-3 days		4-14 days		15-28 days		0-28 days	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net
Birth attendant								
TBA	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Trained TBA	1.9 ***	1.3	1.0	0.9	1.0	1.1	1.5 *	1.0
Hospital	2.7 *	0.5	1.5	2.1	NA	NA	1.8 +	0.5
Cord cutting								
SDK	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
New blade	9.8 ***	1.5 +	2.0 **	1.0	1.6	0.8	2.9 ***	1.2
Old blade	4.2 ***	2.3 **	5.1 ***	2.0 *	3.0 *	1.1	7.1 ***	2.1 ****
Hospital method	12.3 ***	4.2 ***	0.7	0.1 +	2.3	1.1	6.3 ***	2.2 *
Cord dressing								
Thread only	3.4 ***	2.3 ***	1.9 **	1.4	1.4	1.2	2.5 ***	1.7 ***
Thread and medicated materials	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Thread and non-medicated materials	1.8 *	1.0	1.7 +	1.2	2.1 *	1.8	1.8 ***	1.2
+ P<.10; * P<.05; ** P<.01; *** P<.001								

Comparison area

Variables	Age at death							
	0-3 days		4-14 days		15-28 days		0-28 days	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net
Birth attendant								
TBA	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Trained TBA	2.4 *	0.6	2.4 +	1.9	1.0	1.1	2.2 *	0.9
Hospital	4.7 *	0.4	NA	NA	NA	NA	3.1 *	0.5
Cord cutting								
New blade	1.0	1.0	1.0	1.0	1.0	1.0	1.0 ***	1.0
Old blade	1.7 **	1.3	2.2 ***	1.9 ***	1.4	1.4	1.8 ***	1.6 ***
Hospital method	10.2 ***	8.6 ***	1.6	0.7	NA	NA	5.4	3.2 *
Cord dressing								
Thread only	2.9 ***	4.2 ***	2.0 +	2.1	1.5	1.7	2.4 ***	2.8 ***
Thread and medicated materials	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Thread and non-medicated materials	0.2 ***	0.3 *	1.1	1.1	0.9	1.1	0.7 +	0.8
+ P<.10; * P<.05; ** P<.01; *** P<.001								

The probability of dying in the neonatal period and in the different age groups was higher if births were delivered in hospital than if births were delivered by trained or untrained TBAs. This is because the more complicated cases were the ones brought to the hospital. Birth complication is a very high-risk factor in neonatal mortality. For this reason we find that neonatal mortality was significantly higher if a hospital method (complicated births were delivered in hospitals) was used for cutting of the umbilical cord than that of those births where cords were cut by blades or SDKs (Table 5). Mortality during 0-3 days of life was several-fold higher among births in which the hospital method was used for cutting the umbilical cord compared to those using blades. This is true for both the treatment and comparison areas.

There was no difference in mortality between deliveries with untrained TBA and trained TBA (Table 5). One reason for this is the small proportion (eight and one percent) of trained TBAs in the treatment and comparison areas (Table 3 and Table 4). In the treatment area the probability of dying in 4-14 days may be the same between the groups of trained and untrained TBAs since there were a negligible number of tetanus deaths. We do not expect that, in the treatment area, there will be significant difference of 4-14 day mortality between the groups using SDK, a new blade, or an old blade because of the near-absence of neonatal tetanus. In contrast, in the comparison area, it is possible that 4-14 day mortality would be higher among the group who used an old blade for cutting the umbilical cord because neonatal tetanus is still prevalent as a result of a relatively lower level of TT coverage of mothers.

SDKs were available only in the treatment area. Mortality in the neonatal and other age groups was similar for SDKs and new blades. The use of an old blade for cutting the umbilical cord was a risk factor for 4-14 day mortality in both the treatment and comparison areas. The higher mortality among births using old blades for cutting the umbilical cord was probably associated with infection from tetanus originating from old blades in the comparison area but not in the treatment area (Rahman, 1982; Sharma and Lahori, 1977; Kakar, Chopras and Grewal, 1978). In the treatment area, 0-3 and 4-14 day mortality was higher among old blade users than among new blade or SDK users. There is no clear reason why this should happen. One possible explanation is that old blade users are probably poor "health achievers" or members of a less "health conscious" group with a higher early neonatal and neonatal mortality than others.

Neonatal mortality was 1.7 and 2.8 times higher among births whose cord was tied only with thread than for those whose cord was dressed with some powder materials (medicated or non-medicated powder) (last column of Table 5). The beneficial effect of using some materials is pronounced in the 0-3 day period. There is little scientific explanation of the beneficial effect of the use of powder. Application of some materials on the cord probably reflects some efforts of mothers and relatives to care for the health of the baby. This group of mothers or relatives probably also take good care during pregnancy, resulting in lower early neonatal and overall neonatal mortality.

Table 6 and Table 7 show the association of biological, demographic, and socioeconomic factors with mortality at different ages in the treatment and comparison areas. A shorter gestational age and delivery complications are mortality risks for almost all age groups. Young motherhood is a risk factor of neonatal mortality in the comparison area. Previous research (Alam, 1995; Swenson, 1981; Koenig et al., 1990) in Matlab shows that young motherhood is not a risk factor of neonatal mortality after the adjustment of the effect of birth order. However, we do not have information on birth order for the present analysis.

Table 6
Net Odds Ratios (OR) Related to Birth Care Practice, Biological, Demographic,
and Socioeconomic Variables by Neonatal Age in the Treatment Area.

Independent variables	Age at death			
	0-3 days	4-14 days	15-28 days	0-28 days
Birth attendant				
TBA	1.0	1.0	1.0	1.0
Trained TBA	1.3	0.9	1.1	1.0
Hospital	0.5	2.1	NA	0.5
Cord cutting				
SDK	1.0	1.0	1.0	1.0
New blade	1.5 +	1.0	0.8	1.2
Old blade	2.3**	2.0 *	1.1	2.1 ***
Hospital method	4.2 ***	0.1 +	1.1	2.2 *
Cord dressing				
Thread only	2.3 ***	1.4	1.2	1.7 ***
Thread and medicated materials	1.0	1.0	1.0	1.0
Thread and non-medicated materials	1.0	1.2	1.8	1.2
Gestation period				
<8 months	39.2 ***	20.7 ***	18.4.***	35.3 ***
8 months	2.7 ***	4.2 ***	2.3 *	3.1 ***
9 months	1.0	1.0	1.0	1.0
Labour duration				
<24 hours	1.0	1.0	1.0	1.0
24+ hours	1.6 +	1.5	0.3	1.3
Delivery complications				
No	1.0	1.0	1.0	1.0
Yes	3.3 ***	2.9 **	3.0 *	3.7**
Maternal age				
<20	1.3	1.5	1.0	1.3
20-24	1.0	1.0	1.0	1.0
35+	1.3	0.8	1.9 +	1.3
Maternal education				
None	1.0	1.0	1.0	1.0

1-5 years	1.0	0.8	1.3	1.0
6 years +	0.6 +	0.9	0.4	0.7 +
Religion				
Muslim	1.0	1.0	1.0	1.0
Hindu	1.0	1.6 +	1.3	1.3 +
+ P<.10; * P<.05; ** P<.01; *** P<.001				

Table 7
Net Odds Ratios (OR) Related to Birth Care Practice, Demographic,Biological, and Socioeconomic Variables by Neonatal Age in the Comparison Area.

Independent variables	Age at death			
	0-3 days	4-14 days	15-28 days	0-28 days
Birth attendant				
TBA	1.0	1.0	1.0	1.0
Trained TBA	0.6	1.9	1.1	1.0
Hospital	0.4	1.0	1.0	0.5
Cord cutting				
New blade	1.0	1.0	1.0	1.0
Old blade	1.3	1.9 ***	1.4	1.6 ***
Hospital method	8.6 ***	0.7	1.0	3.2 *
Cord dressing				
Thread only	4.2 ***	2.1	1.7	2.8 ***
Thread and medicated materials	1.0	1.0	1.0	1.0
Thread and non-medicated materials	0.3 *	1.1	1.1	0.8
Gestation period				
<8 months	41.5 ***	33.8 ***	14.5 ***	42.1 ***
8 months	2.0 ***	2.0 ***	1.2	1.8 ***
9 months	1.0	1.0	1.0	1.0
Labour duration				
<24 hours	1.0	1.0	1.0	1.0
24+ hours	1.4	0.5	1.3	1.0
Delivery complications				
No	1.0	1.0	1.0	1.0
Yes	10.0**	2.9**	1.7	6.2***
Maternal age				
<20	1.3	1.9**	1.2	1.5**
20-24	1.0	1.0	1.0	1.0
35+	0.9	1.3	0.5+	0.9
Maternal education				
None	1.0	1.0	1.0	1.0
1-5 years	0.7+	1.1	0.6+	0.8
6 years +	0.6+	0.5*	0.6	0.6**
Religion				
Muslim	1.0	1.0	1.0	1.0
Hindu	1.2	2.3***	1.1	1.6**
+ P<.10; * P<.05; ** P<.01; *** P<.001				

Neonates of educated mothers experienced a lower risk of mortality in most age segments, especially in the treatment area. Hindu babies, during 4-14 days, experienced significantly higher mortality than Muslim babies especially in the comparison area where coverage of TT among women is lower than in the treatment area. Hindus' higher risk of mortality is associated with birth care practices. Previous research shows that certain birth care practices of Hindus induce the transmission of neonatal tetanus (Sharma and Lahori, 1977; Kakar, Chopras and Grewal, 1978; Islam, Haque, Mostafa, 1989). For example, among Hindus, deliveries take place and the mother and the new born reside at least for a week in a newly built very small hut whose floor and walls are brushed with mud mixed with cow-dung, a potential source of tetanus neonatarum. Sometimes, deliveries are conducted in a small room built in the veranda and mother and new born reside there at least for a week. Excess risk of 4-14 day mortality is more pronounced in the comparison area than in the treatment area. This is because immunization of mothers against tetanus was more common in the treatment area than in the comparison area.

Discussion and conclusion

By using longitudinal data of very high quality, we examined whether different birth care practices differentially affect neonatal mortality. We find that the use of a new and clean blade is beneficial to neonatal health, particularly during the period when the neonates die from tetanus in a population where coverage of TT among mothers is relatively low. These findings have strong programmatic implications. Health and MCH-FP programs can disseminate information to mothers, TBAs and villagers to use a new blade and a clean piece of thread for cutting and dressing of the umbilical cord after delivery. Strengthening of information, education and communication (IEC) activities of the health and MCH-FP program to promote the use of a new blade and clean thread for cutting and dressing of umbilical cord can reduce neonatal tetanus in particular, and neonatal mortality in general. Since the SDK is provided only in the treatment area and since there was a very small number of neonatal deaths from tetanus, we were not in a position to evaluate the impact of SDKs on reduction of neonatal tetanus.

We do not find any beneficial effects in the use of trained TBAs on neonatal mortality. We would like to exercise caution in interpreting our results. It is possible that trained TBAs are called for in the case of "problem births" or complicated deliveries, which have high risk of both maternal and neonatal mortality. If trained TBAs were used in the case of high-risk deliveries and even if there was some beneficial effect in the use of trained TBAs, we were not be able to document it from the analysis. Since we have included in the analysis a variable that indicates whether or not a birth had complications, it is quite unlikely that the null effect of training of TBAs is explained by the selective use of trained TBAs for complicated pregnancies. Given these we recommend that rural mothers be encouraged through IEC activities to use trained TBAs even

though we do not observe any mortality impact. However, we also suggest a properly designed study be carried out to further investigate the value of trained TBAs. We note, however, that some doubt must exist about the value of trained TBAs, given the limited training involved, and the absence of proof that training significantly changes the TBAs' birth practices.

We find that village mothers or their relatives put some materials in the form of medicated or non-medicated powder on the umbilicus. This effort is probably made with an expectation that the materials will help timely healing of the sore on the umbilicus. Our results show that early neonatal mortality (0-3 days) was lower among the group who used powdered materials on the umbilicus. The lower mortality in this group is probably not related to the use of materials on the umbilicus, rather the group probably had selectively lower mortality. The group might also have health behavior during pregnancy that can result in better health of mother and the baby in the womb. This might have led to lower early neonatal (0-3 days) mortality. This information can be used indirectly in formulating policy. Mothers and relatives always try to use appropriate and affordable means to improve maternal and child health. If health programs can provide information to mothers and relatives on affordable preventive and curative health care inputs, it is likely that they will use them for better reproductive health. A carefully designed program for the dissemination of information on antenatal care and safe delivery can help reduce neonatal mortality through improved pregnancy and birth care practices and higher use of maternity care services. Systematically designed studies should be conducted to learn about practices of mothers and relatives during pregnancy, delivery, and neonatal period that provide beneficial impacts on neonatal and the maternal health.

The use of trained TBAs and the SDKs can influence neonatal mortality and maternal injuries and morbidity associated with pregnancy termination as well as maternal mortality. The present study examines the effects of these variables only on neonatal mortality. Without further study on the impacts of the use of trained TBAs or use of SDKs on maternal injuries, morbidity, and mortality we hesitate to make any firm conclusion about the overall benefits of use of trained TBAs and SDKs. Further studies should be undertaken to examine maternal benefits associated with the use of trained TBAs and SDKs.

Abstract

Using high quality data from the Demographic Surveillance System of Matlab, Bangladesh, we examined the effects of birth care practices on three age groups of neonatal mortality. Logistic regression was applied to estimate the net effects of birth care practices on early (0-3 days), mid (4-14 days), and late (15-28 days) neonatal mortality for about 20,000 live births during 1989-1991. We find that neonatal mortality (in all age groups) was similar among the births that were delivered by untrained traditional birth attendants (TBA) and

trained TBAs. Mortality during 4-14 days of life was lower if a new razor blade was used for cutting the umbilical cord compared to the use of an old razor blade. Early neonatal mortality (0-3 days) was lower among the newborn whose umbilical cords were dressed with some medicated or non-medicated powder and/or liquid. Policy implications of the findings are discussed.

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Appendix

Types of Materials Applied on the Umbilical Cord.

	Number	
Materials	**Treatment area**	**Comparison area**
Ash	184	1,116
Unburnt cow-dung	22	86
Catechu	41	1,608
Chemical powder	134	427
Mustard oil	56	108
Breast milk	18	102
Fomentation	89	1,119
Burnt earth	80	550
Ash and Dettol	102	4
Ash and catechu	1	69
Ash and chemical powder	0	10
More than two of above materials	303	213

12

Evaluation of the role of vaccination in the reduction of childhood mortality.

A case study in Senegal * [12]

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Childhood mortality has strongly declined in Africa since the Second World War. The levels were still very high during the 1950s - 30% to 40% of newborn died before the fifth birthday (Hill, 1989) - but then fell sharply, to between 10% and 25% in the 1970s. The downward trend has since continued, except in those countries where the AIDS epidemic has taken a heavy toll. Which factors produced this decline ? Certainly changes in socio-economic and health conditions were essential. However, is it possible to determine precisely which changes or actions were the most important ?

During the period since the Second World War, health services have developped greatly. Following the World Health Conference in 1977 at Alma Ata, they were also reorganised. Policies were reformulated and reoriented towards 'primary health care', with the aim of providing limited but affordable services at the community level. To reach this target, a fundamental element was the training of community health workers in the villages, their role being to supply basic health care and to monitor pregnancies and assist during delivery. Several programmes targeting mother and child health care have since been added to the original primary health care services, although they involve more sophisticated techniques: for instance, vaccination of children and pregnant women and malnutrition surveillance. Can we measure the relative efficiency of these different types of action. In particular, what was the impact of the child immunization programmes ?

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* Translated from French by L.Sergent.

[12] This chapter presents analyses and results previously published in the chapter on mortality (chapter 5) of the book edited by Pison et al., (1995) *Population dynamics of Senegal* and in the article by Desgrées du Loû and Pison "Le rôle des vaccinations dans la baisse de la mortalité des enfants au Sénégal " (*Population* 1995, 3: 591-620).

The aim of the present chapter is to evaluate the role of vaccination programmes in the reduction of childhood mortality in Africa, by taking Senegal as a case study. Infant and child mortality have fallen notably in this country during the last twenty years, and the demographic and health data are sufficiently abundant to allow us to compare mortality trends and developments in the health sector. As the different types of action have often been concomitant, it is difficult to measure how successful they have been and what share of the national mortality decline can be attributed to each. This problem can be partly handled in population laboratories where the same population is observed continuously over a long time period and where programmes may not have been implemented simultaneously. Such population laboratories can therefore be a precious source of information to study at a finer level the relationship between mortality changes and developments in the health sector. We'll use in particular the Bandafassi population laboratory, which has collected data for the last two decades (1975-1994). There were no important socio-economic or health changes in the population during this period other than a systematic child vaccination effort, implemented in December 1986 in the framework of the Expanded Programme for Immunization (EPI). Since vaccination coverage was extremely low in Bandafassi before this effort, we had natural experimental conditions for measuring the impact of immunization on child survivorship.

