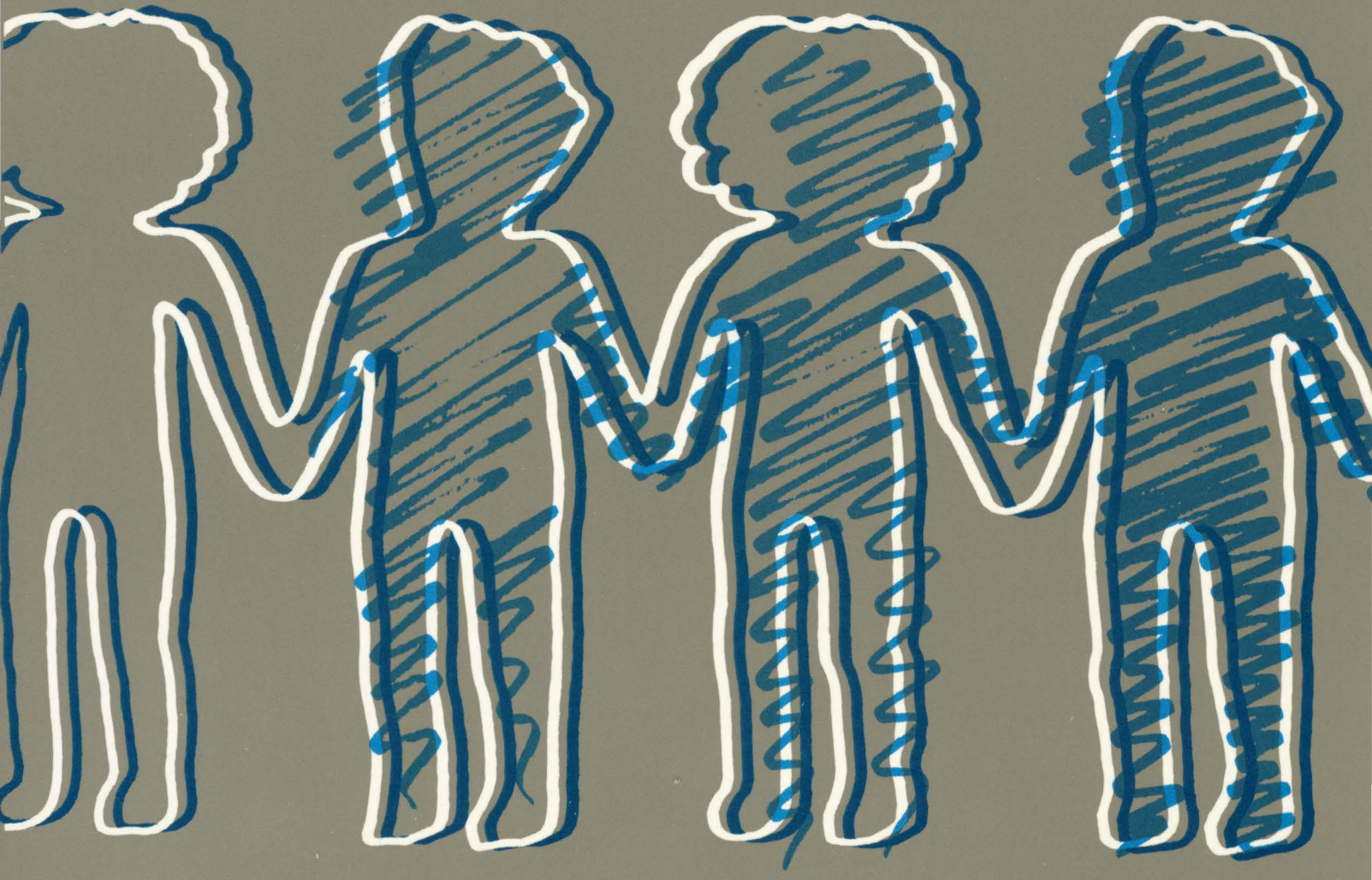
Child Mortality in Developing Countries



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Child Mortality in Developing Countries:

Socio-economic Differentials, Trends and Implications

United Nations New York, 1991

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PREFACE

Social and economic inequality in mortality has long been a concern of the United Nations, amply reflected, for example, in the World Population Plan of Action adopted in 1974 and in the recommendations for its further implementation adopted by the International Conference on Population in 1984. The Plan recommends that "reduction or, if possible, elimination of differential morbidity and mortality within countries, particularly with regard to differentials between regions, urban and rural areas, social and ethnic groups, and the sexes" should be achieved (United Nations, 1975, p. 10). Furthermore, the International Conference on Population strongly urged "all Governments, regardless of the mortality levels of their population ... to strive to reduce morbidity and mortality levels and socio-economic and geographical differentials in their countries and to improve health among all population groups, especially among those groups where the morbidity and mortality levels are the highest" (United Nations, 1984, p. 19).

In order to design policies to reduce mortality inequalities, Governments require adequate information about the types and magnitudes of the differentials and the conditions that cause them. To improve the understanding of socio-economic mortality differentials, the United Nations, in cooperation with other international and national organizations, convened a meeting at Mexico City in 1979, on the socio-economic determinants and consequences of mortality. The Meeting provided the basis for further international comparative research in mortality differentials. In 1985, the United Nations published the first major study of socio-economic differentials in child mortality in developing countries (United Nations, 1985). That study, which was undertaken in cooperation with the World Health Organization (WHO) and the University of Pennsylvania (United States of America), analysed census and survey data on child mortality differentials for 15 countries in Africa, Asia and Latin America.

The purpose of the present volume, which is a follow-up of the 1985 study, is to assess trends in child mortality differentials in some developing countries and to explore the extent to which these trends are related to indicators of socio-economic development and to health policies in each country. Similar data and methods are used for each country to identify categories of children at high risk of child mortality, to investigate patterns of differentials of child mortality and to determine the extent to which those patterns are changing over time. Child mortality has fallen rapidly since the 1950s in many developing countries, and it is important to examine the extent to which the decline can be accounted for by social and economic factors, as well as by other factors that operate independently of socio-economic change.

The current publication was prepared in cooperation with the United nations regional commissions. The chapters on the analytical framework and the methodology (I and II) and the Latin American case-studies (chapters IV-VI) have also been published in Spanish by the Centro Latinoamericano de Demografía (CELADE) and the Population Division of the Department of International Economic and Social Affairs of the United Nations Secretariat (United Nations and CELADE, 1990). The study on Jordan was published by the Economic and Social Commission for Western Asia (ESCWA, 1989).

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Symbols of United Nations documents are composed of capital letters combined with figures.

Reference to "dollars" ($) indicates United States dollars, unless otherwise stated.

The term "billion" signifies a thousand million.

A point (.) is used to indicate decimals.

The following symbols have been used in the tables:

Two dots (..) indicate that data are not available or are not separately reported.

An em dash (—) indicates that the amount is nil or negligible.

A hyphen (-) indicates that the item is not applicable.

A minus sign (-) before a number indicates a deficit or decrease, except as indicated.

Use of a hyphen (-) between dates representing years (e.g., 1984-1985), signifies the full period involved, including the beginning and end years. A slash (e.g., 1984/85) indicates a financial year, school year or crop year.

Details and percentages in tables do not necessarily add to totals because of rounding.