In part I, we describe the decline of childhood mortality in Senegal since the end of the Second World War and review the different health programmes implemented during this period. In part II, we measure more specifically the impact of the immunization programme in rural Bandafassi, discuss its weaknesses and the scope for improvement.

Part 1: CHILD MORTALITY DECLINE AND HEALTH CONDITIONS IN SENEGAL SINCE 1945

The child mortality decline

National trends

Five surveys and one census supply data that permit estimation of the national level of child mortality. The type and quality of data gathered vary among surveys, as do the methodologies used. Accordingly, it is preferable to focus on a simple, robust indicator of child mortality, the probability that a newborn will die before the age of 5 ($_5q_0$). The advantage of this indicator is that it is less sensitive to age-reporting errors than the probability of dying before the first birthday, $_1q_0$, which is more frequently used. It is also less sensitive to biases

linked to the estimation method[13]. Figure 1 shows $_5q_0$ estimates for all of Senegal since 1946[14] (Pison, Hill, Cohen, Foote, 1995). Although these measurements result from different surveys and estimation techniques, they are fairly consistent.

In the 45 years following the end of the Second World War, child mortality ($_5q_0$) declined by two-thirds, falling from a level of roughly 400 per 1,000 (373 in 1946) to 130 per 1,000 (131 in 1988-92). The decline appears to have occurred rather slowly until the early 1970s, with a 25% drop in 25 years (from 373 per 1,000 in 1946 to 280 per 1,000 in 1970), and to have accelerated thereafter, with $_5q_0$ falling by more than 50% in the next 20 years (to a level of 130 per 1,000 around 1990).

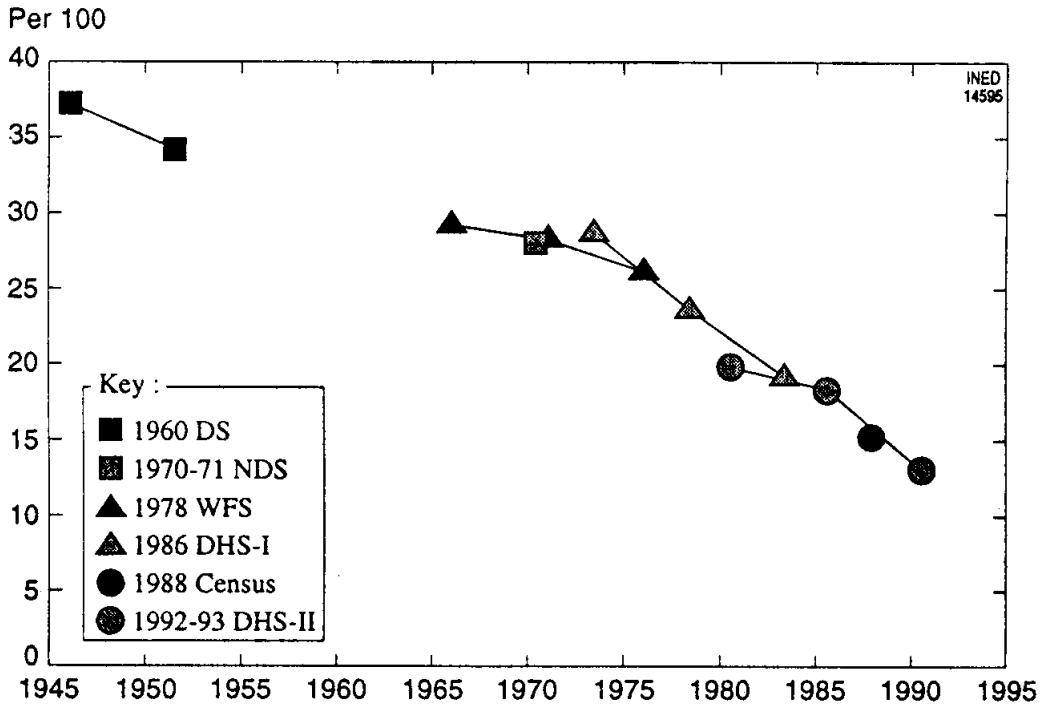


Figure 1. Probabilities of dying before age 5 ($_5q_0$) in Senegal, 1945-90.

Urban-rural differentials

Figure 2 compares the trends of $_5q_0$ in rural areas, in the capital Dakar-Pikine, and in another city, Saint-Louis. The contrast between the cities and rural areas is enormous during the period 1960-75, $_5q_0$ being three times higher in the latter. The Saint-Louis series shows that the differentials are long-standing, resulting from the early, substantial decline in mortality in the cities beginning during the first half of the century. At the end of the 1970s, the situation

[13] The quality of the data is discussed in Pison et al., 1995.
[14] The corresponding data are given in the Appendix.

changed. The pronounced mortality decline in rural areas and a slowing of the progress in the cities reduced the rural-urban ratio to 2 to 1.

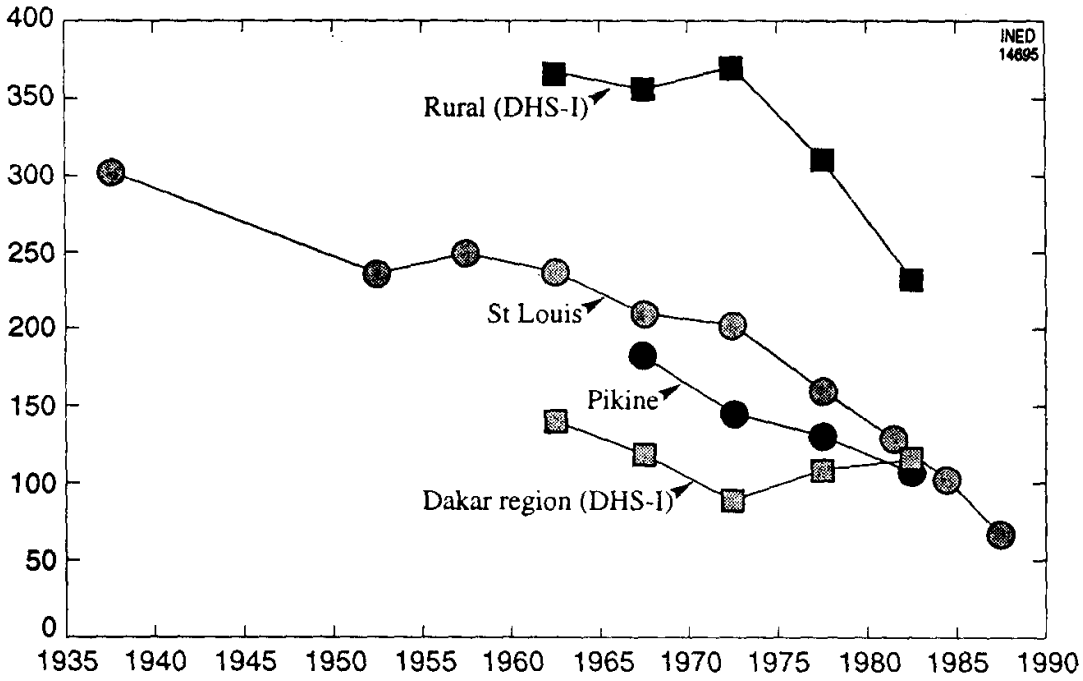


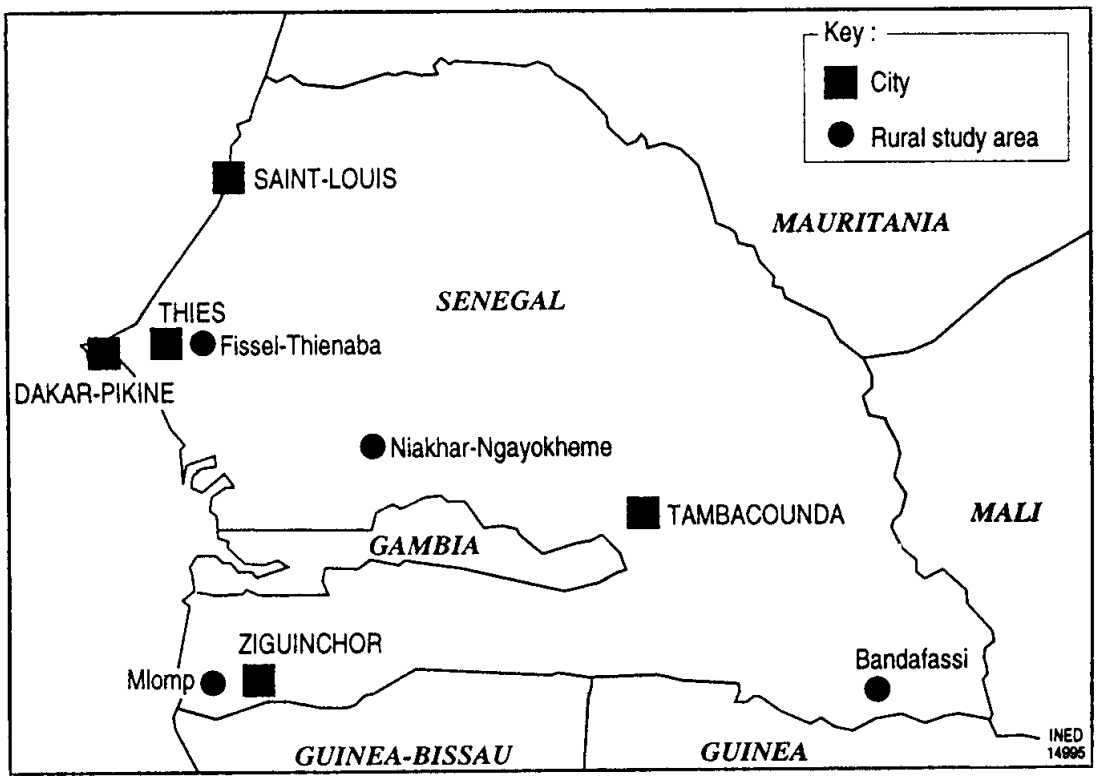
Figure 2. Trends in child mortality ($_5q_0$ per 1,000). Comparison between two cities, Dakar-Pikine and Saint-Louis, and rural areas in Senegal.

The pattern of change in rural areas was not completely homogeneous. Figure 3 shows some local differences recorded by reliable surveys. In the various study regions (see map), we find more or less the same pattern - a plateau, followed by a rapid decline - but with some timing differences. In Bandafassi, the study area furthest from Dakar (700 km.), the decline in child mortality began only in 1986, and is coincident, as we shall see, with the acceleration of the EPI in 1986-87. In Ngayokhème, 150 km. from Dakar, the reduction began earlier, at the beginning of the 1970s. The decline during that period is attributed mainly to reduced rainfall, leading to reduced incidence of malaria (Cantrelle, 1969); however, it persisted at the same pace after the dry years ended. The rural areas of Fissel and Thienaba are closer still to Dakar (120 and 90 km. respectively), and Thienaba is also only 15 km. from the city of Thiès and 10 km. from Senegal's only rural maternal and child health (MCH) centre in Khombole, which began operation in 1957. The child mortality decline was ongoing in 1972, the earliest year for which data on Fissel-Tienaba are available (from the Survey on Child Mortality in the Sahel of 1981-84 (EMIS) (Pison et al., 1995). It probably began still earlier than in Ngayokhème and apparently progressed very rapidly during the 1970s.

Mlomp presents a special case. This rural area, 500 km. from Dakar, is only 50

km. from Ziguinchor, the regional capital. In Mlomp, the population benefited from the establishment of a private dispensary and a maternity clinic in 1961, which soon after they opened were providing high-quality health services to a large majority of the area's residents (Pison, Trape et al., 1993). As a result, an early and very rapid decline in child mortality began in the mid-1960s: the risk of dying before age 5 was cut fourfold in twenty years.

With the exception of Mlomp, the onset of child mortality decline in these rural study areas appears to be correlated with distance from Dakar, a factor that is, in turn, correlated with the availability of health services. The levels of women's education and household income were uniformly low in all the areas during this time, so these factors cannot explain the observed differences in timing. The relatively rapid reduction of rural child mortality beginning in the late 1970s can, however, be linked in large part to infrastructure decentralization and to the new health policy that brought health services to most of the previously deprived rural populations.



Map

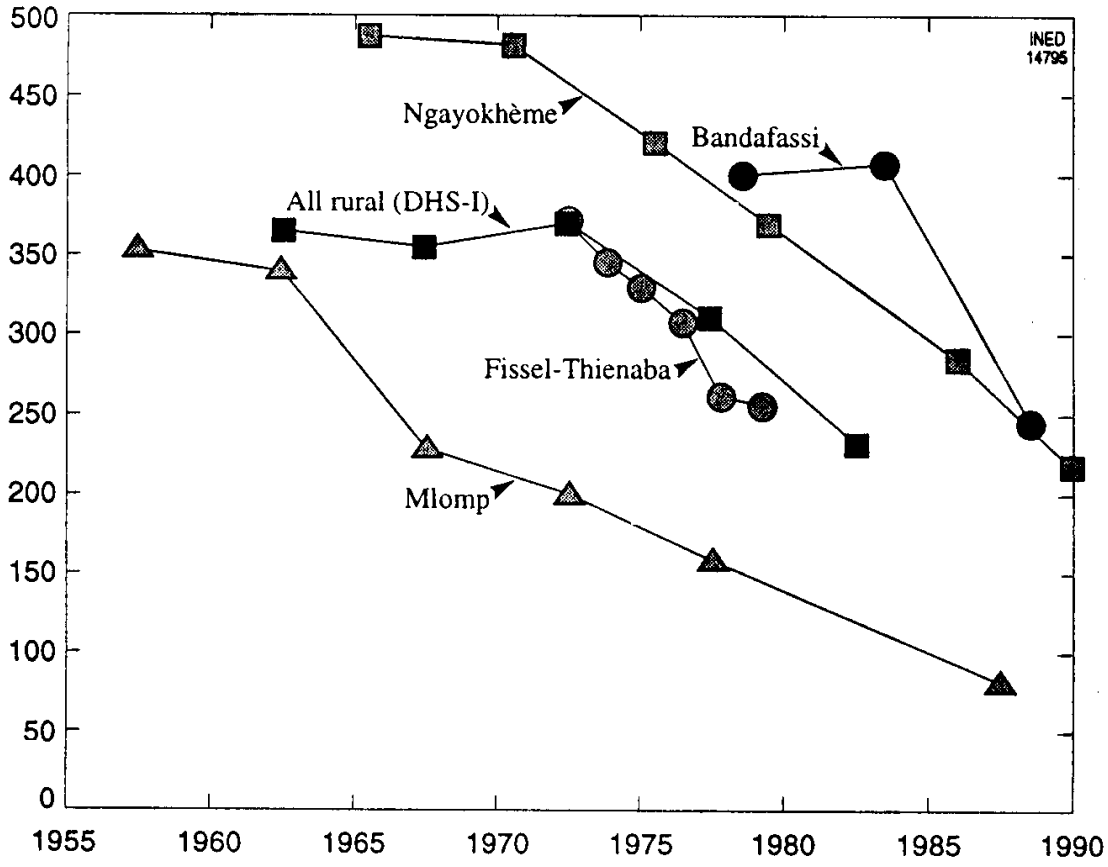


Figure 3. Trends in $_5q_0$ in some rural areas of Senegal.

Age-specific trends

At the national level, the probability of dying between the first and the fifth birthday ($_4q_1$) is higher than the probability of dying before age 1 ($_1q_0$) practically throughout the period, a peculiarity that was first observed in the 1960s (Cantrelle, 1969). At that time, $_4q_1$ was 50% higher than $_1q_0$ (Table 1). In the following years, child mortality declined more rapidly than infant mortality, thus reducing the gap, and by the end of the 1980s the values were equal (68 per 1,000).

Table 1
Trends in mortality during the first year of life ($_1q_0$) and the next four years ($_4q_1$) in Senegal.

Age interval (in years)	DHS-I (1986)			DHS-II (1992-1993)		
	Period 1971-75	Period 1976-80	Period 1981-85	Period 1978-82	Period 1983-87	Period 1988-92
	Probability of dying (per 1,000)			Probability of dying (per 1,000)		
0-1 year	120	96	86	90	84	68
1-5 years	189	155	114	119	109	68
0-5 years	287	236	191	198	184	131

Sources : 1986 DHS-I : Ndiaye *et al.*, 1988
1992-1993 DHS-II : Demographic and Health Survey II, 1994

The rural and urban patterns are somewhat different, but both show the same more rapid decline in post-infantile child mortality (Pison et al., 1995). One of Senegal's distinguishing features, very high levels of $_4q_1$ compared to $_1q_0$, has thus disappeared. It was in part due to the high incidence of infectious disease mortality (malaria and measles) and to its seasonal or epidemic nature (for the former and latter respectively). Health programmes targeting these diseases, by immunization or chemoprophylaxis (malaria), have succeeded in eliminating the related rise in mortality beyond the sixth month.

In addition, these programmes were initiated earlier and have been more effective than those aimed at improving pregnancy monitoring and delivery conditions, which have an impact mostly on mortality in early infancy. That explains why more headway was made in reducing $_4q_1$ than $_1q_0$. This pattern is repeated throughout history: infectious mortality recedes faster than perinatal mortality when general health conditions improve (Poulain, Tabutin, 1980).

Change in health conditions

Before 1978

Senegal's health infrastructure (hospitals, maternity clinics) was until 1978 focused on the cities. Public health programmes to improve sanitary conditions and control disease were developed primarily in the towns, building on these

infrastructures. The poorly served rural areas benefited only from periodic visits of mobile teams from the Major Endemic Diseases Department (Service des Grandes Endémies), whose activities began to deteriorate following independence in 1960. In 1978, following the recommendations made at the World Health Conference in Alma Ata in 1977, Senegal introduced primary health care. Paralleling the effort towards decentralization of the major health facilities (hospitals and dispensaries), this policy led to the training of community health workers and the establishment of village pharmacies and maternity clinics. Using these new village-based infrastructures, several mother and child health care (MCH) programmes were initiated: vaccinations, malaria prevention, rehydration of children suffering from diarrhoea, pregnancy monitoring and assistance in delivery, food supplements for young children.

Health infrastructures

The number of hospitals increased threefold between 1960 and 1988 (Table 2), reflecting the policy to equip each region with a hospital and to divide some hospitals into two in the cities. However, the number of hospital beds has not grown proportionally; it has not even kept pace with population growth. Thus, despite the proliferation of hospitals, the supply of beds per inhabitant has fallen slightly.

Table 2
Change in health infrastructure in Senegal, 1960-88.

Infrastructure	1960	1980	1988
Hospitals	5	12	16
hospital beds	2 400	3 523	5 179
persons per hospital bed	1 300	1 580	1 650
Health centres	34	35	47
Dispensaries	201	376	659
Rural maternity clinics	-	189	502
Population (millions)	3.1	5.6	6.9

Sources : - Situation économique 1988, *Statistiques sanitaires*, Senegal
- Osmanski *et al*., 1991

The number of health centres has not changed much, continuing to be one per departmental capital. They are normally run by a physician and are equipped with hospital beds. The number of dispensaries, on the other hand, has increased sharply: it more than tripled between 1960 and 1988. Run by nurses, these dispensaries are found throughout the country. They are generally located in the district (*arrondissement*) capitals or rural communities.

Maternity clinics were rare and concentrated in the towns until 1977. Beginning in 1978, the primary health care policy led to the construction of a

large number of such clinics in rural areas. In 1988, there were almost as many rural maternity clinics as there were dispensaries.

In 1960, the Dakar region, which had 14% of the population, had 3 out of 5 hospitals (60%) and the vast majority of hospital beds. In 1988, it had 22% of the population, but only 6 out of 16 hospitals (38%) and half of the hospital beds (Table 3). The distribution of facilities between Dakar and the rest of the country, while remaining unequal, appears to have improved considerably. Nevertheless, health personnel remain very concentrated in Dakar, where two-thirds of the country's physicians, pharmacists and dentists and half of its nurses and midwives are found.

Table 3
Public and private health resources in all Senegal and in Dakar, 1988.

Resources	All Senegal	Region of Dakar	Percentage of resources in the Region of Dakar (%)
Infrastructure			
Hospitals	16	6	38
hospital beds	5 179	2 565	50
Health centres	47	7	15
Dispensaries	659	78	12
Personnel			
Physicians	407	280	69
Pharmacists	200	133	67
Dentists	58	42	72
State nurses	937	375	40
State midwives	474	239	50
Population (millions)	6,9	1,5	22
Sources : Situation économique 1988, *Statistiques sanitaires*, Senegal			

Health programmes

Numerous programmes were implemented before 1978, each one having a specific scope of action. They were carried out either by MCH centres in urban settings, or by mobile teams (smallpox eradication and control of leprosy). After 1978, these programmes were integrated into the general primary health care programme carried out by the dispensaries and mobile teams for vaccination. Two of these specific programmes, the antimalaria campaign and vaccinations, are discussed in greater detail below.

Antimalaria campaign

Malaria, which is endemic in Senegal and one of the major causes of child mortality, was the focus of specific eradication programmes beginning in 1953 (Cantrelle et al., 1986). Between 1953 and 1961, an eradication trial was conducted in the region of Thiès and the western part of the region of Fatick, in which homes were sprayed with DDT combined, after 1957, with chemoprophylaxis. This programme was a failure. In 1963, another antimalaria programme, using chloroquine-based chemoprophylaxis (and named 'chloroquinization') was launched throughout Senegal. Its impact appears to have been very unequal, both through time and from one region to another, although there was little follow-up or evaluation. On the whole, its effects on malaria mortality and morbidity appear to have been limited (Garenne, Cantrelle, Diop, 1985). This programme was discontinued in 1979 and malaria prevention was thereafter incorporated into primary health care.

Vaccinations

- Before 1981

Until the Expanded Programme for Immunization (EPI) was launched in 1981, vaccinations were administered in two ways:

- through mass campaigns conducted in successive operations by mobile teams combing the rural and urban areas;
- through MCH centres, which dispensed standard vaccines against tuberculosis (BCG), diphtheria, tetanus and pertussis alone (DTP) or with polio (DTPP), as well as measles starting in 1968. Unlike those given through the mass campaign system, these vaccinations were administered on a regular basis: mothers brought their children to the MCH centres on the days scheduled for vaccination sessions. But since the MCH centres existed only in the towns, this system benefited only the urban population.

- After 1981, the Expanded Programme for Immunization (EPI)

Initiated in Senegal in 1981, the EPI programme was designed to extend vaccination coverage to rural areas, which were at that time not well served, and to improve coverage in urban areas. Its objective was to protect children against seven diseases: tuberculosis, diphtheria, tetanus, pertussis, polio, measles and yellow fever. Its strategy was based on fixed vaccination centres and mobile teams:

- fixed centres: in urban areas, the MCH centres continued to operate as fixed centres, as they had done previously; in rural areas, dispensaries began systematic vaccination at fixed sites. They also provided coverage for people living within a 15 km. radius by means of travelling vaccination teams;
- mobile teams: in rural areas, mobile teams were established to administer vaccinations beyond the 15 km. radius covered by the dispensaries.

The programme concerned young children and also pregnant women, who were given tetanus vaccinations to protect their newborns against neonatal tetanus.

Since its beginning, the EPI has undergone two major acceleration efforts, one in the first trimester of 1987 and the other in the first trimester of 1990. These led to training and mobilization of administrative and health personnel, media information campaigns (especially radio), and the outfitting of dispensaries with new equipment, especially in 1987.

The percentage of children aged 12-23 months who were fully vaccinated[15] increased from 18% in July 1984 to 35% in July 1987 to 55% in June 1990 (Table 4). The 1987 and 1990 percentages probably represent maxima for the period 1987-90. Indeed, in both years the surveys were carried out just after an acceleration phase, and the average for the period is probably somewhat lower. Detailed analysis of vaccination dates confirms that the increased coverage rate coincides with the two acceleration campaigns that took place in early 1987 and early 1990.

Table 4
Vaccination coverage of children aged 12-23 months (%), by date and vaccine (1).

Vaccine	1984 (2)	July 1987 (3)	June 1990 (3)
BCG		92	94
DTPP-1		81	91
DTPP-2		69	83
DTPP-3		47	63
Measles		63	76
Yellow fever		72	75
Fully vaccinated children (4)	18	35	55

Sources : 1984 and July 1987 : Claquin *et al*., 1987
June 1990 : Evaluation du PEV au Sénégal, OCCGE-Muraz,1990

Notes :
(1) Measure based only on the information contained in health cards or vaccination cards. When these documents were lost, the child was not counted as being vaccinated. These are therefore minimum estimates.
(2) For 1984, the detailed data by type of vaccine are not known.
(3) Method: vaccination coverage survey, standard World Health Organization method.
(4) Vaccinated against seven diseases.

Complete vaccination coverage increased 1.2-fold in the Region of Dakar between 1984 and 1987, and 1.5-fold in the other urban areas (Table 5). The impact of the acceleration of the EPI in early 1987 was therefore relatively slight in the towns. In rural areas, on the other hand, where coverage was

[15] That is, vaccinated against seven diseases: tuberculosis, diphtheria, tetanus, pertussis, polio, measles and yellow fever.

particularly low in 1984, there was a threefold increase in 1987, so that the gap with the towns was practically made up in one go.

Table 5
Percentage of children aged 12-23 months fully vaccinated, according to residence, 1984 and 1987.

Residence	Percentage of children fully vaccinated	
	July 1984	July 1987
Region of Dakar	32	39
Urban (other than Region of Dakar)	25	37
Rural	12	34
Total	18	35

Sources : Claquin *et al*., 1987

Notes :
- Method : vaccination coverage survey, standard World Health Organization method.
- Data not available for 1990: the 1990 vaccination coverage survey report does not give the results broken down by residence.

Vaccination coverage relative to pregnant women was evaluated from the 1990 vaccination coverage survey (Evaluation du programme élargi de vaccination (PEV) au Sénégal, 1990) and from the 1986 DHS-I and 1992-93 DHS-II surveys. At the national level, 37% of women who had delivered during the twelve months preceding the 1990 survey had received two doses of tetanus vaccine (Evaluation du programme élargi de vaccination (PEV) au Sénégal, 1990). Since this is estimated to give 80% protection, and since some unvaccinated women were immunized as a result of vaccinations during previous pregnancies, we can say that 32% of newborn were protected against neonatal tetanus. There were marked regional differences: only 11% were protected in the regions of Tambacounda and Kaolack, compared to 62% in the Region of Dakar.

Tetanus vaccination of pregnant women made substantial headway between the two DHS surveys: 31% of women who had a liveborn baby in 1981-86 had received at least one dose of tetanus vaccine, a proportion which rose to 71% in 1987-92.

Conclusion: does mass vaccination explain the decline in child mortality?

Child mortality has declined continuously in Senegal since the Second World War. In 45 years, from 1945 to 1990, the probability of dying before the age of 5 was cut in three, from approximately 400 per 1,000 to 130 per 1,000; the

greatest reduction was in post-infantile mortality. The decline accelerated in the late 1970s and early 1980s, when a new health policy oriented towards primary health care was initiated. The proliferation of health infrastructures in the different regions, whereas they had previously been highly concentrated in Dakar, and the implementation of the Expanded Programme for Immunization (EPI) probably contributed significantly to the accelerated decline.

Urban and rural areas experienced different patterns of mortality change. In urban areas, with Dakar in the lead, mortality had already fallen significantly in the first half of the century, and the pace slowed down sharply in the late 1970s and early 1980s. Conversely, mortality remained high in rural areas until much later. The decline began in earnest in these areas only in the 1970s or 1980s. The trend, which started in the rural areas surrounding Dakar, gradually extended to the most remote regions, thus following the spread of health facilities. Once the decline had begun in rural areas, it spread rapidly, thereby narrowing the gap between rural and urban areas. The acceleration of the EPI in 1987 seems to have contributed heavily to reducing this differential.

These observations suggest that the development of health infrastructures and health programmes has been essential to the reduction of child mortality, especially in the countryside. The timing of this reduction suggests that the immunization programme has played a central role. However, it is difficult to assess its impact at the national level, since the EPI did not reach all the regions at the same time, but was implemented gradually between 1981 and 1987. Hence the interest of a case study based on data from the Bandafassi population laboratory, in the region of Tambacounda.

Part 2: IMPACT OF THE E.P.I. IN A RURAL ZONE, BANDAFASSI

Demographic surveillance of the population of Bandafassi, a rural area of Senegal, has been ongoing since 1975. The Expanded Programme for Immunization (EPI) did not reach Bandafassi until 1987, when the effort was accelerated in rural areas. The programme has been the only major health sector development in the study area since the beginning of observation. We can thus evaluate the impact of immunization on child survivorship by comparing mortality levels pre-EPI, when vaccination coverage was practically zero, and post-EPI, when most children had been vaccinated at least once.

Population and survey methods

The rural area of Bandafassi

The Bandafassi area is located in the *département* of Kedougou, in the region of

Tambacounda, close to the borders with Guinea and Mali. The region of Tambacounda is one of the furthest from Dakar, and is the least privileged in terms of public and health infrastructures. Vaccination coverage is the lowest in Senegal: in 1990, only 27% of children were vaccinated, vs 48% at the national level[16]. Bandafassi is a relatively isolated area (see map), 700 km. from Dakar and 250 km. from the regional capital, Tambacounda; the nearest town, Kedougou, is 14-60 km. from the villages. Moreover, the available roads are often blocked in the rainy season (June to October).

On 1 March 1992, 8,389 persons were living in this area of 38 small villages. Population density is low, about 10 inhab./sq km. The population comprises three ethnic groups, generally living in separate villages: the *Bedik* (28%), the *Peul* (also known as *Fula Bande*) (57%) and the *Malinké* (or *Niokholonko*) (15%). Some villages are situated in the lowlands, and others on hillsides or hilltops, where access is often difficult.

Survey methods

Since a first census in 1975, when each compound was visited and baseline information was collected, all villages have been visited once a year. At each round, information was gathered on births, marriages, migrations and deaths since previous round and on current pregnancies (Pison, Langaney, 1985); the head of the compound was also questioned on vaccination sessions held since the previous round.

We conducted a vaccination coverage survey among children aged 1-10 during the February 1992 round. Vaccination cards were consulted, but barely more than half the children still had one. When the card had been lost, the mother was asked in how many vaccination sessions the child had participated. Consequently, we had to calculate immunization coverage by number of vaccination sessions attended and not by type of vaccine administered. As we have said, vaccination sessions were not frequent in the region, particularly in the less accessible villages, and most children were relatively old when they were vaccinated for the first time. It was quite common that children were aged 9 months or more at the initial session, and so could be administered measles and yellow fever as well as BCG and DTPP-1 vaccines.

In order to study immunization coverage over time, we have examined the coverage in February 1992 among children who were 12-35 months old in February of 1987, 1990 and 1992. Since some of the vaccinations may have been received after the inferred date, and since immunized children are likely to have better survival, the method used here may have produced overestimates of the coverage in 1987 and 1990. However, such biases are unlikely to affect the major changes over time.

[16] EPI evaluation survey, 1990 (Evaluation du programme élargi de vaccination (PEV) au Sénégal, 1990).

Evolution of vaccination coverage

History and organization of vaccinations

Until 1982, the area had not known any vaccination campaigns except isolated operations such as the nationwide campaign against measles in 1969. Thus, the only children who were immunized were those who had been taken to the dispensary in Bandafassi; they were nearly all from this village.

Between 1982 and 1985, vaccination sessions were organized in a few villages. They were not systematic and were only small-scale operations conducted to protect a handful of villages when there was an outbreak of measles.

The situation changed radically with the national immunization campaign launched in 1987, in the framework of which vaccination sessions were scheduled to be held in every village. To organize them, the study area was divided into two different sectors, depending on different health services. The southern sector was covered by the public health system. Since there was only one dispensary, located in Bandafassi village, a health attendant travelled around by motor bike to vaccinate children in villages up to 15 km. away; in more remote villages, vaccines were administered by mobile teams based in the town of Kedougou. The northern sector was covered by the Catholic mission in Kedougou, which sent a nurse to each village three or four times a year, to vaccinate and also to examine children and mothers.

Owing to the difficulties of access during the rainy season and to the fact that the population was then dispersed in the fields, vaccination sessions were held only between December and April.

In 1987, the immunization campaign covered practically all the villages in the study area. But for the public sector, this was a unique feat: the mobile teams that vaccinated children in the more remote villages did not make any new rounds after 1987.

Vaccination coverage

Achieved vaccination coverage in Bandafassi is low compared to the national EPI objectives. In 1992, only 39% of children aged 12-35 months were fully vaccinated (that is, they had participated in at least three vaccination sessions); 67% had participated in at least one (Table 6). Only 55% were immunized against measles, which is one of the primary causes of death in this age group (Pison, Desgrées Du Loû, 1993)[17].