The following abbreviations have been used in this volume:

BCG	bacillus Calmette-Guérin
CELADE	Centro Latinoamericano de Demografía (Latin American Demographic Centre)
CONSUPLANE	Consejo Superior de Planificación Económica (Higher Council of Economic Planning, Honduras)
DPT	diphtheria, pertussis and typhoid
EDENH	Encuesta Demográfica Nacional de Honduras (National Demographic Survey)
ESCWA	Economic and Social Commission for Western Asia
GDP	gross domestic product
JDS	Jordanian Demographic Survey
JFS	Jordanian Fertility Survey
KDHS	Kenya Demographic and Health Survey
KFS	Kenya Fertility Survey
NDS	National Demographic Survey (Kenya)
SOFT	Survey of Fertility in Thailand
TDHS	Thai Demographic and Health Survey
UNFPA	United Nations Population Fund
WHO	World Health Organization

OVERVIEW

*Anouch Chahnazarian**

A general decline in child mortality has been observed throughout the less developed regions since the 1950s, but disparities in the levels of child mortality remain, not only among countries but among different social and economic groups within countries. The purpose of the present study is to describe the trends and socio-economic differentials in child mortality in various less developed regions and, whenever possible, to document the trends in the differentials observed. Towards this end, six country case-studies are presented here. These case-studies are treated in a comparative perspective: the same key socio-economic factors are examined for their effects on child mortality and a common analytical methodology is applied to all studies.

The countries were selected from different less developed regions: Africa (Kenya); Latin America (Costa Rica, Honduras and urban Paraguay); and Asia (Jordan and Thailand). They represent a wide range of mortality levels and levels of development. For all countries, the period under review extends from the late 1960s or early 1970s to the late 1970s. During that period, substantial declines in child mortality (measured here as the probability of dying by age 5, ${}_5q_0$) were observed in all the countries, even though the level of mortality and the pace of the decline varied from case to case. Among the six countries, the highest levels of mortality were observed in Honduras and Kenya, with probabilities of dying by age 5, ${}_5q_0$, as estimated for this study, of 149 per 1,000 around 1974 in Kenya and 117 per 1,000 around 1979 in Honduras. The lowest level was observed in Costa Rica, where ${}_5q_0$ was estimated to be 23 per 1,000 around 1979. As is shown in the country case-studies, the largest absolute declines in ${}_5q_0$ were experienced in Costa Rica, Honduras and Thailand; in relative terms, the declines were largest in Costa Rica and Thailand. During the 1970s, the pace of economic development varied but, in general, the levels of economic and social development increased in the six countries considered here, as attested by higher educational levels for the populations of those countries, better material living conditions and better nutrition. Moreover, a marked expansion of the health sector was observed in Costa Rica, Honduras and Thailand, especially through the development of primary health-care centres in rural areas.

The socio-economic determinants of child mortality examined in this study are individual characteristics describing the parents' socio-economic status (mother's and father's education and occupation), characteristics of the place of residence (degree of urbanization and location), characteristics of the dwelling reflecting the family's material living conditions (quality of the water-supply, house-building materials, method of refuse disposal, method of lighting, type of lavatory facilities) and cultural factors (parents' ethnicity, religion or language). Data on the key factors among these variables, maternal and paternal education, paternal occupation and degree of urbanization of the place of residence, are usually provided by population censuses and surveys; these factors are therefore included in most of the analyses carried out in the country studies. Data on other factors are found in only some of the sources used in the country studies; such factors are therefore not included in all of the studies.

The mechanisms through which socio-economic factors affect child health and eventually determine death are complex, as each factor can produce a variety of direct and indirect effects. A comprehensive analysis of the ways in which each factor or set of factors produces its effects is beyond the scope of the present studies, as it would require detailed information normally not available from standard demographic sources. The importance of certain key factors as determinants of child mortality has been widely recognized. Because information on these factors is generally available from standard demographic sources, they provide the basis for the comparative approach used here.

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The common analytical methodology applied in these country studies was developed by Trussell and Preston (1982) and was used in a previous United Nations study of socio-economic differentials in child mortality in developing countries (United Nations, 1985). This methodology permits the multivariate analysis of differentials in child mortality when data are not available for individual children but can be obtained for individual mothers. Censuses and surveys usually collect information on the total numbers of children ever born and surviving from each woman interviewed; the proportion of her children who have died, given her age or duration of marriage, can then be related to life-table estimates of child mortality. Each woman's information on the mortality experience of her children can also be related to her socio-economic characteristics and to characteristics of her household; Trussell and Preston show how to model such relationships using multivariate regression.

The country studies presented in this publication analyse the relationship between the mortality experience of the children a woman has had and the socio-economic characteristics of that woman and her household. Typically, the women selected for analysis from each demographic census or survey sample were currently married women under age 35. Selection by current marital status ensures that characteristics of the husband shall be included in the analysis, and selection of younger mothers helps limit mortality estimation to relatively recent periods before the census or survey.

The originality of this project arises from its comparative approach, which focuses on key factors, uses widely available data and employs a common analytical methodology. The limitations, however, derive from the simplification in the explanatory framework serving as the basis for the country studies.

Each case-study presents the socio-economic and demographic context of the country, highlighting changes in the levels of social and economic indicators that are usually thought to be related to the health status of a population and its mortality. When the information is available, changes in the health programmes observed in the country during the period of interest are also described. The levels and trends in child mortality are documented in each study, using the probability of dying by age 5 as the mortality indicator. This indicator was selected because it captures mortality experience through the years of high mortality risk for children. The data sources used and the specific factors under examination are reviewed in each case-study before the analysis of differentials is presented. Results of linear regression analysis provide the major part of the findings of the country studies. With a view to providing health planners with information on potential population targets, the population subgroups most at risk of high levels of child mortality are identified. Each case-study presents and discusses its findings in detail; in addition, the comparable analytical approaches make it possible to take a broader view of the country-specific results and to draw some general conclusions.

This group of studies undoubtedly underscores the predominant role of the mother's education in determining the mortality risks of her children. The negative relationship between the level of maternal education and child mortality is illustrated in all the country studies by large and statistically significant regression coefficients. In most countries, the multivariate regression coefficients estimated for the mother's education are larger than the coefficients estimated for the other variables included in the models. The father's education also plays a significant role in determining a child's probability of dying, but this role is less salient than that of maternal education.

In examining the negative relationship between maternal education and child mortality, one important question is that of a possible threshold, below which a limited increase in educational level of the mother is not expected to produce large differences in the mortality risks of her children, but above which an improvement in child survival is likely. The results of the country studies suggest that such a threshold could occur around the end of primary school, even though in some cases, any primary school education for a mother can be useful in protecting her child's life. Another question of interest in this study is that of the trends in the differentials in mortality observed by maternal educational level. Surprisingly, this set of studies suggests that although child mortality is declining in developing countries, inequalities remain (or have even increased) in the probability of dying of children whose mothers have different educational

levels. In some cases, the difference between the mortality risks of children of illiterate mothers and those of other children appears to be especially pronounced. Even though the proportions of mothers with no formal schooling tend to decline over time, these signs of increasing marginalization call for special attention.

Among the other individual characteristics included in these analyses, the father's occupation reveals a specific, and statistically significant, association with the risk of dying in childhood. Although child mortality is lower when the father is employed in a professional or clerical occupation, the mortality risks are significantly higher when the father is employed in agriculture; mortality is also often high when the father has a manual occupation. These differentials, which persist when the effects of paternal education and degree of urbanization of the place of residence are controlled, underscore the importance of a family's economic standing in determining the probability of dying of its children. The decline over time in the proportion of agricultural wage-earners in some of the countries under study has probably contributed to the general decline in child mortality.

The degree of urbanization of the place of residence is usually negatively related to the probability of dying in childhood. In fact, the country studies confirm that there are lower risks of child mortality in urban areas than in rural areas. These differences tend to remain statistically significant, although over time the differentials between urban and rural areas tend to decline, perhaps as a result of the expansion of health services into the rural regions of some of the countries under study. Geographical differences are also examined in one instance (Thailand) and are found to be significant. The question whether these differences could be related to variations in the health infrastructure is beyond the scope of this study.

Material living conditions are another focus of the country studies. Because of variation in the availability of census and survey data on material living conditions, only three of the case studies include such indicators. Whereas the quality of water used by the household is a factor widely recognized for its association with the prevalence of morbidity and mortality in children, in these studies, the type of water-supply does not show a strong relationship with child mortality after controlling for the effects of the other factors described above. The quality of house-building materials, the type of lavatory facilities and the method of refuse disposal show the expected associations with child mortality.

Individual characteristics related to the cultural setting in which the child lives are considered in some of the case-studies. The language spoken by the mother and both the religion and the ethnicity of the parents reveal strong associations with child mortality, which persist when the effects of other factors are controlled. An examination of the direction of the cultural differentials shows that the highest mortality risks prevail in groups representing minorities in the populations under study. The evidence is insufficient to determine a possible trend over time in those differentials, which could be related to differences in utilization of health services.

One of the objectives of this project is to identify the population subgroups most at risk of child mortality so that they can be target groups for public-health policy. Subgroups are defined for each country by a combination of factors including, in all cases, the mother's education and the degree of urbanization of the place of residence, as well as the father's education or occupation, maternal occupation and housing quality, or two of those factors. Child mortality was estimated for each subgroup, using the mortality indicator derived by Trussell and Preston (1982). The subgroups were then pooled into larger risk groups, according to their mortality level in relation to the national average. Five risk groups are defined for each country; the definitions of "high" and "low" risk vary from country to country. The proportions of women and live births are given for each risk group, so that it is possible to examine the redistribution of the children between risk groups over time.

As expected, the population subgroups at higher risk of child mortality consist mainly of poorly educated parents living in rural areas and deriving their income from agricultural or unskilled manual occupations. The proportions who are in the high-risk groups, compared with the national average, vary and sometimes include a majority of the children. The redistribution of children among the various risk groups over time indicates how much

each subgroup has contributed to the general mortality decline observed in a country. Of the four countries for which this analysis is possible, the two that had reached the lowest levels of mortality by the end of the 1970s, Costa Rica and Thailand, show declines in the proportion of children at higher mortality risk and increases in the proportion at lower risk, compared with the national average. In contrast, Honduras and Jordan show increases in the proportions of children at higher relative risk of mortality. Such redistribution patterns indicate that some socio-economic groups have not been able to benefit as much as others from the improvement in the levels of social and economic development or from the expansion of the health sector in some countries.

In view of the small number of case-studies included in this project, these results remain somewhat tentative; they suggest, however, that public-health policies may be usefully informed by the analysis of the impact of a small number of key factors, on which information is widely available from standard demographic sources.

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Part One

ANALYTICAL FRAMEWORK AND METHODOLOGY

I. AN ANALYTICAL FRAMEWORK

*Hugo Behm**

Despite a general decline in infant and child mortality in the world, there is still enormous variation among regions and countries, associated with economic and social conditions. It is estimated that as recently as the period 1975-1980, the developing countries as a whole had the infant mortality rate that prevailed in the developed countries in 1910 (United Nations, 1983). The decline in the rates has been more rapid in the developed countries; therefore, the relative excess mortality in the developing countries increased between the periods 1950-1955 and 1980-1985. There are also large differences in child survival among social groups in each developing country. These differences are of particular importance because of their great magnitude, because the groups with the highest risks of dying are numerically large and because the differences occur in a context of high mortality.

Most of the diseases to which the high mortality can be attributed are of infectious origin, with malnutrition significantly increasing susceptibility. The differences in the mortality rates from these causes between the developed and the developing countries are remarkably large.[1] Effective means of prevention and treatment are now available for the majority of these diseases, but they must be used efficiently and in suitable conditions. It is therefore important to identify the conditions underlying these dramatic contrasts, with a view to promoting the implementation of effective policies to eliminate them as quickly as possible.

This chapter provides a theoretical framework intended to facilitate interpretation of the results of the country studies in this publication. Various theories about the determinants of mortality differentials are presented. Consideration is then given to some general issues in the investigation of this problem, so that the findings of these studies can be compared with those of similar studies and their significance for health policies can be assessed.

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A. THE ANALYTICAL FRAME OF REFERENCE

There is no general theory concerning the determinants of mortality and the mechanisms by which those determinants operate. Various conceptual frameworks have been developed for analysis of the conditions determining health and sickness in childhood.[2] Although these frameworks reflect different disciplinary approaches and different thinking about society itself, they do agree on the following points:

(*a*) Death is the final biological expression of a process that is determined basically by the economic and social structure of a country or region. These conditions influence the occurrence of disease and its development, one of the possible outcomes of which is death;

(*b*) Structural determinants are mediated at the family level, because the child's growth and development are heavily dependent upon the living conditions of the family. These conditions generate the biological risk factors that act directly on the child's health.

These two propositions are examined below, beginning with the determinants acting within the household. A more detailed discussion of general problems in the analysis of determinants follows.

Determinants in the home

The family must solve the problem of how to satisfy the needs of its members, with its available resources. To this end, a pattern of behaviour is developed which constitutes the family's survival strategy. Almost all the decisions taken may affect, directly or indirectly, the survival of the child. Although such decisions are necessarily taken within the restrictions that the social system imposes on the family, the family is an important mediating mechanism.

Mosley and Chen (1984), using a multidisciplinary approach, produced a useful classification for the

analysis at this level. On the one hand, they consider the socio-economic determinants acting at the levels both of the family and of its individual members. On the other hand, they distinguish the proximate determinants, the intervening variables through which the socio-economic determinants affect the child's health status and disease process.

The intervening variables can be grouped into five categories: (*a*) maternal factors in the reproduction process, such as age, fertility and spacing of births; (*b*) environmental contamination, which encourages the spread of infectious agents and the incidence of infectious diseases; (*c*) nutritional deficiency due to inadequate supply of nutrients for the child and mother during pregnancy and breast-feeding; (*d*) injuries to the child (accidents); and (*e*) practices in the care of healthy and sick children, including both traditional practices and modern medicine.

The socio-economic variables that affect the proximate determinants include the capacity of the parents (and other economically active family members) to generate the income the family needs, a capacity that is determined by the nature of their work and earnings. Another factor is the parents' capacity to manage those household activities which, directly or indirectly, affect the child's health, and the time available to them for this purpose. For all these reasons, the parents' education is an important variable.

A second group of variables consists of cultural factors, including power relationships in family decision-making, the value assigned to children and, above all, beliefs about the origin of children's illnesses and their treatment, which are important determinants of the use of health services.

Lastly, the level of the family income and the way in which it is used are decisive factors in determining the family's material living conditions. Important among these conditions are the quality of housing, including water-supply and lavatory facilities, the availability of energy, items of personal hygiene and home sanitation, means of obtaining preventive and curative child care and access to information.

Determinants pertaining to the social structure

Family survival strategies are limited by factors rooted in the structure of the society to which the family belongs. A systematic presentation of these structural determinants and their interrelationship with the family depends upon how one conceptualizes social structure.

Mosley and Chen (1984) distinguish factors of ecology, political economy and health-care systems. The first group includes geographical and climatic factors, which are more important in developing countries, where human life depends more heavily upon nature (food production, presence of vectors of transmittable diseases), than in developed countries; they also affect physical access to public services. Economic factors include the organization of production and the policies affecting the distribution of goods and services among the population. The physical infrastructure influences the distribution and relative cost of health services. Important roles are also played by political institutions (local and central authorities, community organizations, political parties etc.). The organization, policies and efficiency of the formal health-care system are of particular importance for child survival.

In Schultz's economic model (1985), child survival depends upon: (*a*) the biologically determined heterogeneity of the child in terms of health status; and (*b*) the health input selected by family members to minimize losses of health and to achieve their other purposes. These input items are determined by the economic situation of the household and by community restrictions, such as the availability of health services, regional wages and prices, and ecological conditions.

In a structural-historical analytical framework, Breilh and Granda (1984) maintain that, in a given social formation representing a combination of various modes of production, the position in the productive process distinguishes social classes by the nature of their work and patterns of consumption. The resulting material living conditions affect child health positively or negatively. Accordingly, each social class develops a set of favourable or unfavourable biological conditions which determine its health and sickness profile. In these

circumstances, the family devises various strategies to ensure the material and social survival of its members.

Some aspects of the conceptual frameworks that have been summarized are illustrated below by empirical studies.