[17] Our vaccination coverage survey concerned children only. No information was collected on tetanus vaccination of pregnant women. But it is known from the national surveys that the proportion having received at least one dose of tetanus vaccine rose from 18% in 1981-86 to 57% in 1987-92 in the DHS north-eastern Grand Region to which Bandafassi belongs (Ndiaye

Table 6
Proportion of vaccinated children aged 12-35 months, by group of villages and date: Bandafassi, 1987-92.

Group of villages	Date	Proportion of children having participated in at least		Proportion of children probably vaccinated against measles
		one vaccination session	three vaccination sessions	
Group A : Public health sector, located less than 10 km from dispensary, and private sector	February 1987 :	94 % (79/84)	74 % (62/84)	94 % (79/84)
	February 1990 :	95 % (99/104)	81 % (84/104)	91 % (95/104)
	February 1992 :	98 % (115/117)	78 % (91/117)	95 % (111/117)
Group B : Public health sector, located more than 10 km from dispensary	February 1987 :	76 % (91/120)	29 % (35/120)	76 % (91/120)
	February 1990 :	66 % (86/131)	17 % (22/131)	40 % (52/131)
	February 1992 :	45 % (74/164)	11 % (18/164)	26 % (43/164)
Total	February 1987 :	83 % (170/204)	48 % (97/204)	83 % (170/204)
	February 1990 :	79 % (185/235)	45 % (106/235)	63 % (147/235)
	February 1992 :	67 % (189/281)	39 % (109/281)	55 % (154/281)

Note : The number of children probably vaccinated against measles has been estimated as the number of children participating in at least one vaccination session after 9 months of age.

But these global figures conceal considerable disparity between the villages covered by the public sector and by the private sector. In the latter, vaccination coverage was homogeneous and relatively high. Within the public sector, on the contrary, coverage varied a great deal from village to village (Desgrées Du Loû, Pison, 1994).

We examined these variations in relation to seven factors: distance between village of residence and dispensary; location of village (lowlands or uplands); size of village; child's ethnic group; mother's age at birth of child; size of compound where child lived; number of children aged 1-10 years living in this compound. The chances of being immunized varied principally with geographical factors: distance from dispensary and lowlands or uplands location of village. In age group 2-3 years, the probability of being fully vaccinated was 16 times higher for a child living in the lowlands than in a hilltop village, and 37 times higher if the child lived less than 10 km. from the dispensary than if he or she lived more than 15 km. away (Table 7).

S., Sarr I., Ayad M., 1988; Ndiaye S., Diouf PD., Ayad M. 1994).

Table 7
Relative risks of immunization, by age and selected geographical and demographic factors: Bandafassi, February 1992.

Factors	Relative risk (95% confidence interval)			
	12-23 months ** child vaccinated		2-3 years ** child vaccinated	
	at least once	three times	at least once	three times
Geographical location of village (lowlands/uplands)	9.8 (5.33-18.05)	36.4* (2.3-576.2)	1.3 (1.13-1.6)	16 (7.3-35.3)
Village population 0-149 inhab./ > 149 inhab.	0.4 (0.21-0.76)	0.1* (0-1.2)	1 (0.74-1.26)	0.7 (0.39-1.38)
Ethnic group				
Bedik/Peul	0.3 (0.19-0.52)	0.3 (0.11-0.64)	0.8 (0.7-1)	0.6 (0.38-0.88)
controlling for geographical location	1.8 (0.88-3.68)	2.3 (0.98-5.28)	1 (0.81-1.25)	1.6 (1.09-2.39)
Population of compound 0-11 persons / > 11 persons	1.6 (1.22-2.13)	1.4 (0.87-2.22)	1.2 (1-1.36)	1.7 (1.29-2.34)
Number of children in compound 0-7 / > 7	1.7 (1.25-2.3)	1.4 (0.88-2.36)	1.1 (0.95-1.26)	1.9 (1.35-2.59)
Distance between village and dispensary				
0-9 km / > 15 km	7.7 (5.01-11.72)	66.6* (4.2-1054.3)	2.3 (1.9-2.74)	37.4 (19.8-70.6)
10-15 km / > 15 km	2.9 (1.3-6.46)	8.7* (0.46-162.5)	1.9 (1.5-2.5)	15.3 (5.6-41.7)
Mother's age (in years)				
< 20 / > 40	0.7 (0.41-1.19)	0.4 (0.1-1.56)	0.8 (0.54-1.3)	0.9 (0.46-2.)
20-29 / > 40	0.6 (0.41-1)	0.7 (0.33-1.62)	0.9 (0.66-1.11)	0.7 (0.46-1.15)
30-39 / > 40	0.7 (0.45-1.09)	1 (0.46-2.12)	0.9 (0.72-1.16)	0.6 (0.37-0.99)

* Logit estimator (the Mantel-Haenszel estimator being not available).

** Age in complete months or years as of 1 March 1992.

We have therefore divided the villages into two groups. Group A, where vaccination coverage was high (between 65% and 100% of children aged 12-35

months were fully vaccinated in 1992), consists of all villages covered by the Catholic mission and those located less than 10 km. from the dispensary in Bandafassi. Group B, where coverage was low (between 0% and 50% fully vaccinated), consists of the villages more than 10 km. away or in the uplands: all villages that should have been covered by the mobile team of the Ministry of Health belong to this group.

Vaccination coverage evolved very differently in groups A and B between 1987 and 1992. In group A, there was an improvement, from 74% to 78% of fully vaccinated children in age group 12-35 months. But in group B there was a sharp regression, from 29% to 11%, due principally to the absence of the mobile teams, who did not keep up the vaccination sessions in remote villages after 1987 (Table 6).

The obstacles to the EPI in rural areas

Prior to the 1987 campaign, vaccination coverage was practically zero in the study zone. The campaign completely changed the situation: three-quarters of under-5s participated in at least one vaccination session that year, and almost all villages were concerned. However, the vaccination effort has been very unequal. Excluding the villages covered by the Catholic mission, which are in a specific situation, the EPI has been very limited in the villages which are difficult to reach by road. The success of the 1987 campaign was due to the special efforts made by the health authorities to reach all the villages, by sending mobile teams to villages which were remote from the dispensary and by persuading people in villages where no sessions were organized to take their children to neighbouring villages where they were. The system of mobile teams stopped functioning as early as 1988, and the villagers have not made up for this by taking their children to the (rare) villages where immunization sessions were being held. Their experience of vaccination was no doubt too short-lived: the benefits for their children's health have not yet become obvious enough to change attitudes in this respect. In contrast, the villages covered by the dispensary have maintained their high score of 1987. Thus, the relatively poor coverage for the study zone as a whole conceals great disparity between some villages that are correctly immunized and others that are virtually not immunized at all.

The impact of vaccination on child mortality in Bandafassi

To measure child mortality change in relation to the EPI, we calculated the risks of dying in the six years before it was implemented in Bandafassi, from 1981 to 1986, and in the following six years, from 1987 to 1992. Between the two periods, there was a marked decline in ${}_5q_0$, from 374 to 260 per 1,000. To study the role of the EPI in this decline, we broke the second period down into 1987-88, to see the immediate effects of the immunization campaign, and 1989-92, for the more long-term effects. For each period, we calculated mortality rates in the two sets of villages, group A where immunization

coverage was high and group B where it was low (Desgrées Du Loû, Pison, Aaby, 1995). Three age groups have been studied, each one corresponding to specific risks and specific vaccines:

1. less than one month (0-28 days): the only vaccine children could have received is BCG, but they may have benefited from their mother's tetanus immunization;
2. one to eight months: children could have received BCG and DTPP 1-3 vaccines;
3. nine months to five years: children could have received BCG, DTPP 1-3, measles and yellow fever vaccines.

Death rates fell in all three age groups between 1981-86 and 1987-92, but the decline was most marked in the neonatal period (31%) and in the age group nine months and more (48%) (Table 8). When we excluded measles deaths, which were far from negligible during the first period, the mortality decline was no longer significant in age group 1-8 months (16%, with a 95% confidence interval -10 to 35) but remained substantial between nine months and five years (31%, with a 95% confidence interval 18 to 42).

Table 8
Death rates by age group and period: Bandafassi.

Period	Age group		
	0-28 days	1-8 months	9-59 months
	Death rate per 1,000 (no. of deaths / no. of live births)	Death rate per 1,000 (no. of deaths (*by measles*) / person-years at risk)	Death rate per 1,000 (no. of deaths (*by measles*) / person-years at risk)
1981-1986	108 (220/2 038)	109 (126(*11*)/1 156.6)	74 (345(92)/4 637.9)
1987-1988	81 (58/719)	62 (26/418.4)	37 (76/2 026.1)
1989-1992	71 (103/1 448)	99 (85(*4*)/858.9)	39 (165(*7*)/4 197.3
1987-1992/1981-1986 (95% confidence interval)	0.69 (0.57-0.83)	0.80 (0.63-1.02)	0.52 (0.44-0.61)

The role of vaccination coverage

Just after the immunization campaign of 1987, mortality decreased in all villages, but the decline was far more pronounced in villages of group A where immunization coverage was better; this is particularly clear for children aged more than one month (Figure 4, Table 9). Between 1981-86 and 1987-88, the death rates in age groups 1-8 months and 9-59 months fell by 53% and 55% respectively in group A, compared to 32% and 45% in group B. Furthermore,

between 1987-88 and 1989-92 mortality remained stable (at 1-8 months) or continued to decrease (by 16% at 9-59 months) in the villages in group A, where vaccination coverage continued to be high, while it doubled at 1-8 months and rose by 20% at 9-59 months in group B, where immunization coverage fell when the mobile teams stopped operating. Thus, whereas mortality in the pre-immunization period was higher in group A than in group B, after 1989 the order is inversed[18].

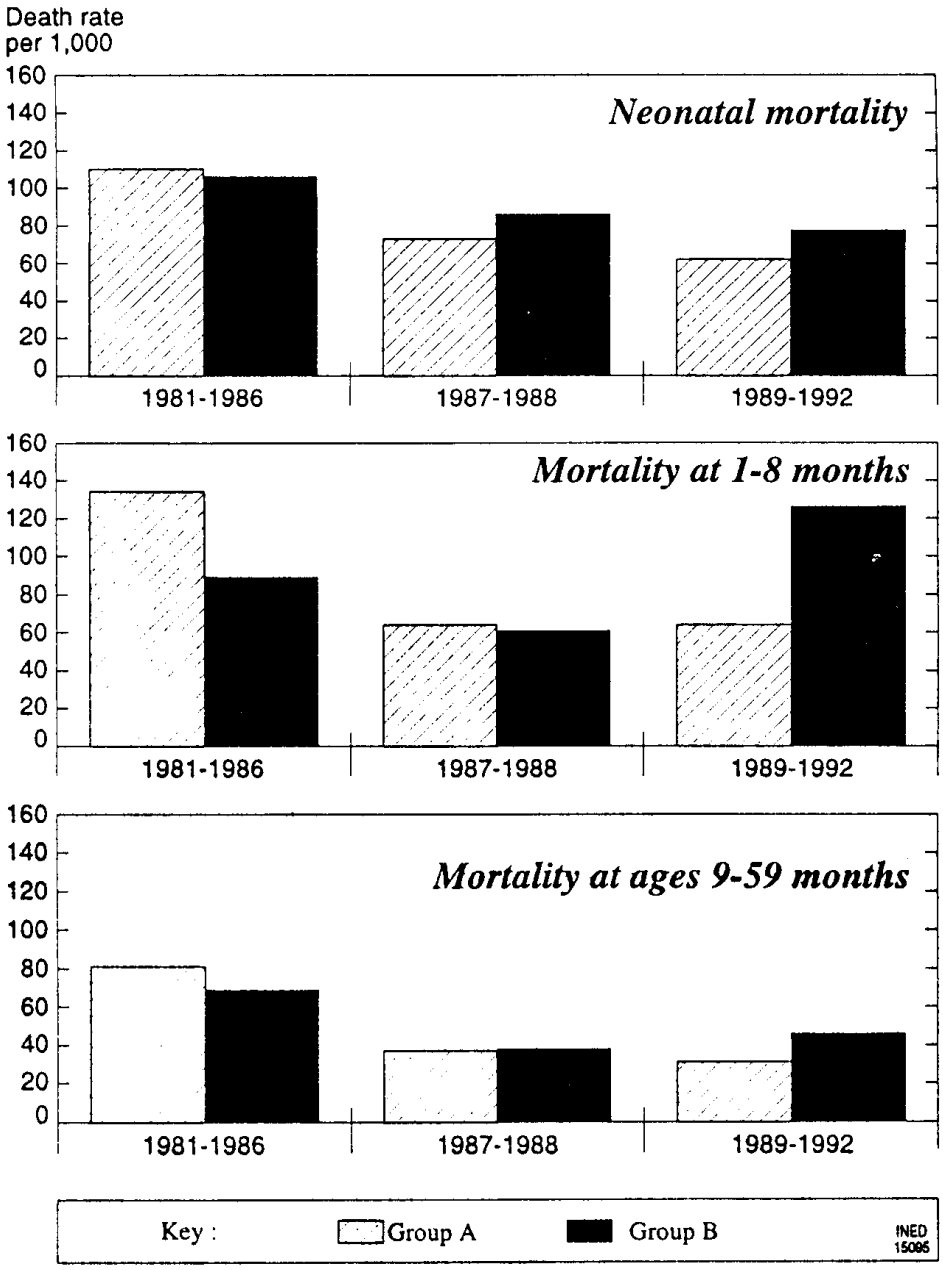


Figure 4. Infant and child death rates by age, period and village group. Group A: good immunization - Group B: bad immunization.

[18] The mortality ratio A/B was higher than 1 before 1987 (1.50 (95% CI 1.08-2.09) in age group 1-8 months; 1.17 (0.96-1.44) between nine months and five years); it was significantly lower than 1 after 1989 (0.51 (0.33-0.79) and 0.68 (0.50-0.93) respectively).

Table 9
Death rates by age and village group and period: Bandafassi.

Village group	Period	Age group		
		0-23 days	1-8 months	9-59 months
		Death rate per 1,000 (no. of deaths / no. of live births)	Death rate per 1,000 (no. of deaths (*by measles*) / person-years at risk)	Death rate per 1,000 (no. of deaths (*by measles*) / person-years at risk)
Group A: public health sector, located less than 10 km from dispensary, and private sector	1981-1986	110 (100/908)	134 (68(*6*)/506.9)	81 (163(*49*)/2 009.0)
	1987-1988	73 (23/314)	64 (12/188.4)	37 (32/871.9)
	1989-1992	62 (39/626)	64 64(24(*2*)/373.6)	31 (59/1 885.6)
Group B: public health sector, located more than 10 km from dispensary	1981-1986	106 (120/1 130)	89 (58(*5*)/649.6)	69 (182(*43*)/2 628.9)
	1987-1988	86 (35/405)	61 (14/230)	38 (44/1 154.2)
	1989-1992	78 (64/822)	126 (61(*2*)/485.3)	46 106(*7*)/2 311.7)

There were only two major health interventions in Bandafassi during the period 1981-92: an onchocercosis programme launched in 1986 and the EPI in 1987. The other actions organized as part of the primary health care effort (construction of wells or drill holes, training of community health workers to run new village pharmacies...) all began before 1981, and so the sudden changes observed between 1981 and 1992 cannot be attributed to them alone. The onchocercosis programme is unlikely to have had much impact on child mortality before age 5. Consequently, the EPI appears to play a leading role in the sharp reduction of child mortality between 1981-86 and 1987-92. Indeed, death rates fell more sharply in the villages in group A, which benefited more from the immunization programme than those in group B. Differences in location (distance from dispensary, lowlands or uplands) and in facilities (some villages had a well or drill hole, a school, others did not) could be confounding factors, since villages in group B are less accessible and have fewer infrastructural installations than villages in group A. But these differences existed already in 1981 and have not changed between 1981-86 and 1987-92. They cannot explain why mortality fell more rapidly in group A, resulting in the inversion of the mortality ratio between groups A and B. Only the introduction of the immunization programme, which did not cover the two groups of villages to the same extent, can account for these different mortality trends. This is confirmed by the fact that in the villages where the EPI effort continued after 1987, the mortality decline was confirmed, whereas in those where vaccination dropped off, the death rates (except neonatal) rose again.

The effect of tetanus and measles immunization

The reduction in neonatal mortality observed between 1981-86 and 1987-92 was 31%. This figure is subject to caution, since prior to 1985 there was apparently some confusion between stillbirths and early neonatal deaths. This type of error virtually disappeared with a change of collection procedure in

1985, each mother of a dead child being systematically interviewed. With the removal of this bias, the stillbirth ratio (stillbirths to live births) rose from 2.6% in 1981-86 to 3.9% in 1987-92; part of the drop in neonatal mortality can thus be attributed to this change. But combining stillbirths and neonatal deaths gives an overall decline of 15%, from 137 to 117 per 1,000. There was thus an actual reduction of neonatal mortality during the period, even if it is smaller than reported.