B. General problems in the analysis of determinants

The foregoing summary shows that the study of the determinants of child survival is not an easy undertaking. Research is often subject to limitations in interpretation of the results; some examples of such limitations are discussed here.

Any study obviously requires a conceptual framework to guide the analysis. Wunsch and Duchêne (1985) indicate that several steps must be taken in this process. The assessment of theoretical relationships between abstract concepts is followed by the operationalization of such relationships through indicators, the validity and reliability of which must be stated. The subsequent analysis of these indicators through statistical models is subject to empirical verification.[3] These requirements are not met in most studies of the determinants of mortality. The data used are often secondary data (censuses, birth and death registers and surveys designed for other purposes), and they are interpreted as indicators for the concepts under study. Thus, in many cases, the analytical process consists of hypothesizing about the nature of the associations found between the available independent variables and some function of mortality. It is important to distinguish between an independent variable (father's occupation, for example), which has an empirical basis, and an analytical category (such as social class), which forms part of a theoretical construction (Breilh and Granda, 1984). This difference is essential for the interpretation of the associations observed and for the evidential importance to be attributed to them.

If it is accepted that there are contextual factors which influence the child's survival through social and biological conditions operating in the home, then the interpretation of the associations found in the micro-analysis of the family demands that contextual variables be taken into account. Comparative international studies have the advantage of being able to detect certain regularities in the associations of given factors with child mortality in different countries. Great variability is often observed, however, and the results are sometimes contradictory, with no means of objectively interpreting them.

In any national study it seems essential to determine the most important structural characteristics of the population. Part of this information is qualitative and cannot be the object of statistical analysis, but it should be included in the conceptual framework. Together with the traditional indicators of economic and social development it is important to determine, among other characteristics:

(*a*) The prevailing mode of production and the stage of development;

(*b*) The existing model of economic and social development;

(*c*) The degree of development of the forces of production;

(*d*) The type of dependence upon foreign markets and financial centres and the characteristics of the external debt;

(*e*) The degree of labour organization (a factor that affects the distribution of the product of social labour);

(*f*) The policies actually implemented concerning the distribution of wealth and social services, and the indicators of that distribution.

Another frequent problem in the study of determinants of child survival is the exclusion from the analysis of factors for which no information is available. The exclusion of such factors can alter estimates of the effects of the variables included in the analysis, depending upon the degree of correlation with the omitted variables. For example, lack of information about use of medical services is commonplace. In a study on infant mortality in India, Jain (1985) confirms the

usual association between the mother's education and the risk of dying in childhood. But when variables relating to utilization of the health-care system are introduced, it is found in the path analysis that 86 per cent of the "effect" of maternal education operates indirectly through health-service utilization.

According to the analytical frameworks described above, there is no doubt that the analysis should distinguish between the various levels at which the determinants operate and should adequately define the interrelationships between those levels. This is the purpose of multilevel studies; problems in the application of multilevel analysis are discussed by Casterline (1981). Schultz (1985) provides an example of a solution to such problems by estimating two functions. The first solution is a function of health production, which relates child mortality to the health input used by the family. The second is an equation in which the demand for health input is presented as a function of the household's human and economic resources and of various regional indicators that express contextual restrictions on satisfying this demand.

There are several problems in obtaining these functions. Sometimes it is only possible to relate mortality directly to individual and community variables in the demand equation. When this method is applied in Colombia, for example, it is found that mortality in rural areas is correlated with ecological factors (temperature, altitude); such correlation remains after controlling for the effects of socio-economic variables and appears to have a larger impact on less educated women.

Using a historical-structural analysis, Bloch and others (1985) conducted a longitudinal study of the health of children from birth, in which the families were classified according to the socio-economic status of the main economic provider. They identify three social groups (mostly unskilled workers or workers in unstable occupations) for which the living conditions are unfavourable (low education, poor housing, unstable personal relationships etc.). It is these groups that the health statuses of mothers and children are found to be most deficient, with a greater proportion of pregnancies in higher risk groups, a higher incidence of low birth weight etc. The children exposed to these conditions display retarded growth and development indices, and their morbidity tends to be higher. As concerns the use of the health-care system, these social groups have less knowledge of standards of child care and preventive medical consultations occur later and less frequently, but frequency of visits for treatment of illness is similar to that of the other groups. Lastly, infant and child mortality is greater in the social groups that have been exposed to this chain of unfavourable social and health conditions. This example shows that when an investigation is designed in accordance with a specific conceptual framework, its results can be interpreted more satisfactorily.

An analysis at the microlevel of the family can take into account information about the sequence in which the various determinants operate. For Khartoum (Sudan), Farah and Preston (1982) analyse the effects of variables pertaining to the parents' childhood (that is, in the household conditions of their own parents), to the time of their marriage and to the time of the survey. In this design, if the estimated effect of a variable declines when another variable is subsequently introduced into the regression equation, this decline can be interpreted as the effect of the first variable operating indirectly through the second.

The analysis of interactions can contribute to a fuller interpretation of the associations of the independent variables with infant mortality. Cramer (1987), for example, found that in the United States of America, the mother's race and education are associated with infant mortality, but he also found an interaction between those two explanatory variables. The higher mortality rates of infants whose mothers are less educated, confirmed in whites and in blacks, is much lower in Hispanics; the author postulates that this result is due to specific health practices in Hispanic culture. Furthermore, birth weight emerges as an important intervening variable in the association of social variables with infant mortality, but an interaction of birth weight with each of these social variables also exists.

The limitations of the studies that seek to explain the origins of infant mortality are often expressed by the authors as the need for more information. DaVanzo (1985) concludes that regional variations in mortality in Malaysia are basically associated with differences in the distribution of the population by

ethnic group, but more information about regional cultural characteristics would be needed to identify completely the underlying factors. Similarly, Cramer (1987), although he had a large amount of information, concludes by listing the new variables that would have to be known in order to ascertain the reasons that some groups have higher infant mortality. The implications of these limitations for policies designed to reduce infant mortality are discussed below.

In current conditions in developing countries, where the problem of infant mortality requires immediate action, research must make use of all available sources of information, of a multidisciplinary approach and of a suitable analytical framework. In addition to demographic techniques, use can also be made of epidemiological methods, such as case-control studies, which permit estimates to be made of the relative risks associated with biological and social factors in comparing those who die with those who survive. The need to combine quantitative analysis with qualitative information was mentioned above in the discussion of the importance of the historical-social context. There is no doubt that it is also necessary to incorporate cultural characteristics identified by anthropological methods, which are essentially qualitative. The difficulties of these interdisciplinary analyses are well known, but progress is being made in the combination of these methodologies (Caldwell and Hill, 1985).

C. INTERPRETATION OF ASSOCIATION OF INDEPENDENT VARIABLES WITH CHILD SURVIVAL

The country studies presented in this publication are based on data from population censuses and surveys, using individual characteristics and characteristics of the family's place of residence. The foregoing discussion has shown some limitations of this type of research and the need to take into account additional information about the context of the country or region in order to enhance the interpretation. It should be added that various studies (Hobcraft, McDonald and Rutstein, 1984; DaVanzo, Butz and Habicht, 1983; and Cramer, 1987) show that the importance of some determinants varies according to the child's age. The results presented in the present country studies, which do not distinguish age groups, must therefore be interpreted as average effects on the risk of dying in the first few years of life.

In the following subsections, interpretation of the association of independent variables with child survival is discussed, based mainly on earlier studies by the United Nations (1985)[4] and by Hobcraft, McDonald and Rutstein (1984).[5]

Father's occupation

The father of the child whose mortality is under study cannot be identified with certainty from census data. The exclusion from analysis of families if the father does not live in the home can distort results. There are also errors in the reporting of occupation which can lead to inconsistencies in the findings.[6]

Furthermore, such census data as occupation, occupational category and branch of economic activity do not always accurately identify the socio-economic nature of the occupation. These variables do not allow determination of social class, which is the most relevant analytical category. Moreover, it is not easy to identify groups that may be of interest for the analysis. In the agricultural sector, for example, the separation of farmers (who work their own land) from waged agricultural workers is made difficult by the frequent presence of an intermediate group: semi-proletarianized farmers. In the non-agricultural sector, it is difficult to define the so-called "marginal" groups, which are at greater risk of child mortality. The categories used in international studies are very large and heterogeneous; intercountry comparison is difficult. Lastly, the results should be interpreted in the light of information about the social context, especially when countries at different stages of development are being compared.

International studies show that child mortality is lower in the more highly skilled occupational groups which perform non-manual activities (professionals, technicians, white-collar workers) and that the risk is greater when the father is employed in agricultural production; the other groups occupy an intermediate position. In some countries, excess mortality is common to all groups except the most highly skilled.

In rural Bangladesh, D'Souza and Bhuiya (1982) found lower mortality in age group 1-4 when the household head owns his land and has animals to farm it. In Costa Rica, the evolution of differentials between 1960 and 1983 was analysed, using finely defined occupational groups (Behm, Granados and Robles, 1987). Waged agricultural workers have higher mortality at first because their living conditions are more adverse than those of farmers who own their land. The decline has been general in both groups, but it is greater among the waged workers who have more extensive social security benefits. In the non-agricultural sector, workers in marginal activities always have higher mortality than workers in the production of goods and services.

If the family's socio-economic characteristics are controlled in a multivariate analysis, the child mortality differentials associated with paternal occupation decline substantially; this is especially true when paternal education is controlled. In the analysis by Hobcraft, McDonald and Rutstein (1984), occupation is determinant in the model of best fit in only 8 out of 28 countries. In roughly half of the countries included in the United Nations analysis (United Nations, 1985), children of professionals and white-collar workers tend to have lower mortality, and children of production workers and workers in the agricultural sector have the highest mortality risks.

The interpretation of these results depends upon the conceptual framework guiding the analysis. It can be postulated that when the father has a less skilled occupation and lower social status, it is more probable that socio-economic conditions adverse to the child's survival exist in the family: low income; low maternal educational level; poor housing; and other conditions that are not usually measured, such as the persistence of beliefs inconsistent with healthy child-care practices and limited access to and use of health services. This is what the univariate analysis shows. In this hypothesis, the reduction of this association, when the family's socio-economic characteristics are controlled, would indicate that they represent some of the intervening mechanisms through which the father's occupation affects the child's health. The role of the father's education in this process is discussed below.

Mother's participation in productive activities

In most households, the mother combines child care with various domestic tasks. If the living conditions are unfavourable, these activities can be fairly exhausting and can have an adverse effect on the development of the foetus and the child. However, the work done by the mother is not necessarily economically remunerative and the woman may appear as "inactive" in the analysis. This situation must be borne in mind, as this group is used as the basis for comparison.

The effect of the mother's involvement in remunerative work on the child's survival depends upon the social conditions in which her activity takes place. If the entire family has to work in order to ensure its survival (as often happens in less developed agricultural economies) or if the mother is forced to work owing to the inadequate income of the household head or because she has no other source of maintenance, there is a deterioration in the care of the child, who is already exposed to hazardous living conditions in the home. Additional risk factors are the absence of other family members who could take care of the child and the fact that work outside the home makes it difficult for the mother to continue breast-feeding. It is also probable that such women will be employed in unskilled jobs with low earnings.

The situation is very different when the family's living conditions are better and the mother's participation in economic activities is part of an historical process of development of the woman's role. If the child can be cared for in the home or in institutions when the mother is away, it may be supposed that the higher income and social status of the mother, including her role in the home, will have a favourable effect on the child's health. This point again highlights the role of contextual variables, such as the availability of day-care facilities, social security protection for the mother during pregnancy and after childbirth and discrimination against mothers in the labour market.

The United Nations study (1985) is limited by data gaps, the difficulty of interpreting the very broad occupational categories and the

non-availability of some important variables. Nevertheless, the results indicate that child mortality tends to be higher when the mother reports participating in labour-market activities. This excess mortality varies considerably among the countries analysed. It is usually independent of the mother's educational level and occupational category, but the risk for the child is lower when the mother's occupation involves higher skills. It is not possible to explore the hypothesis of inverse causality: that the mother works because her child has died.

Multivariate analysis shows an irregular association between the mortality of children and the employment of mothers. In the study by Hobcraft, McDonald and Rutstein (1984), this variable appears to have a significant effect in fewer than one third of the models of best fit explaining child mortality.

In short, this type of analysis cannot determine with precision the role of the mother's work in the set of determinants of child health. It is possible that in national studies, when families are categorized according to a typology of socio-economic situations, more information can be obtained about the impact of the mother's work on the survival of the children. There is no doubt, however, that this factor contributes to the excess mortality among certain social groups, when employment takes place in adverse conditions.

Mother's education

All the studies of child mortality determinants have found that the mother's level of formal education is inversely related to child mortality. Although the degree of association varies according to the population studied, maternal education appears to be the variable most significantly related to child survival. In the analysis by Hobcraft, McDonald and Rutstein (1984), it is included in more than half of the models of best fit and its importance is greater for mortality in age group 1-4. In the United Nations study (1985), the estimated regression coefficient indicates an average reduction of 3.4 per cent in child mortality for each additional year of maternal education, once the effects of all other independent variables that could be controlled were eliminated.

A mother's level of education is an indicator of the socio-economic conditions of her own parents' household, illustrating a generational effect of social class on child survival. Farah and Preston (1982) show that at Khartoum (Sudan), the mortality of the grandchild is higher if the maternal grandfather was employed in unskilled activities. The association operates mainly through the daughter's education, for the strength of the association declines considerably when this variable is added to the regression equation. It has also been speculated that the consequences of the mother's poor nutritional status in childhood represent a risk for the foetus during pregnancy and the child during birth, and that these factors are more common in mothers with little or no education.

The most obvious mechanism through which the mother's education affects child survival directly is in her knowledge of appropriate care for both healthy and sick children. However, as Caldwell, Reddy and Caldwell (1983) note, the effect of maternal education is greater than the mere contribution of knowledge. It is related to the greater role of an educated mother in family decision-making about allocation of resources, distribution of food among its members and recourse to modern medicine despite traditional beliefs about procreation and the causes of illnesses and their treatment. Education is thus part of a global process of social change towards "modernization".

The relationship between maternal education and the use of medical services is important for interpretation of the studies based on population censuses that exclude this latter variable. Jain's (1985) research in rural India identifies the mother's education as an important determinant of the use of medical services, together with the availability of those services; as already stated, it is thought that the association of child mortality with maternal education operates mainly through this mechanism. Tekce and Shorter (1984), in a study in Jordan, found that maternal literacy is associated with better personal hygiene, greater use of health services and better child nutrition. Even in a country like Cuba, where access to the health-care system is very broad and without restrictions among social groups, a study of perinatal mortality showed that the timing and number of prenatal visits were

less satisfactory among poorly educated women (Cuba, 1980).

The educational levels of both spouses are correlated; therefore, part of the association of maternal education with child mortality, in the univariate analysis, could be explained by the effect of paternal education. The United Nations study (1985) analyses child mortality in terms of the schooling of each of the parents. The analysis shows that if the parents have different educational levels, better maternal education is more decisive for the child's survival than is better paternal education. Thus, the importance of a number of mechanisms associated more closely with the mother's attitudes and behaviour is underlined.

There are many interactions between maternal education and other factors. Cramer (1987), for example, concludes that the greater risk of child mortality associated with very young maternal age is due largely to the mother's low educational level. The interaction of education with race has already been mentioned with respect to its effect on infant mortality in the United States. In contrast, there is no evidence that the effect of the mother's education changes according to urban or rural residence, nor is the residential relationship with the mortality rate made clear in the study by Hobcraft, McDonald and Rutstein (1984). Mosley (1985), however, shows that in Kenya the increase in infant mortality associated with a low level of maternal education is greater in the poorer regions.