There has been no change in birth practices in the study area since 1981: antenatal consultations and the presence of a health attendant during delivery have only been developed in two villages, and most mothers still give birth at home without any medical assistance. Deaths related to complications of pregnancy or delivery are, therefore, unlikely to have decreased. The only change which could provide a likely explanation for the reduction of neonatal mortality is the tetanus immunization of pregnant women[19].

Though we have no data specific to the study area, it is known that coverage for tetanus immunization during pregnancy increased in the region to which Bandafassi belongs from 18% to 57% during the period (Ndiaye S., Sarr I., Ayad M., 1988; Ndiaye S., Diouf PD., Ayad M., 1994). Tetanus was the most deadly infectious disease of the neonatal period before the acceleration of the EPI. In Niakhar, for instance, another rural area of Senegal, tetanus was responsible for 31% of neonatal deaths between 1983 and 1986 (Leroy, Garenne, 1989).

Much of the important decrease in mortality between 9 months and 5 years can be attributed to measles immunization, which is specific to this age group[20]. Before the Expanded Programme for Immunization reached the area in 1987, measles was one of the primary causes of child death, accounting for almost one-third of deaths between one month and 5 years (Pison, 1985). The mortality decline in age-group 9-59 months that followed the EPI was greater in the villages where vaccination coverage was high (Figure 4). Since there were immunized and unimmunized children in both groups of villages, we decided to perform an additional analysis to evaluate the real impact of the measles vaccine. We calculated death rates in age group 9-35 months in both sets of villages for the years 1987-88 (all children were immunized against measles in 1987), 1989-90 (the vaccination effort was maintained in group A and relaxed in group B) and 1991-92 (vaccination was abandoned in group B). We considered only the cohorts aged 9 months or more at beginning of each period, to exclude any children who might have been vaccinated in a previous period. In group A, mortality declined steadily (54 per 1,000 in 1987-88, 49 in 1989-90, 37 in 1991-92). But in group B, it fell from 66 per 1,000 in 1987-88

[19] Given the frequency of the vaccination sessions, BCG immunization during the first month of life is not likely to concern more than 8% of newborn.

[20] Immunization against yellow fever - the other vaccine administered specifically at nine months and over - has not had the same effect, since this disease accounts for few deaths before age 5.

to 44 in 1989-90, then rose to a level of 115 per 1,000 in 1991-92. In other words, in the villages where the measles vaccination effort was not continued after 1988, the death rate tripled two years after it was stopped. This spectacular upturn in mortality at age 9-35 months when vaccination was abandoned in group B suggests the primary role played by measles immunization. It is of interest that the mortality increase related to the withdrawal of the vaccination effort was not immediate, but occurred after a time lag of two years. Following the campaign in 1987, the proportions vaccinated were high enough to provide a 'herd immunity' protection throughout the study area, that is, to spare the whole community (including unvaccinated children) any new outbreak of measles. But when vaccination was discontinued, the proportions immunized became too low to ensure this herd immunity.

A nonspecific beneficial effect of immunization?

The mortality reduction post-EPI in age group 9 months to 5 years was much greater than can be attributed to measles alone. In fact, the suppression of measles deaths reduced mortality by 16% between 1981-86 and 1987-92. Measles mortality fell in both groups of villages, perhaps as a result of the above-mentioned herd immunity throughout the zone. However, when we excluded deaths from measles, the residual mortality decline was greater in group A than in group B: 43% vs 23%. It is unlikely that this excess reduction was due to another vaccine: the suppression of tuberculosis, polio, diphtheria, tetanos or yellow fever would not affect child mortality to this extent, and pertussis apparently caused as many deaths after 1987 as before (unpublished data). The explanation could be an indirect effect of measles vaccination, in that by reducing the incidence of measles it also reduces the long-term consequences of this disease; however, recent studies contest the idea of a long-term debilitating effect of measles on children (Aaby, unpublished data). Furthermore, the mortality decline continued between 1987-88 and 1989-92 in the villages where vaccination coverage was high (Figure 4), although there were no cases of measles in 1987-88. Hence, apparently part of the mortality reduction is related to vaccination coverage but is independent of the suppression of measles epidemics. This might point to the existence of a nonspecific beneficial effect of immunization, in particular measles immunization, as some authors have suggested (Aaby et al., 1993; Aaby, Samb, Simondon et al., 1995). The underlying mechanism has not yet been elucidated. Measles infection as well as measles vaccine may stimulate the immune system in nonspecific ways (Aaby, Samb, Simondon et al., 1995; Petralli et al., 1965); it should be worthwhile to investigate whether this is the case and how it works.

Conclusion

There has been a substantial reduction of childhood mortality in Senegal since the end of the Second World War. The decline gathered momentum in the late 1970s when primary health care was implemented. The strategy adopted

(decentralization of health infrastructures, development of simple programmes to improve sanitary conditions and nutrition, pregnancy monitoring, immunizations) has been globally very successful.

Our study in Bandafassi, a rural area of Senegal, illustrates the major role played by the Expanded Programme for Immunization (EPI) in regions located far from the capital and deprived of health infrastructures. Child mortality fell drastically when the EPI reached the study area, and the continuation of the decline has been closely related to the level of immunization coverage.

These results show the potential contribution of immunization programmes to the reduction of childhood mortality in the less privileged countries. And their success does not depend on socio-economic context: Bandafassi's population is entirely rural and largely illiterate. Tetanus vaccination of pregnant women and measles vaccination of children was linked to the decline of neonatal mortality and mortality above nine months respectively. The mortality reduction was, moreover, greater than expected, suggesting the existence of a nonspecific beneficial effect of immunizations, in particular measles immunization.

In the light of these results, the continuation of immunization efforts can be considered a priority for high-mortality countries.

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APPENDIX

Proportion of children dying before age 5 in Senegal, 1945-90.

Survey	Date	Period	Reference date	Data gathered and estimation method	5q0 (per 1,000)
Demographic	1960		1946.2	1	373
Survey			1951.6	1	343
National					
Demographic	1970-1	1970-71	1970.5	3	281
Survey					
World Fertility		1964-68	1966.1	2	293
Survey Senegal	1978	1969-73	1971.1	2	283
		1974-78	1976.1	2	262
Demographic		1971-75	1973.5	2	287
and Health	1986	1976-80	1978.5	2	236
Survey-I		1981-85	1983.0	2	191
Census	1988	1987-88	1987.9	4	154
Demographic		1978-82	1980.6	2	199
and Health	1992-3	1983-87	1985.6	2	185
Survey-II		1988-92	1990.6	2	131

Data and method:
1- indirect method, number of children born and number of surviving;
2- direct method, maternity histories (status of each child - living or dead - and age at death if deceased);
3- direct method, multi-round survey data;
4- direct method, deaths within the last twelve months (after correction for under-reporting of deaths under 1 year of age).
Sources: national surveys.

13

Social inequalities associated with prenatal screening for Down's syndrome:

Results of French surveys *

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The screening of foetal anomalies has been widely practised in our societies for the last twenty years. This provides an opportunity for assessing the factors in the spread of the techniques used for this type of prevention, for measuring social inequalities concerning access and use of these techniques, for assessing the long-term consequences of the development of prenatal screening on the reception of children suffering from prenatal deficiencies and for proposing measures for correcting inequalities.

For the purpose of clarity, this paper will deal with only one type of genetic anomaly: that of Down's syndrome (T21) which is the most widespread chromosomic anomaly in humans. It occurs in one new-born child out of 700 on average. The prevalence at birth increases exponentially with the age of the mother and the increase is very marked after 35 (Table 1). Whereas the prevalence of other severe mental handicaps decreased between 1972 and 1976 then stabilized, cases of Down's syndrome have continued a very gradual increase (Aymé et al., 1992; Cornel et al., 1993). This is due to the conjunction of two social phenomena: the continued and progressive increase in the mean age of mothers which is the main risk factor for Down's syndrome, and the slow spread of the use of prenatal screening techniques which are the only prevention methods available.

* Translated from French by Paul Belle.

Table 1
Risk of Down's syndrome at mid-trimester of pregnancy, by maternal age.

Maternal age	Risk	Maternal age	Risk
16	1:1257	31	1: 637
17	1:1252	32	1: 546
18	1:1245	33	1: 459
19	1:1235	34	1: 379
20	1:1222	35	1: 307
21	1:1206	36	1: 246
22	1:1185	37	1: 194
23	1:1158	38	1: 151
24	1:1123	39	1: 117
25	1:1081	40	1: 90
26	1:1029	41	1: 68
27	1: 996	42	1: 52
28	1: 895	43	1: 39
29	1: 814	44	1: 30
30	1: 727	45	1: 22

Source: Cuckle et al., 1987

People know about T 21 and it is the archetypal congenital anomaly resulting in mental handicap and social dependence but its image is less negative for the general public than for health professionals (Julian-Reynier et al., 1993). The fear of having a T 21 child is, however, widespread among women since 76% of them say they have discussed this risk with their spouses at some point during the first three months of the pregnancy.

T 21 screening methods

The T 21 diagnosis is based on a foetal karyotype. Foetal cells are obtained by amniocentesis, choriocentesis or the taking of a blood sample of the foetus. Although all these techniques are not complicated they are delicate and do lead to a percentage of foetal deaths of over 1%.

Because of complications due to amniocentesis, to the limited number of cytogenetic laboratories and to the cost of tests, the systematic offer of foetal karyotypes to all pregnant women has never been envisaged in any country. From the beginning of the 70s, all the developed countries have, however, offered access to chromosomal prenatal diagnosis for groups qualified as high-

risk groups: women over 35 or 38 years of age according to the country (Reid, 1991; Cornel et al., 1994).

The development of foetal imaging techniques and their extensive use have made it possible to screen foetal malformations which in more than 10% of cases are due to a chromosomal anomaly. A second risk group was defined at the beginning of the 80s: that of pregnancies with foetal morphological anomalies.

At the beginning of the 90s, new risk indicators were discovered: they are biochemical markers that can be dosed in the mother's blood between 15 and 18 weeks and the levels of which are significantly different in a T 21 pregnancy than in normal pregnancies. The three markers that provide the most information are the chorionic gonadotropin hormone (Cgh), the alpha-foetoprotein (AFP) and oestrogen (uE3). Because these three markers are independent they can be combined and the specific risk of a pregnancy assessed by evaluating the risk according to the doses and by combining this risk with the risk linked to the age of the mother. One can thus define a new high-risk group and decide about the risk threshold beyond which the proposal of an amniocentesis is justifiable. The threshold generally corresponds to the risk of a woman aged 35 or 38 , since this threshold is the one which gives the mother the right to have access to prenatal diagnosis. The markers can also be used to avoid amniocentesis for women of 38 and over, if the risk calculated after dosage is low (Haddow et al., 1994).

T 21 prenatal screening policies

People's aversion to mental handicap, the availability of foetal karyotyping, the possibility of identifying high-risk groups, and the high cost to society of T 21 (Moatti et al., 1990 b) have incited all the social players involved to elaborate a policy for the prevention of Down's syndrome.

Currently all the techniques for taking foetal cell samples are available in all the European countries except Malta, and therapeutic termination of pregnancy is legal everywhere except in Malta and Ireland. All European countries, as well as other developed countries, have adopted a screening policy based theoretically on the systematic proposal of amniocentesis or choriocentisis to all women of 35 and over, this limit being 38 in France and Italy and 36 in the Netherlands. The differences in the threshold ages are not logically linked to the prevalence of T 21 and are purely political and economic. The decisions have been taken either by the health care professionals themselves (auto-regulation) or by the health authorities according to laboratory resources, locations, the goodwill of the professionals and the budgets available.

In most countries women below the age limit may have access to the test if they pay and if the laboratory is willing to do the test. The attitude of the laboratories depends on their workload. This leads to a high geographical and social inequality of access to the test.

No country has organized systematic screening or encouraged its professionals to prescribe foetal karyotypes or sought to systematically inform the women concerned although all the economic analyses carried out showed that screening based on the age of the mother was highly cost effective (Moatti et al., 1990 b). This is linked to the fact that this type of screening does not correspond to international criteria deemed necessary to justify systematic screening. Benefits from screening do not concern the individual being screened (the foetus) but its parents and the procedure used is iatrogenic, inducing at least 1% of deaths among healthy foetuses. The policies elaborated by all countries have been to allow the spread of such practices take place spontaneously among people who wished to have this type of test carried out. This means accepting the likelihood that they will spread in a very unequal fashion, something which has been confirmed by facts.

With the publication of the first results of research on the risk evaluation markers, several countries have organized pilot evaluation surveys (Bogart et al., 1991; Mancini et al., 1991; Palomaki et al., 1993; Byrne et al., 1993; Aymé et al., 1994; Goodburn et al., 1994) who confirmed that these markers are more precise tools than using only the age criteria. Anglo-Saxon countries have started to use these tests, in a geographically very unequal manner in the United Kingdom, more uniformly in the USA where the dosage of these markers very quickly became a standard of good obstetrical practise. In Belgium, the dynamism of several laboratories has led to a very rapid spread of screening without State intervention. In France the Ministry of Health preferred not to make any decisions until after having consulted the *Comité National Consultatif d'Ethique* on the type of policy to be implemented. A decision was pronounced on June 11th, 1993. The Committee "does not object to a programme aimed at a more precise definition of the medical indications for the cytogenetic diagnosis of foetal T 21 by using, for women who wish it, blood tests." However, they set down three conditions: "prior appropriate and clear medical information about the test being proposed must be given to the woman and counselling must also be made available." The dosage must be made by a licensed laboratory, "it must be associated with a consultation in a licensed centre for prenatal diagnoses including at least one biological geneticist and a specialist in foetal ultrasonography." The "*Bioéthique*" law, dated July 29th, 1994, lists the serum markers as one of regulated examinations. The orders for the application of the guidelines dated May 1995 define obligations of the prescribers in the application of prenatal screening that include the obligation to provide complete information and to obtain free and informed consent.

Institutional logic should lead to a rapid development of screening by markers since this approach is even more cost-efficient than that based on age (Shackley et al., 1993) and is preferred by the women concerned (Roelofsen et al., 1993; Julian-Reynier et al., 1993).

The impact of prenatal T 21 screening

The impact of T 21 screening can be measured thanks to data from European registers of foetal anomalies (EUROCAT report 6) federated within a network (Cornel et al., 1994). In Table 2 the proportion of T 21 cases diagnosed in utero and the abortions ("avoided cases") varies from 0 in Dublin to 36.3% in Paris for the period from 1980-1992.

Table 2
Prevalence of Down's Syndrome and proportion of screened cases in several European countries (1980-1990).

Country	Register	Prevalence per 10 000	% of abortions
Germany	Berlin	8,9	22,4%
Belgium	Hainaut	10,2	13,8%
Denmark	Odense	12,9	18,8%
France	Marseille	18,0	27,0%
	Paris	18,5	36,3%
	Strasbourg	14,3	21,2%
Ireland	Dublin	16,9	0%
Italy	Emilia-Romagna	13,1	17,2%
Netherlands	Groningen	12,7	16,1%
United Kingdom	Glasgow	12,3	19,4%
	Liverpool	10,5	8,2%
	Belfast	14,3	5,7%
Switzerland	Zurich	9,1	22,7%

Source: Eurocat Report 5 and Cornel M., 1994

The spread of the use of prenatal tests has been slow and gradual as French data indicates (Table 3). In 1980, almost 10 years after the technique became available, only 14% of women of 38 and over used this prenatal diagnosis and in 1990, 20 years after the technique became available, less than 60% of women of this high-risk age group benefited from it.

Table 3
Evolution 1980-1990 of the number of foetal karyotypes performed in women aged 38 and over and proportion of these women screened.

Year	Number of foetal karyotypes	% of births in women aged 38 and over	Coverage rate of these women
1980	2 759	1,87	13,08
1981	3 912	1,95	19,0
1982	4 440	2,04	21,7
1983	5 454	2,09	28,7
1984	7 124	2,27	34,2
1985	9 420	2,57	39,9
1986	12 666	2,88	45,2
1987	15 352	3,22	48,7

1988	18 703	3,47	53,0
1989	21 544	3,80	56,1
1990	24 460	4,06	58,2

The proportion of cases avoided by this policy is currently estimated at 35.4% for mothers aged under 35, 65.5% between 35 and 37, 72.7% between 38 and 39 and 90% at 40 and over (data from French registers). The prevention system set up is therefore very unequal since the prevention rate depends on the age of the woman. This seemed admissible at a time when the only known risk factor was the age of the mother but this is no longer the case now that tools for evaluating risks independent of the age of the mother also exist.