To sum up, little or no maternal education appears to be an important factor in excess child mortality, acting both directly and indirectly through those socio-economic characteristics of the home which it has been possible to study. The association between mortality and maternal education is affected by the differential use of health services, which itself depends upon their availability and accessibility. The important role of the mother's schooling is significant for the purposes of mortality reduction policies, because it is a component that can be improved on the national scale, even though the mechanisms through which it works are numerous and are not yet completely elucidated.

Father's education

The father's education has a systematic inverse association with child mortality, as is the case for the mother's education. The association is marked and declines when other socio-economic characteristics of the household are controlled, but a significantly greater risk always persists for the children of fathers with little or no education.

Selection of spouses has already been mentioned as one of the mechanisms that explain this association. But the father's education can also affect child health through a number of direct and indirect mechanisms similar to those related to the mother's education. Those mechanisms influence household decisions, including the decision to use the health-care system.

Furthermore, a worker's educational level is an important determinant of the nature and level of work to which he has access. The United Nations analysis (1985) shows that much of the association of occupation with child mortality disappears when this educational factor is controlled. In each paternal education group, however, agricultural work has the greatest association with child mortality in most countries. In the study by Hobcraft, McDonald and Rutstein (1984), paternal education (with the effects of occupation and other variables controlled) appears in half or more of the models of best fit.

D'Souza and Bhuiya (1982) found that in every category of rural employment, no education or little education of the head of household is associated with greater child mortality and that in every category of education lower occupational status is associated with greater risk for the child's survival, except among the minority with seven or more years of education. In a different historical context, García (1983), found that at Medellín, Colombia, the social class and education of the head of household separately affect the mortality of children under age 3; mortality differentials related to education are greater among the social classes living in the poorest conditions.

In short, paternal education affects child survival through various mechanisms. Some operate through the social conditions associated with the

nature of the father's work. Others operate directly, in ways similar to the effects of maternal education. It is probable that the relative importance of these two groups of mechanisms depends upon the contextual stage of development, the socio-economic level of the household and the social class to which it belongs.

Place of residence

In developing countries, the urban and rural populations are usually two very different universes, whose different characteristics influence child survival through many different mechanisms. Industrial development, public services, financial and commercial activities and political decisions are concentrated in the larger towns—in the national capital in particular—which are generally more advanced in the process of "modernization" and have better living conditions. Only the constant migration flows from other regions to larger towns alter this situation in that the market cannot absorb all those migrants, who may have to accept poorly paid marginal occupations. This situation often results in the creation of large residential zones consisting of temporary dwellings in poor condition.

The rural population is usually found at various stages of transition, from a pre-market economy to a developed market economy. The land distribution is often very unequal and the growth of modern agricultural enterprises producing goods for export tends to create greater inequalities. Moreover, trade unions are generally less developed among farmers with small holdings and waged agricultural workers than in other economic sectors and they may be less effective as pressure groups. Lastly, in some countries, indigenous groups, which have the worst living conditions, tend to be found predominantly in the countryside.

In these circumstances, the studies show, with very few exceptions, higher infant and child mortality among rural populations, although this excess varies greatly among countries. Lower mortality is often found in the larger towns, with the mortality of the remaining urban sector being between these two extremes. This pattern varies across countries. Guzmán (1984) shows that in Latin America, the mortality decline is earlier and sharper among the urban population. The rural subgroups, even the most scattered ones, joined this trend later, although to a varying extent depending upon the country. Accordingly, it is possible for urban/rural differentials in mortality to increase before entering a phase of steady decline.

In multivariate analyses based on population censuses or surveys, it is found that when the effects of various socio-economic household characteristics are controlled, the urban/rural differential declines to often insignificant levels. This residual effect appears somewhat greater in the study by Hobcraft, McDonald and Rutstein (1984). The variable for place of residence appears in roughly one third of the models of best fit for each country. In those models, compared with rural residence, metropolitan residence appears to be related to a reduction in mortality of between 24 and 70 per cent, depending upon the country and the age at which the child died.

The fact that most of the urban/rural differences disappear when other variables are controlled has been interpreted to mean that the unequal quality and distribution of medical care between the two population subgroups does not play an important role in those differences. However, since health-service characteristics and utilization are not included in most studies, it can be argued that their effects are confounded with that of the variables included in the regression equation, in particular, maternal education. In Costa Rica, it was found that the extension of the health-care system to the rural population, particularly in the most remote areas, was a much more decisive factor for the decline of infant mortality than improvements in other indicators of the standard of living (Rosero, 1985).

In some Latin American countries, the urban/rural continuum can be broken down into as many as five categories, ranging from metropolitan to low-density rural populations. In Guatemala, for example, it was found that when the household head is employed in a non-agricultural activity and the mother is illiterate or semi-illiterate, mortality is lower if they live in the capital city. This finding could mean that even in the unfavourable conditions of those families, living in a place where public services, including health services, are concentrated facilitates actual access to them. In

contrast, when the household head is employed in agricultural production and the mother is illiterate, infant mortality is high regardless of the degree of urbanization of the place of residence (Behm and Vargas, 1984).

In the United Nations study (1985) it was sometimes possible to ascertain the mother's place of birth. It was concluded that if the mother was born in a rural area, the child's mortality risk is greater, regardless of the current place of residence. This risk factor works mainly through other factors established in the mother's childhood, such as race, education and religion, indicating a transgenerational effect of the adverse conditions of the household of the maternal grandfather.

Regional contrasts

The differences in child survival among geographical regions of a country are a very important factor for regional planning. Reasons for such differences vary in nature. For instance, natural geographical conditions such as climate and altitude, may affect the land's productivity and may be particularly important in primitive economies where man has only limited control over nature. Furthermore, climatic conditions can increase the incidence of infectious and parasitic diseases. Anker and Knowles (1977), in an analysis at the microlevel and the macrolevel in Kenya, identified endemic malaria as the most relevant variable for the mortality differentials among children under age 3.

There is also an economic, social and cultural heterogeneity; regions can differ in their prevailing type of production and also in their policies for distribution of economic and social benefits. Moreover, ethnic groups may predominate in one region more than another, adding further differential factors. There can also be wide differences in the degree of urbanization; the region that has the capital or main towns is often the most developed.

The interrelationships between socio-economic and ecological factors are complex. In Brazil, for example, the differences in infant mortality between the southern states and those of the north-east are extremely large and are increasing. The former region includes the largest industrial centre in Latin America, with rich natural resources and significant urban development. The north-east is subject to periodic droughts, its farming economy is backward and the living conditions of its inhabitants are very poor.

The United Nations study (1985) shows regional differences in child mortality in all the countries included. These differences vary greatly in size and express the diversity of the epidemiological situations. Controlling for the effects of the available socio-economic variables relating to the members of the family produces an uneven reduction in the mortality differentials by region, and sometimes the direction of the effects changes. The authors question the validity of some of the indicators used. The analysis also shows, however, that without a good description of the socio-economic context of each region (information that is available to some extent in every country), the interpretation of the results is limited and hypothetical. For example, DaVanzo (1985) could not explain regional differentials in Malaysia for lack of sufficient data on ethnicity.

Ethnic factors

Several developing countries have numerically large ethnic groups which differ in many of the determinants of child survival. The national integration of different races has often been difficult in the period following colonial rule. Economic and social differences often persist among ethnic groups, expressed in different living conditions in a context of general underdevelopment. Furthermore, the cultural patterns of those groups can be quite varied and different groups may be at different stages of transition in the process of cultural change. Their beliefs about procreation, child care and the causes of childhood diseases and their treatment are of special interest for the problem under discussion. Other differential factors may be connected with natural resources and ecological conditions in the territories in which the various ethnic groups live.

The studies based on census data and demographic surveys permit only a limited analysis of the nature of the ethnic contrasts in child mortality, because of the lack of anthropological data and other contextual characteristics. The

United Nations study (1985) shows that ethnic differentials in child mortality are of considerable size in 11 countries, mainly in Africa and Asia. The effects are reduced in the multivariate analysis but the association remains statistically significant, indicating that the differentials are related to factors not analysed. It is assumed that such factors are mainly cultural and are associated principally with health practices. In some countries, it was observed that ethnic differentials in mortality were smaller in the urban population, perhaps because of the process of incorporation into urban culture.

A study in Guatemala (Behm and Vargas, 1984), where there is a large indigenous population, found that when the home environment is very unfavourable, that is, when the mother is illiterate or semi-illiterate, indigenous and non-indigenous populations have similarly high mortality rates, regardless of the father's occupation and of rural or urban place of residence. The excess mortality of the indigenous population emerges when the mother's educational level reaches from four to six years, especially in the rural areas and agricultural sector, probably as a result of differential access to social and economic benefits.

The differences in child survival associated with ethnicity are important for health policies. They identify the highest risk groups, indicate the need to overcome the socio-economic inequalities between ethnic groups, and emphasize that development programmes must take into consideration and overcome the cultural barriers that partially explain this situation.

Living conditions

Living conditions, especially water-supply and lavatory facilities, directly affect contamination of the household environment and thus may facilitate the dissemination and incidence of various infectious diseases, particularly diarrhoea. Of course, the quality of housing depends upon the economic standing of the family and, in turn, upon contextual factors, such as the level of development and policies with regard to housing construction and water distribution.

The variables available to study the relationship between housing quality and child mortality refer to building materials and their condition, and to availability of water, a lavatory facility and electricity. Using data from six countries, the United Nations study (1985) shows that, in general, old housing, deficient sanitary conditions and lack of electricity constitute risk factors for child survival. When the effects of several socio-economic characteristics of the household are controlled, this association weakens and remains present only in some of the cases studied. The authors suggest that behavioural factors, mainly personal hygiene and health practices with respect to the child, are more important considerations than the physical environment of the household.

Using more information, Tekce and Shorter (1984) found that at Amman, Jordan, after controlling for other socio-economic characteristics of the household, there remains a net negative effect of deficient housing on the mortality of children under three years of age. Multiple classification analysis identifies personal hygiene as an intermediate variable, which is more deficient when the water-supply is inadequate. Quality of housing also appears to be associated with the nutritional status of the child; the relationship between malnutrition and repeated infections is well known.

Merrick (1983) analyses the impact of availability of piped water on child mortality in Brazil. Access to piped water in the house, when the effects of household contextual variables are controlled, is associated with a reduction in mortality of approximately 20 per cent.

It is therefore possible that analyses based on census and survey data underestimate the role of unsanitary housing in determining the health status of children. Moreover, international comparisons are difficult because of problems with the comparability of categories used to characterize housing. It is quite possible that maternal education, received through formal schooling or through contact with health services, contributes to reducing the contamination risks generated by deficient housing. The experiences of Costa Rica and Cuba show that it is possible to reach an infant mortality level below 20 per 1,000 even with a relatively high proportion of deficient dwellings, the improvement of which would be a costly and slow

process. Palloni (1985) shows that in such countries, the fundamental factor was the deliberate implementation of egalitarian health-care policies which reduced other risk factors of child mortality.

In addition, the knowledge of living conditions contributes to the identification of major risk groups, which should receive priority attention. In Costa Rica, among the groups at highest risk of infant mortality, 41 per cent of births occur to families living in poor housing conditions (Behm, Granados and Robles, 1987).

D. Implications for policies designed to reduce mortality

The real purpose of the study of the determinants of child mortality is to contribute to the implementation of measures to bring about a sharp drop in the excess mortality of the developing countries and in the social inequalities in the right to live.

The policy implications of the analysis of risk factors, such as those described above, depend upon many elements. It is not only the mortality level of a subgroup that is important but also the proportion of the population in that subgroup. Certain determinants such as ethnicity and religion, cannot be modified but they do point to populations at higher risk that should receive priority consideration in efforts to control factors adversely affecting child survival. On the other hand, with respect to education and health services, the differentials emphasize the necessity to implement policies to provide more equal access to those benefits.

Furthermore, the modification of certain risk factors, such as housing quality, involves high costs and long implementation periods, which makes it more difficult to achieve. Political feasibility is also an important consideration; agrarian reform, for example, is usually more problematic than is the expansion of education.

There is another important factor for the investigation of the problem, one relating to goals. There is no doubt whatsoever that better knowledge of the conditions determining higher child mortality and of the mechanisms through which they act can provide the basis for more rational and effective policies to improve child survival. The foregoing discussion shows the difficulty of attaining this objective, as studies usually conclude with a statement of the need for more and more information in order to produce an adequate explanation.

These research requirements contrast with the urgency and magnitude of the problem of excess mortality in the developing countries. It is useful to remember that when Costa Rica and Cuba initiated the policies that time has proved successful, they did not have detailed knowledge about the possible impact of those policies. The expansion of education, health care and other benefits in the best way possible was a political decision which recognized the enjoyment of those benefits as an unquestionable human right.[7] Thus, there is a need to articulate the continuing investigation of determinants of child survival with other areas of study of immediate application.

The health sector is a focus of attention, though its importance should not be exaggerated. The key factor is to know how to prevent or treat the majority of diseases causing excess child mortality in developing countries; it is the health sector that is responsible for this knowledge. There is therefore a need for operational studies directed to shedding light on two crucial issues:

(*a*) Determination of the most realistic, efficient and effective health policies and the most suitable health-system organizations, and the most appropriate technologies for the various epidemiological situations existing in developing countries, and of the way in which their implementation should be promoted;

(*b*) Determination of the impact that such measures can have in view of the limitations in each economic, social and political context, which are so decisive for child survival.[8]

Despite the limited explanatory capacity of the international study discussed here and other similar studies, they do make a very valuable contribution to the identification of the social groups in which children are exposed to the greatest mortality risks in each country. They can help answer the questions that are fundamental for targeting

subsequent action. What is the magnitude of the child mortality differentials? Each year, how many children are exposed to those differential risks? Where are the children most at risk located geographically? What social, economic and other characteristics help identify the families most at risk? What progress is being made in changing this epidemiological situation?

These possible ways of making practical use of the results of this type of study, supplemented with information about the corresponding social context, ought to be fully explored and exploited.

NOTES

[1] In Latin America, where mortality is generally lower than in Africa and Asia, the under-five mortality rate in 1978 was 29 times higher than in the United States for acute respiratory diseases and 84 times higher than for diarrhoeal diseases (Behm, 1987).

[2] Among the more general and recent conceptual frameworks, see Mosley and Chen (1984); Schultz (1985); Breilh and Granda (1984); Beghin and others (1983).

[3] For a discussion of the problem as applied to the study of mortality, see Palloni (1987).

[4] This study covers 7 African, 5 Asian and 3 Latin American countries. The study is based on samples of population censuses or fertility surveys carried out in the 1970s.

[5] The study includes 4 African, 12 Asian and 12 Latin American (including Caribbean) countries; it is based on the material of the World Fertility Survey and covers births that occurred 5-15 years prior to the survey.

[6] Even in a country with good census traditions, such as Costa Rica, the cross-tabulation of the occupation data with education produced several serious inconsistencies.

[7] McIntosh and Finkle (1985) point out that the use of demographic knowledge for political decisions (especially in the short term) is determined less by the quantity and quality of the demographic data than by the nature of the State's political and bureaucratic system. The establishment of policies is primarily a political process guided by political and not technical considerations.

[8] For a discussion of some aspects of this question with respect to population studies, see Mosley (1985).

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II. METHODOLOGY

José Miguel Guzmán[*]

The purpose of this study is to examine the socio-economic determinants of child mortality on the basis of retrospective data available from population censuses and surveys. More specifically, for each woman in the sample, data on the number of children ever born and the number of her children who died are used to construct an aggregate child mortality indicator. The indicator can be incorporated in a regression model in which the independent variables are obtained from the same data sources. This indicator can also be used to estimate the probabilities of dying for different population subgroups, with a view to identifying those high-risk groups which need priority attention.