Factors linked to the spread of T 21 prenatal screening

The use of T 21 prenatal screening depends on many factors which are as follows: the availability of resources for the taking of foetal samples and karyotypes, the knowledge by professionals of the indications for such tests, the opinion and attitude of potential professional prescribers, the knowledge of pregnant women about the possibility of prenatal screenings and their indications, the opinion and the attitude of women regarding prenatal screening and abortion, the knowledge, opinion and attitude of Public Health officials in charge of organizing and funding such activities. The use of prenatal screening depends on the attitude of the three major categories of social actors: the prescribers, the users and the Public Health decision-makers.

Prescribers of prenatal screening

The prenatal screening consultation is very specialized, and unless the women are personally very well informed they have to go to their doctor to find out the indications and the practical aspects. The knowledge, opinion and attitudes of the prescribers have therefore played a very important role and continue to do so in the use of prenatal diagnosis. In addition to ignorance, the impact of reluctance on the part of doctors is another important factor explaining the low rate of access to prenatal diagnosis (Lippman-Hand and Piper, 1981). In France, the percentage of doctors who find therapeutic abortion justified in the case of T 21 was 78% in 1986 (Julian et al., 1989). It is now 91% among Parisian obstetricians (Geller et al., 1993) but remains close to 78% in another region of France (Picardie) and in Quebec (Renaud et al., 1993). The same surveys revealed that doctors exert more influence than the rules of the profession permit, especially in France. A third of the doctors in the Bouches-du-Rhône region of France said they were prepared to express their personal opinion regarding prenatal diagnosis and therapeutic abortion to their patients (Julian et al., 1989). To the statement: "It is for the doctor and not for the woman to decide if a defect requires an abortion", 16% of English-speaking doctors in Quebec, 27% of French-speaking doctors in Quebec and 39% of doctors in France answered that they were in agreement (Renaud et al., 1993).

The real influence exerted by doctors, at least by French doctors, is revealed in another survey (Julian-Reynier et al., 1994 a) which interviewed all the women aged 38 or over in a delimited geographical area, during a fixed period. This survey revealed that although 65% of the women had had a prenatal test, among the 35% of those who had not had a prenatal test, half the women only refused after their doctor offered it to them. The other half were dissuaded by their doctor or their doctor never mentioned it. There are therefore still 18% of doctors in charge of pregnancies who do not propose prenatal tests (14%) or who even dissuade women who ask about them (4%). Another survey (Wertz, 1993) showed that women doctor geneticists exert less influence than men: they favour an approach in which they help their patients to understand all the options open to them, they work at reducing the feeling of guilt and anxiety of their patients and accept the patient's final decision, whatever that decision may be; whereas men prefer to tell their patients what they should do, inform them what they would do in such a situation, and what other patients have done in the same situations.

All these surveys concur in showing the important role played by doctors in whether or not prenatal screening of T 21 is carried out (Bernhardt and Bannerman, 1984).

Users of prenatal screening

Use of prenatal screening also depends on women's attitudes, which depend on their knowledge, their wish to avoid the birth of a T 21 child and their acceptance or not of therapeutic abortion (Marion et al., 1980; Marteau et al., 1989; Evans et al., 1993).

Two surveys (Sokal et al., 1980; Moatti et al., 1990a) have shown that women with access to prenatal diagnoses have a higher level of education and are from a higher social background than those who do not have access. In the same way those women who live far from a screening centre have less access to such medical care than women residing near to a test centre. Women who seek chromosomal prenatal testing have more qualifications, are more likely to have a job (Table 4) and when they work outside the home they more frequently occupy a managerial position. The survey carried out in the Bouches-du-Rhône in 1988 (Moatti et al., 1990a) revealed that despite the fact that prenatal testing was free for women aged 38 and over there was a substantial cultural difference between women having access to prenatal testing and those who do not and that this difference is even greater when the prenatal diagnosis is not free (women under 38) (Table 5). Predictably the proportion of women who stated having sought prenatal screening is much higher (35.5% versus 15.1%) among women having to pay for the test (n=152) than among women who obtain it free (n=199). These data prove that the fact that the test is free partially makes up for social inequalities of access to the tests.

Table 4
Uptake rate of prenatal diagnosis and socio-cultural level of the women.

	Consultations for prenatal diagnosis	Global population
Level of education of the mother :		
University	30,7%	13,3%
Secondary	55,0%	38,5%
Primary	14,3%	48,2%
Profession of the mother:		
Farmer	0%	0,2%
Craftsman, Retailer, Entrepreneur	2,1%	0,9%
Executive, Liberal professions	12,9%	4,0%
Middle management, Teaching	21,2%	10,5%
Salaried employees	25,6%	27,0%
Workers	2,1%	5,1%
Housewives, Unemployed	36,1%	52,3%

Source: Moatti JP. et al., 1990a

Table 5
Cultural level of women, reasons for having an antenatal diagnosis and ways of accessing the prenatal diagnosis centre.

Level of education of the mother	Women 38 and over free consultations		Women under 38 paid consultations	
	Came on own initiative	Sent by a doctor	Came on own initiative	Sent by a doctor
Primary and secondary	9,3%	90,7%	22,6%	77,4%
Higher Education	22,7%	77,3%	44,7%	55,3%

Source: Moatti JP. et al., 1990a

This social inequality in resorting to prenatal screening is not due to a difference in the reasons inciting women to undergo them or refuse them. A Californian survey (Press and Browner, 1993) showed that there were differences between ethnic groups or between socio-economic categories concerning the type of decision they made when a screening test was proposed to them. What influences the woman's decision is the way the information is given to her.

The crucial issue is that of the information given to women which is closely linked to their socio-economic level since doctors do not play fully their role as health educators. A survey conducted in the Southeast of France among women who had recently given birth to a normal child (Julian-Reynier et al., 1993) showed that 89% of women knew about amniocentesis and what it is used for. Their information about this came from the media (42%), from people they knew (25%), their studies (20%), from their doctor (9%) or other sources (4%).

The opinion of women concerning the acceptability of prenatal screening and of therapeutic abortion is, on the whole, very close to that of doctors, but their opinion is strongly influenced by their personal risk (Table 6). Their confidence in the possibilities of the tests offered is greater the lower their level of education (Table 7). In the group of women of over 37, 93% of them are in favour of screening for Down's syndrome, yet in the same region in the same year, only 65% of them had a prenatal test carried out. The difference is due to the attitude of doctors and the lack of systematic proposal of the test, which is the only way of correcting the social inequalities observed.

Table 6
Proportion of women having just delivered a normal child, who declare being in favour of antenatal screening for T 21 (n=514).

Age of women	% in favour of screening for T 21
17-30	73%
31-34	82%
35-37	90%
>37	93%

Source: Julian-Reynier et al., 1993

Table 7
Cultural level of women and confidence in sonography for antenatal screening.

Level of education	Answer to the question: "Can one be sure that a child will be normal if sonography reveals no anomalies?"			
	yes	no	do not know	number
primary	14,1%	82,1%	3,8%	213
secondary	9,2%	87,8%	3,1%	98
higher education	2,5%	96,5%	1,0%	202
number	44	456	513	

Source: Julian-Reynier C. et al., 1994b

Public Health decision-makers and prenatal screening

We have just seen that the use of screening tests for Down's syndrome has increased slowly during the last twenty years despite the theoretically high acceptance among the target populations. The slow uptake can be explained by concern about keeping increases in proportion with the production capacities of the most experienced laboratories (and to the lack of qualified cytogeneticists) and to avoid a deregulation of professional quality control of the diagnoses where "error is not acceptable". It is also due to ethical problems that such an approach to prevention raises (Dunstan, 1988). The choice made in all the countries to limit access to prenatal tests and to do nothing to increase its use among target populations is certainly due to a perceived risk of social attitudes drifting towards using prenatal tests as a justification for abortions in the cases of minor defects. It is certain that such legitimate motives would have been better served by being expressed in a more open and explicit manner in discussions concerning the decision process.

In the United States there has been much heated debate concerning prenatal screening among women's rights activists. Some maintain that prenatal screening was conceived by health care professionals and imposed by politicians without consulting women within the general framework of medicalising pregnancy and childbirth, as a tool used to control the bodies and the lives of women (Lippman, 1991). They maintain that the policies being implemented create needs and reinforce social inequalities. Others on the contrary believe that women exercise their right to choose whether or not to have a prenatal test, are glad to have such a choice, and believe that a mentally handicapped child is a very heavy burden, one that is borne mainly by women (Wertz and Fletcher, 1993).

Future scenarios

New possibilities for extending prenatal screening by using serum markers in the mother's blood enable the screening of women with a high-risk of having a

Down's syndrome child before advising them to undergo amniocentesis have reopened these debates. The rules for decision-making adopted according to the threshold biological measurements of the markers are likely to vary considerably depending on the importance given (or not) to aspects which have undeniable ethical dimensions, such as the taking into account of the iatrogenic risk of the sample taking methods (consequences of false positive test results of the markers), the psychological costs and the risk of increasing the rejection of the handicapped child at birth for women who have not been advised to have amniocentesis after a serum screening and who will nevertheless, give birth to a T 21 child (false negative test result), or on the contrary the reassurance the majority of women will derive from a "normal" test result of the serum screening (real negative test result).

The most worrying potential impact of the development of screening programmes, not only among the small target population (older women), but among all women who want it, may concern whether the handicapped child is accepted at birth when it has not been detected by the screening test (Julian-Reynier et al., 1995).

Our societies should be able to face up to their contradictory natures and take all possible measures that are likely to correct social inequalities of access and use of prenatal screening whilst respecting the autonomy of people and ensuring the protection of the children with defects who will inevitably continue to be born.

Abstract

Techniques for prenatal screening for Down's syndrome have been available for approximately 20 years. The pace with which these techniques have been adopted in different countries has varied greatly but has, however, been very slow everywhere. The analysis of available data shows that health care professionals have played a role in checking the wider use of screening and have even been using their influence on patients. Women are well informed about the availability of screening but its use is unequally distributed among the different social classes, women from higher income categories making wider use of screening than others. The proportion of avoided cases in France, the country where the use of screening is highest, is currently at 50%. Access to screening is largely confined to women in high-risk groups based on maternal age. The prevention system is also very unequal since the rate of prevention depends on the age of the woman. No country has really organized the information process because of doubts concerning questions of ethics that such an approach to "prevention" raises. Our societies should, however, correct social inequalities in access and use of prenatal screening whilst respecting the autonomy of people and ensuring the protection of children suffering from deficiencies of prenatal origin.

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14

Does a health program reduce excess female child mortality in a son-preferring society?

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In most of the societies of the world, couples have a preference for the sex of their children. Some prefer more sons, some prefer more daughters, some prefer an equal number of sons and daughters and some even prefer sons and daughters in a specific birth order. While these preferences as such may not have any demographic significance, they often influence couples' behavior and thus affect both fertility and mortality. The literature on fertility impact of sex preference for children is quite large (Sheps, 1963; Bairagi and Langsten, 1986; Chowdhury and Bairagi, 1990; Rahman and DaVanzo 1993; Chowdhury, Bairagi and Koenig, 1993). Some recent studies suggest that this preference is not a big constraint on fertility transition of a population (Arnold, 1987; Bairagi, 1993). While this provides us some comfort, the effect of sex preference of children on mortality and abortion creates a serious problem in some societies. With the availability and accessibility of the facilities of sex detection of the fetus and subsequent abortion, the sex ratio at birth has reached an abnormally high level in China, Korea and some other countries as a result of son preference (Gu and Ping, 1994; Hong, 1994; Cho and Kim, 1994).

In Bangladesh, son preference is quite strong (Ahmed, 1981; Bairagi and Langsten, 1986) and leads to discrimination against female children. Here food distribution and use of health care facilities were found to be biased in favor of male children (Chen et al., 1981). This discrimination aggravates during food crises (Bairagi, 1986). Bhuiya and Streatfield (1991) and Bairagi (1986) pointed out that higher socioeconomic status and higher mother's education did not help to reduce discrimination, although these variables helped to improve the mortality and nutritional status of children. Muhuri and Preston (1991) observed that this discrimination against female children was selective: Girls who had sister(s) at the time of their birth were discriminated against more than the girls who did not have a sister. Das Gupta (1987) and Amin (1990) showed similar results in Punjab, India. It is also observed that a

decline in both fertility and mortality did not help to reduce this discrimination (Alam and Bairagi, 1994).

Excess female child mortality is the ultimate consequence of discrimination against female children. By excess mortality we mean the mortality due to discrimination. There may be different interventions such as educational programs, women's empowerment, and employment opportunities for girls for reducing this excess mortality. This paper examines whether a maternal and child health and family planning program can be of any help in this regard.

Matlab MCH-FP project

The data for this study came from Matlab, the well known field station of the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B). Matlab has become legendary for population and health scientists, planners and policy makers of the world. It is a rural and a low-lying deltaic floodplain intersected by canals and branches of two big rivers of Bangladesh. It is about 50 kilometers southeast of Dhaka, the capital of the country. Its communication with Dhaka is still very poor and, in Matlab itself, travel between villages and the market town is on foot or by country boat during the rainy season when except for raised household courtyards most of the area goes under water. Floods, which occur quite frequently, create havoc in the area. Farming is the main occupation, but 40% of families are landless. Seventy-five percent of adults are illiterate. Eighty-five percent are Muslims and the remaining are Hindus.

Matlab, always a cholera-prone area, was chosen in 1963 as the site for the vaccine field trials of the Cholera Research Laboratory (CRL), the precursor of the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), which was established in 1978. Because the efficacy of a vaccine may depend on age, sex, pregnancy, etc., the Matlab field station initiated the recording of such demographic data and tracking of movements (marriage and migration) of households and individuals. Within a couple of years, the scientists of the then Pakistan-SEATO Cholera Research Laboratory were struck by the value of demographic findings obtained from the 132 villages studied, such as patterns of fertility and mortality by age and sex. That excitement subsequently led to the initiation, after the 1966 census, of a comprehensive surveillance system covering 233 of Matlab's villages and so the Demographic Surveillance System (DSS) formally came into existence.

The description of the Matlab MCH-FP Project is available in several places (Haaga et al., 1993; Phillips et al., 1984). The Matlab family planning program has proved the hypothesis that a carefully designed family planning program without any intervention to or change in socioeconomic situation can bring a substantial change in fertility in a poor society. The Matlab family planning program, with doorstep distribution of pills and condoms was started in Matlab

in 1975. Although there was an initial increase in contraceptive prevalence within a year from a CPR of less than 5% to about 20%, it came down to 10% by the second year of the project. This worried the project people and they felt the necessity of an alternative delivery and supervision system. Since then, many modifications were implemented and several interventions introduced in the program at different stages with a major change in the program in 1977, when the project was modified to include a wide range of contraceptives among which injectables administered by workers who are female, young, married, educated, resident in the locality, from elite families, and practicing family planning themselves. Only one half of the Matlab DSS area has been receiving services from the MCH-FP project. The other half of the DSS area, called the comparison area, has been receiving the same governmental services as other rural areas of Bangladesh. Each area had about 100,000 population in 1994. At the beginning of the MCH-FP project, both areas had the same socioeconomic and demographic situations. But the two areas had more than 20 percent points difference in contraceptive prevalence rate (CPR) in 1990 and one child difference in total fertility rate (TFR) (3.8 vs 2.8) in 1994. The 1982 household socioeconomic survey provided information on socioeconomic status of households.

Data and methods

As we mentioned earlier, MCH-FP services have improved in an incremental fashion in the Matlab MCH-FP area (Table 1). Initially, this area was divided into four blocks. Each block received many of the interventions at different times. For example, measles vaccination was started in blocks A and C in 1982, and was extended to blocks B and D in 1985. It should be noted that although there was no intervention in the comparison area from ICDDR,B, some interventions or services were provided in this area by the government program. EPI services, which were intensified in Bangladesh in 1989, covered more than 60 percent of children of the country including the Matlab comparison area for tetanus toxoid (TT) and DPT over a period of 2 years.

Socioeconomic variables for the entire Matlab DSS population after 1982 are not available. A recent study based on a sample showed that the Matlab MCH-FP project did not bring about any change in the possession of items such as radios and watches, although there was an almost three fold increase in these items in each area of Matlab (Razzaque et al., 1996). However, this project was successful in improving children's education. Data on mothers' education and religion were obtainable from birth records of children and were used in this study. This study considered only the mortality of children 1-4 years of age. Infant mortality is heavily influenced by biological factors and is relatively insensitive to familial behavior. By contrast, the mortality of 1-4 year-old children is very responsive to variations in parental and household characteristics. There are about 3,000 births and 1,000 deaths each year in each area (MCH-FP and Comparison) in Matlab.

Table 1. Interventions in MCH-FP, Matlab, Bangladesh, 1978-1990.

ICDDR,B Intervention	Date	MCH-FP BLOCKS A	B	C	D	Comparison area
Family Planning	October 1977	X	X	X	X	
Tetanus toxoid to pregnant women	March 1978	X	X	X	X	
ORT	January 1979	X	X	X	X	
Tetanus toxoid to all women	December 1981 December 1985	X X	X	X X	X	
Measles vaccine	March 1982 December 1985	X X	X	X X	X	
Antenatal care	September 1982 January 1986	X X	X	X X	X	
Iron/folic acid to Pregnant women	January 1985 January 1986	X X	X	X X	X	
Oral cholera vaccine trial	May 1985	X	X	X	X	X
EPI Immunizations BCG, DPT,polio)	March 1986	X	X	X	X	
Nutritional rehabilitation	September 1988	X	X	X	X	
Vitamin A distribution	January 1986	X	X	X	X	X (ended June 1990)
Maternity care	March 1987			X	X	
ARI	April 1988 July 1991	X	X X	X	X X	
Dysentery	April-December 1989		X		X	

Results

In Matlab, CPR increased and the total fertility rate (TFR) declined gradually between 1978 and 1994 (Figure 1). In fact, fertility started to decline in both areas in the mid '70s and mortality in the mid '80s. The increase in CPR and decrease in TFR and IMR and child mortality were much faster in the MCH-FP area than in the Comparison area. The success of the Matlab MCH-FP project in improving CPR and decreasing TFR and infant mortality is quite clear in Figures 1 and 2. This success has proved the hypothesis that a carefully planned MCH-FP project without any socioeconomic intervention can bring about a change in population control.

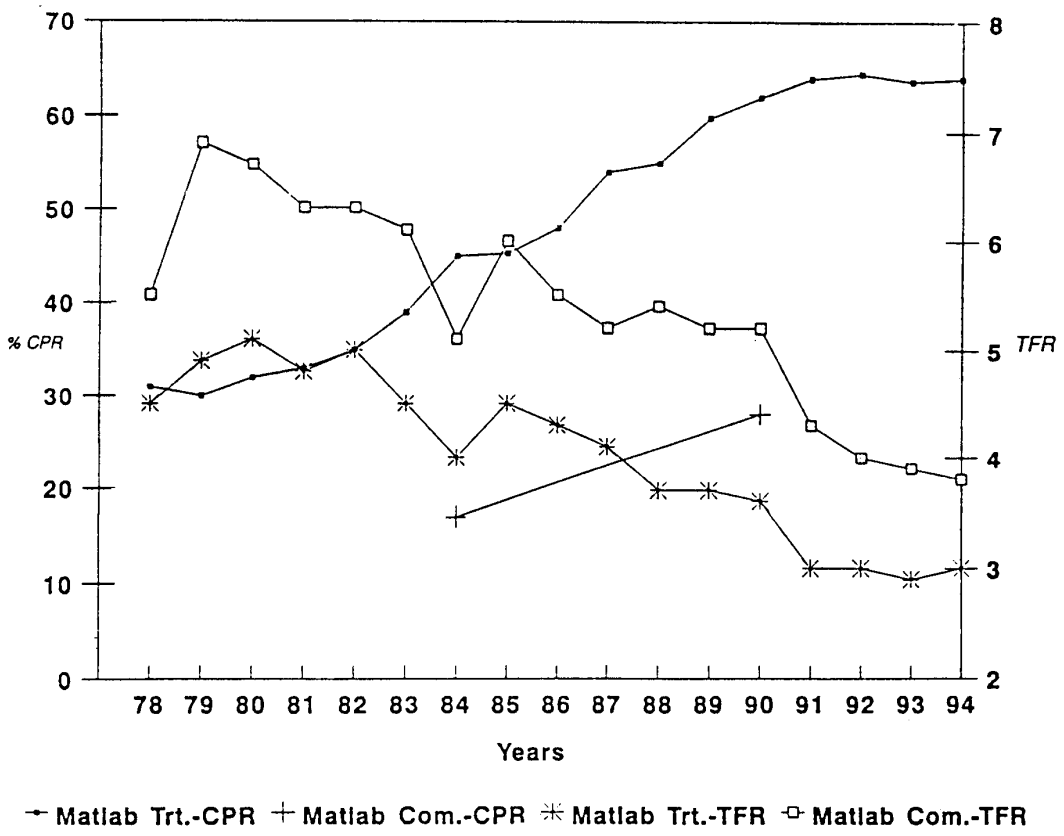

Figure 1. Contraceptive Prevalence Rate (CPR) and Total Fertility Rate (TFR) in Matlab, Bangladesh, 1978-94.

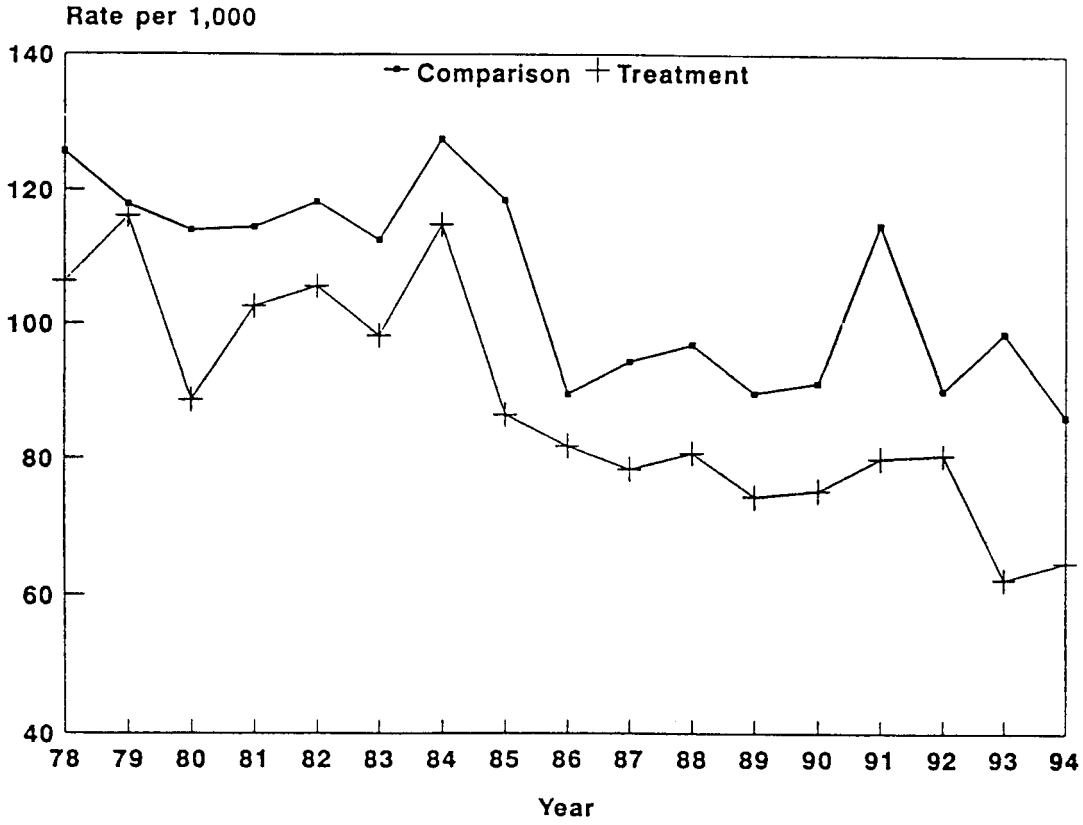

Figure 2. Infant Mortality Rate, Matlab, 1978-94.

Figure 3 presents the percentage of women using contraceptives according to the number of living sons and living children in the Matlab MCH-FP area, and Figure 4 presents the percentage of women giving birth in 3.5 years (1982-86) according to the number of living sons and living children. Contraceptive use was lowest and fertility was highest for those women who did not have any son. On the other hand, contraceptive use was highest and fertility was lowest for those women who had sons as well as a daughter. This trend was observed in other years in Matlab and in other areas in Bangladesh (Rahman and DaVanzo, 1993; Mozumder et al., 1995). It suggests that CPR and fertility depends on sex composition of existing children. Couples in Bangladesh prefer sons but also like to have a daughter. Let us examine whether this preference has any effect on mortality.

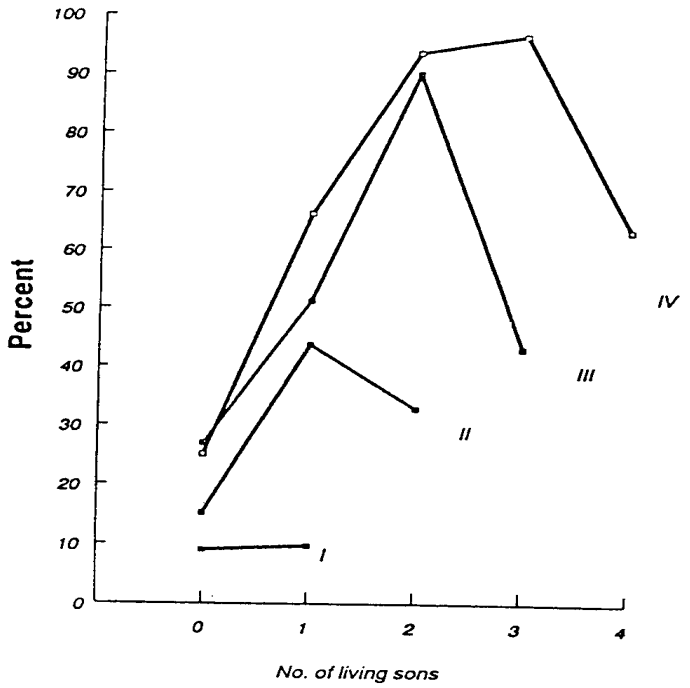

Figure 3. Contraceptive Prevalence Rate (CPR) according to number of living sons and living children (Roman numerals) in MCH-FP area, Matlab, Bangladesh, 1990.

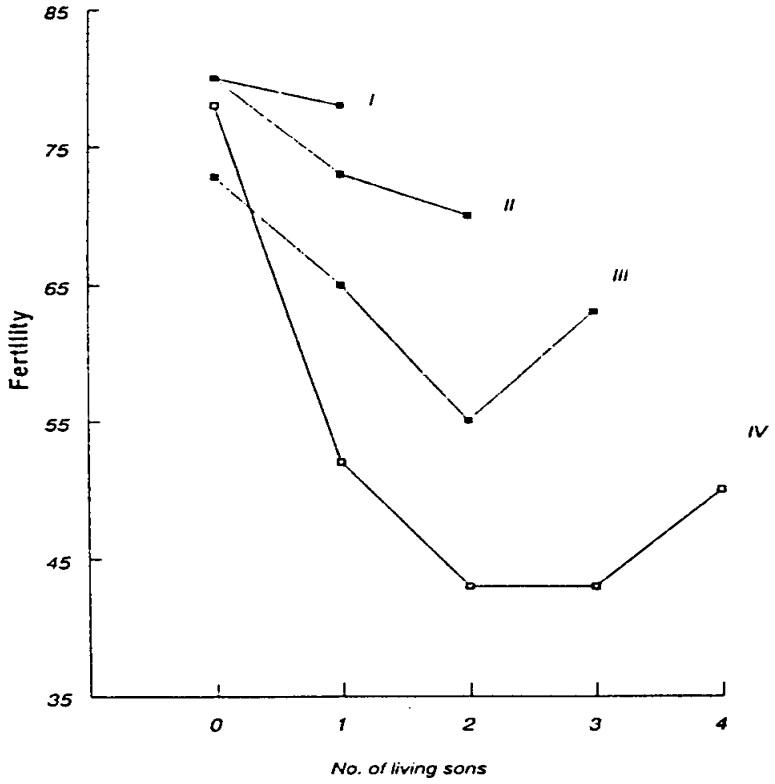

Figure 4. Fertility of women (percent giving birth in 3.5 years) according to number of living sons and living children (Roman numerals) in MCH-FP area, Matlab, Bangladesh, 1982-1986.

It is well known that the female is more capable than the male of surviving because of biological reasons. So for any age group, the sex ratio of child mortality (M/F) should be more than one. In developed countries, the sex ratio of mortality of 1-4 year-old children is more than 1.25 (UN, 1987). It is more than one at any level of mortality in the Model Life Table (Coale and Demeny, 1983). But as we can see in Figures 5 and 6 for the MCH-FP area and the comparison area respectively, female child mortality was always higher than male child mortality. This excess mortality of female children is nothing but the result of discrimination.

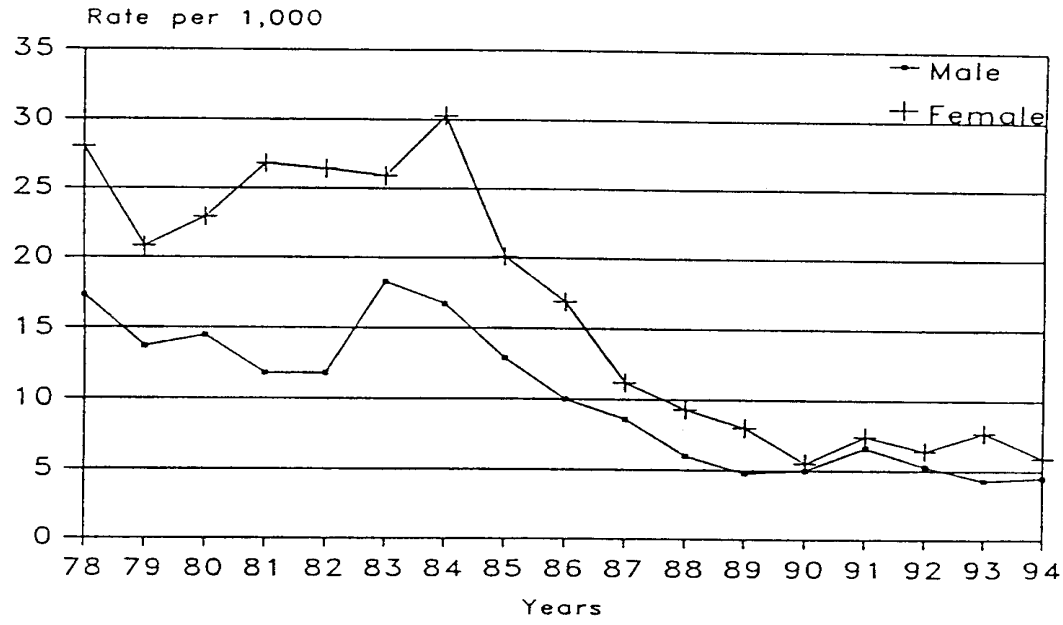

Figure 5. Mortality rate of children aged 1-4 years by sex in MCH-FP area, Matlab, 1978-94.

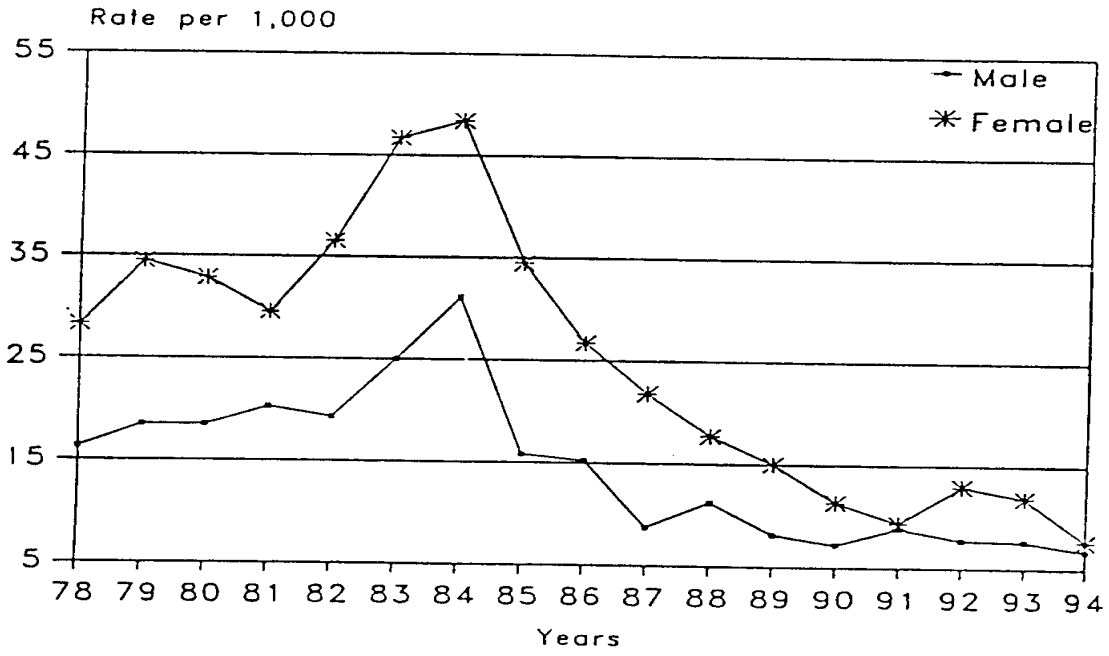

Figure 6. Mortality rate of children aged 1-4 years by sex in comparison area, Matlab, 1978-94.

It may be noted that the difference in male and female child mortality did not start to narrow in the MCH-FP area until 1983 and in the comparison area until 1988 (Figures 5 and 6). This phenomenon is clearer in Figure 7, in which three-yearly moving average of the sex ratio of child mortality in two areas is given.

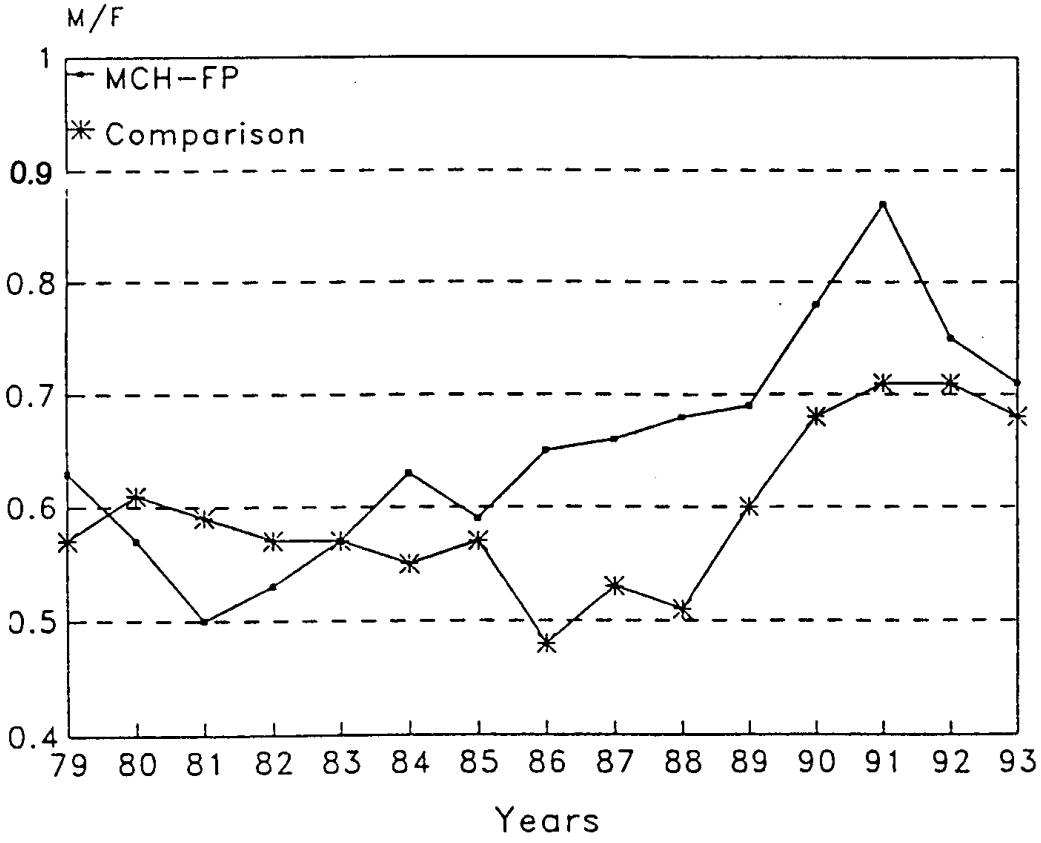

Figure 7. Three years moving average of sex ratio (M/F) of child deaths between ages 1 and 4, Matlab, 1978-94.

There was a substantial decline in fertility and infant mortality in both areas by the late '80s in comparison with 1978. Initial results as reported by Alam and Bairagi (1995) suggested that this decline was not associated with an egalitarian sex ratio of child mortality. However, with the passage of time, this ratio started to increase, first in the MCH-FP area and then in the comparison area with a lag time of about five years.

The discrimination against female children is likely to have two components, one social and the other intentional. Social discrimination means that society as a whole may feel that a girl does not need as much nutritional, medical or other care as a boy does. On the other hand, intentional discrimination means that in addition to the usual neglect of a girl, she may be neglected at the household level. In the latter case, the neglect is expected to be specific for some of the girls. Since Matlab women like to have a daughter also, the only

girl is expected to have lower mortality than a girl with sisters. Tables 2 and 3, in which the results of three birth cohorts are presented, supports this point.

Table 2
Mortality rates (per 1,000) between ages 1 and 4 in males and females and female to male mortality ratio, according to sibling sex composition, comparison area, Matlab, Bangladesh 1977-92.

Characteristics	Birth Cohort								
	1976-77			1981-82			1986-87		
Older siblings	M	F	F/M	M	F	F/ M	M	F	F/M
None	12.9	23.7	1.8	19.4	28.2	1.4	7.5	14.7	1.9
Only brothers	18.0	23.7	1.3	32.8	34.9	1.1	9.7	17.1	1.7
Only sisters	10.5	33.2	3.2	21.3	47.1	2.2	4.4	19.3	4.5
Brothers & Sisters	17.5	29.5	1.7	26.8	46.8	1.7	9.7	15.4	1.6
All	15.5	27.9	1.8	25.5	40.5	1.6	8.3	16.7	2.0

Table 3
Mortality rates (per 1,000) between ages 1 and 4 in males and females and female to male mortality ratio, according to sibling sex composition, MCH-FP area, Matlab, Bangladesh 1977-92.

Characteristics	Birth Cohort					
	1981-82			1986-87		
Older siblings	M	F	F/M	M	F	F/M
None	15.2	19.6	1.3	7.2	5.9	0.8
Only brothers	16.3	20.8	1.3	5.5	5.2	0.9
Only sisters	15.5	27.8	1.8	4.9	6.3	1.3
Brothers & Sisters	15.2	29.0	1.9	5.6	10.5	1.9
All	15.5	24.7	1.6	5.9	7.6	1.3

Child mortality was strongly influenced by sex composition of older siblings in families. Mortality was higher for girls than for boys. The girls with sisters experienced even higher mortality compared to the girls with brothers only in

each area in all birth cohorts. This finding is consistent with the results from previous studies (Das Gupta, 1987; Amin, 1990; Muhuri and Preston, 1991). Similarly, mortality of a boy with only brothers was higher than the mortality of a boy with only sisters.

To explore further this pattern, a logistic regression of child mortality between ages 1 and 4 was carried out, including sex of child and numbers of brothers and sisters as independent variables in the analysis. The coefficients of the interaction terms between the sex of the index child and the sex of the siblings in the multivariate analysis are consistent with these findings: girls with sisters had higher mortality than the girls without sisters, and boys with brothers had higher mortality than the boys without brothers. However, the effect of the existence of sisters on female child mortality was much more acute than the effect of the existence of brothers on male child mortality. Higher mortality risk of a girl without any sister compared to a boy without any brother could have been due to generalized sex bias against girls. Higher mortality risk of a girl with sister(s) compared to a girl with brothers or higher mortality risk of a boy with brothers compared to a boy with sisters might have been due to selective discrimination against those children. However, these results are available for the birth cohorts only up to 1986-87. The data for later cohorts are yet to be analyzed.

Discussion

It may be noted that this study is based on the largest, longest and most accurate demographic data-set of the developing world. A number of important findings of this study should be underscored. First, fertility started to decline in the mid '70s, but infant and child mortality did not start to decline before the mid '80s in the Matlab area. This is the exact opposite of the well-known European demographic transition, in which mortality decline was followed by fertility decline. This difference in Matlab, and perhaps all over Bangladesh, is most likely the result of the Bangladesh family planning program, which initially placed emphasis on increase in contraceptive use and decrease in fertility. Unlike Europe, demographic transition in Bangladesh is not the result of a transformation from agrarian to industrialized society. Second, the success of the Matlab MCH-FP project in reducing fertility and infant and child mortality is quite apparent. Third, the reduction in infant and child mortality was followed by a reduction in sex ratio of child mortality, first in the MCH-FP area and then in the comparison area. Any improvement in survival was found to be relatively more in female than in male in the world (Coale and Demeny, 1983). Sex ratio of mortality of children remained at the level of 0.70 in the '90s in Matlab, whereas it is about 1.07 in the Model Life Table at the current level of mortality with 60 years of life expectancy at birth in Matlab. It means that about 35 percent ((1 - 0.70/ 1.07) x 100) of deaths of 1-4 year-old female children were due to discrimination against them. In the '70s this excess

female child death was more than 40 percent.

Sex ratio of child mortality started to improve in the MCH-FP area in 1983 and in the comparison area in 1988. It was consistently higher in the MCH-FP area than in the comparison area for the period 1984-91. Since 1992, the difference between the two areas has become negligible. This finding reemphasizes the importance of the continuation of the Matlab Demographic Surveillance System (DSS). Analyzing the data up to the birth cohort of 1986-87, Alam and Bairagi (1995) concluded that fertility and mortality decline is not a factor to bring about a change in sex ratio of child mortality. We find here that this ratio responded to mortality decline in Matlab immediately after that study period.

We may hypothesize a number of mechanisms, demographic and non-demographic, by which this change in sex ratio of child mortality was possible. A reduction in fertility may affect it positively or negatively. Because a small family is less likely to have children of the desired sex, there may be more discrimination in a declining fertility situation. On the other hand, discrimination against female children is found to be greater for higher birth order children (Muhuri and Preston, 1991). Further investigation is needed to measure the contributions of these opposite forces in Matlab.

While the impact of fertility decline on the sex ratio of child mortality remains unknown, one of the main forces for its reduction is thought to be health interventions in the area. Diarrhoea, measles and ARI are three major causes of deaths of children in Matlab. Sex ratio of child mortality by cause from 1981 to 1992 is given in the 1992 Matlab DSS report (ICDDR, B, 1995). It is shown there that the sex ratio of child mortality by these diseases improved, first in the MCH-FP area and then in the comparison area. It should be noted that interventions for these diseases were given first in the MCH-FP area and then in the comparison area, although on a smaller scale, as a part of the national program. Mortality improvement is expected to be more for female child than male child due to a health intervention and overall mortality decline (Coale and Demeny, 1983; du Loû, Pison, and Aaby, 1995). Of course, the relationship between different MCH interventions and the onset of the improvement in sex ratio of child mortality is not very clear (Table 1 and Figure 7). It leads us to think that the improvement in the sex ratio of child mortality is likely to be the result of some socio-cultural changes in the country in addition to the effect of the MCH-FP programs. If health interventions and reduction in mortality were the only reasons for this improvement, the difference in this ratio between the two areas would remain much higher in 1992 and onwards, because the difference in health interventions and in infant and child mortality between two areas did not show any remarkable decline in the '90s. Perhaps a silent revolution, big or small, improving the status of women and female children took place in Bangladesh as a result of different actions taken by the government and non-governmental organizations (NGOs). For example, the Bangladesh government declared 1990 as the "Year of Female Children" and made the first 8 years of education free for girls residing outside of the municipalities. In 1992, the government started giving a monthly stipend and

book allowance to girls for 6-10 years of education in rural areas. In addition, mass media, particularly radio, television and daily newspapers and periodicals have been campaigning for women's status, and many national and international NGOs have been promoting empowerment of women in the family and society and building women's social and economic organizations to safe-guard their rights and stop discrimination.

However, this study indicates that an MCH-FP services will lead to more egalitarian sex ratios of child mortality in Bangladesh. Excess mortality of girls, particularly of girls with older sisters, was not only due to unintended discrimination. Public health interventions alone might not be able to improve girls' survival fully without concomitant change in the social, economic and political status of women. Sex bias in child mortality has been found to be related to female autonomy and kinship structure (Bardhan, 1974, 1982, 1984; Dyson and Moore, 1983). Raising women's status may have been important in eradicating discrimination against females in general.

The mortality consequences of sex preference in Bangladesh are declining and are currently not as serious as in China and Korea where sex ratio at birth is unacceptably high due to sex selective abortion of the fetus (Gu and Roy, 1995). In those countries, discrimination against female children begins before birth. In Bangladesh it begins after birth. Induced abortion without detection of the sex of a fetus was found to be related to the sex composition of the existing children; a mother with sons and a daughter was more likely to have induced abortion for a subsequent pregnancy than a mother with only daughters or with more daughters than sons (Bairagi, 1996).

It may be a serious mistake to assume that the upward trend in the sex ratio of child mortality (Figure 7) will continue and that no further action is necessary to reduce discrimination against female children in this country. What do we learn from China (Gu and Roy, 1995)? It is a son-preferring country. Its sex ratio at birth was much higher than normal in the '30s and '40s as a result of the female infanticide, became normal in the '60s and '70s as a result of the action of the communist government, which tried to modify customs as well as traditional practices that it viewed as harmful, but rose again to abnormally high level in the '80s as a result of sex selective abortion. If no further positive action is taken to eradicate or reduce son preference in Bangladesh, there is a possibility that this country will in the future face the same consequences as in China and Korea once technology for sex identification becomes available. Necessary steps including monitoring of the situation to stop discrimination against female children should be undertaken soon in order to avoid the related problems in the future.

Abstract

Gender preference, particularly a preference for sons, is quite strong in Bangladesh. This study investigated the levels and trends of the effects of this preference on mortality of 1-4 year-old children and examined whether an MCH-FP program could bring about any change in the effects in rural Bangladesh. Data for this study came from the Demographic Surveillance System, Matlab, where an MCH-FP project was started in a 100,000 population in 1977-78, with another 100,000 population retained as the comparison area, in which the government services were available as a part of the national program. Male to female mortality ratio of 1-4 year-old children was used as the main dependent variable in this study. The Matlab MCH-FP program was found to be successful in increasing contraceptive use and decreasing fertility and infant and child mortality. Fertility started to decline in mid '70s and infant and child mortality in the '80s in both areas. Sex-ratio of child mortality started to improve first in the MCH-FP area and then in the comparison area and rose from 0.6 in the '70s to 0.70 in the '90s, when the ratio in both areas was almost equal. The MCH-FP program was probably helpful, as were societal changes in the society took place in favor of a reduction in excess female child mortality. Yet, 35 percent of deaths of female children of 1-4 years in the '90s were due to discrimination against female children in the Matlab area.

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List of other contributed papers

Demographic evaluation of urban health programmes in South Africa
O Chimere-Dan

Perception of factors related to high risk sexual practices in Homa Bay district, Kenya
David Ojakaa

The association between family planning services and maternal mortality levels in Zimbabwe
Ravai Marindo-Ranganai

Demographic evaluation of the Guatemalan midwife program
Alfredo Mendez Dominguez

Impact of vaccination on child mortality in the wilaya of Saida, Algeria
Baya Banza

Impact of the Bagré Dam on health of surrounding populations
Driss Khodja Hadj

Contributions to elaboration of social and health programmes for elderly people in the framework of ageing in Romania
(Des contributions à l'élaboration d'un programme de services sociaux et sanitaires pour les persones âgées dans le cadre du vieillissement démographique en Roumanie)
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The art of evaluation now forms a scientific discipline in its own right, the primary objective of which is to measure the success of programmes in reaching their objectives. In the field of population, evaluative research has been directed essentially at family planning programmes, and, to a lesser extent, health interventions. It is however clear that demography has built up an important expertise in a variety of health-related areas: mortality, fertility, as well as migrations and population projections.

In 1996, the Committee for International Cooperation in National Research in Demoraphy (CICRED) convened a seminar on "The Demographic Evaluation of Health Programmes", with the aim of promoting the transmission of technical knowledge, and providing a workshop forum to stimulate and foster the development within this framework of collaborative projects between national population research centres.

More than twenty centres were invited to attend the seminar, which was coordinated by Myriam Khlat, researcher at the Institut National d'Etudes Démographiques in Paris, and in this volume she publishes the participants' papers. In the first part are treated the various approaches and problems associated with evaluation, including data sources, collection methods, outcome measures and estimation techniques. Part two presents examples of evaluative research concerning the impact on mortality of specific health programmes. These are based on a variety of sources, including survey data, the demographic surveillance system of Matlab, population laboratories in Africa, and death registers. Finally, given that equity is often seen as an important concern in evaluation, the contributions in the third part examine the impact of interventions on health differentials within populations.