The approach used here was developed by Trussell and Preston (1982) for application in cases where detailed information is not available on the date of each live birth or on the date of death of children who did not survive. The authors propose an exposure-standardized indicator of child mortality, measured for each woman on the basis of the proportion dead among her children, for use in such cases. They show that despite its aggregate nature, the regression model using this indicator makes it possible to derive estimates of the effects of socio-economic factors on child mortality that are comparable to those obtained when more detailed information on each birth and death is available and more refined statistical techniques are used. This model was used in a previous United Nations study on socio-economic differentials in child mortality (United Nations, 1985).

In the country studies presented in this publication, the Preston and Trussell methodology is used on data from various censuses and surveys. Although each case-study has its own specificities, the same approach is used in all. In most studies, the data are supplied by two recent sources. The population under study is limited to young women or to women at short durations of marriage, so that the child mortality estimates will refer to periods close to the date of the census or survey. The women selected were the wives or companions of the heads of households or were women heads of households with spouses living in the household, so as to permit inclusion of the father's socio-economic characteristics in the analyses, along with the mother's socio-economic characteristics and the characteristics of the household.

This chapter describes the common methodology used in the country studies. In section A, the regression model is presented. In section B, the calculation of the mortality indicator is explained. Section C then considers some aspects of the application of the regression model, and section D discusses some limitations of the mortality indicator and the regression model. Lastly, an alternate use of the mortality indicator is presented.

A. THE REGRESSION MODEL

The regression model used in this study expresses child mortality as a linear function of a set of explanatory variables representing individual and contextual characteristics of the population studied. The dependent variable, mortality in the first years of life, is represented by an indicator, M, of the mortality of each woman's children in relation to the national mortality level, standardized by the duration of exposure to risk.

The independent variables, for their part, refer to the geographical context of residence (type of place and region of residence), educational level (duration of the mother's and father's schooling), socio-economic stratum (father's occupation), living conditions and basic sanitation of the dwelling (access to potable water, lavatory facilities etc.); and cultural characteristics, such as ethnicity, religion or language spoken. These variables are often indicators of a number of possible determinants of child mortality that are not directly observed because of the limitations of the data sources. As a result, potentially important factors, acting at the community, household or

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individual level, are not included in the model. This model thus remains limited, even though it does provide useful guidance in the study of determinants of child mortality.

The form of the regression equation is:

$$M = a + \sum_{k=1}^{K} \sum_{j=1}^{J_k-1} b_{jk} X_{jk} + e \quad , \qquad (1)$$

where M = mortality indicator;
a = regression constant;
b_{jk} = regression coefficient of category j of variable k;
X_{jk} = independent variable, representing category j of variable k;
J_k = total number of categories of variable k;
K = total number of variables;
e = error term.

M is a continuous variable with a mean of approximately one, while all independent variables are categorical. In this study, the model is estimated using the ordinary least squares regression technique. In the regression model, each woman is weighted by the number of her children ever born; thus, the child, and not the woman, is treated as the unit of analysis.

B. Calculation of the Mortality Indicator M

The mortality indicator M, which is the dependent variable in the model, is obtained for each woman with at least one live birth. It represents the mortality of each woman's children in relation to the national mortality level, standardized by the duration of exposure to risk.

For each woman in the sample, the data sets used in the country studies provide information on the number of children ever born and the number of children who had died. Thus, the proportion of children dead among those ever born can be calculated for each woman. For a large group of women, the proportion dead of children ever born is mainly a function of two factors: the underlying level (and to some extent the age pattern) of child mortality; and the children's average exposure to risk of dying (and to some extent its distribution). Exposure can be taken into account by classifying women by age group or duration of marriage, thus making it possible to relate the proportions dead to the probabilities of dying in childhood. It is this principle that underlies the well-known Brass method for estimating child mortality from the proportions dead among children ever born (Brass, 1964; United Nations, 1983).

Trussell and Preston (1982) propose using this process in reverse for studying the correlates of child mortality using individual-level data. Given estimates of probabilities of dying in childhood, generally obtained from an aggregate-level analysis of proportions dead among children ever born, the Brass procedure is used in reverse to estimate, for each age group or duration of marriage, an expected proportion who had died among the children ever born. This proportion is thus standardized for the average exposure to risk of the children of mothers in the group, given the overall estimates of child mortality risks. For each woman, an expected number of children dead is calculated by multiplying her parity by the standard proportion dead for her exposure group. The indicator M is then calculated as the ratio of the actual number of dead children she reported divided by the expected number for her exposure group. Thus, for each woman, i, the mortality indicator, M_i, can be expressed as:

$$M_i(e) = \frac{PD^o{}_i(e)}{PD^e(e)} \quad , \qquad (2)$$

where $PD^o_i(e)$ = the observed proportion of children dead for woman i, in exposure group e. This is obtained by dividing her number of children dead by her total number of live births;

$PD^e(e)$ = the expected proportion of children dead for a woman in exposure group e if her children's mortality conformed to the national level.

Across all women, M should average close to unity; for an individual woman, a value above unity indicates a higher than expected number of children who died, whereas a value below unity indicates a lower than expected number.

The expected proportion of children dead is obtained by applying in reverse the Brass procedure for estimating probabilities of dying from the average proportions:

$$PD^e(e) = q_s(a)/k \quad , \qquad (3)$$

where $q_s(a)$ = the standard probability of dying from birth until age a of a model life-table selected to represent the level and structure of mortality by age of the total population studied (the method of determining these probabilities is described below);

k = the multiplier for converting, in the Brass method, the proportion of children dead into probabilities of dying. Each k is specific to an exposure group of the women and to age of the children.

The standard life-table probabilities, $q_s(a)$, are calculated as follows. The mortality levels corresponding to a "family" of the United Nations or Coale-Demeny model life-tables are obtained for each exposure group (United Nations, 1982; Coale and Demeny, 1966). The family selected is assumed to best represent the age structure of mortality in the population. The mortality level for each exposure group is determined from the proportions of children dead of all women in that exposure group by applying the Trussell variant of the Brass method (United Nations, 1983). A standard level of mortality, assumed to represent the level of child mortality for the total population, is obtained by averaging the estimates obtained for the various exposure groups. The standard life-table probabilities, $q_s(a)$, are determined for each exposure group of the women; each probability corresponds to a specific age a of the children. The expected proportions dead are calculated by dividing the life-table probabilities by the appropriate multiplier k.

In the majority of the country studies presented here, age of the woman is used as the measure of exposure to the risk of dying; one study uses duration of marriage. In most cases, age groups 15-19, 20-24, 25-29 and 30-34 are used. The advantages of using only the younger age groups or the shorter durations of marriage are twofold: it ensures that the mortality estimates shall pertain to recent periods prior to the census or survey; and it minimizes the recall errors that frequently affect data obtained from older women or women married for longer periods of time.

C. APPLICATION OF THE REGRESSION MODEL

The dependent variable: M

For the total population of women, the value of M must be theoretically equal or very close to unity. Nevertheless, in the country studies presented in this publication, the observed national value often differs from unity because estimation of the regression models is based on information provided for all the characteristics studied, with respect to selected populations of women who were currently married or in a consensual union.

The independent variables: X_{jk}

The independent variables of the regression model, X_{jk}, are dichotomous variables constructed to represent the various categories j of all K variables. Each variable k is expressed by a set of $J-1$ dichotomous variables which assume the value of unity if the woman belongs to that category and the value of zero if she does not. One category of each variable is used as the reference category, with which the other categories of the same variable are compared. Categories in which the lowest level of child mortality is expected are selected as reference categories in the country studies.

The constant: a

The intercept or constant, a, estimated in the regression model, represents the value M for women belonging to the reference categories of all variables.

The regression coefficients: b_{jk}

The regression coefficients, b_{jk}, are the parameters, estimated in the regression model, which represent the increment in the mortality indicator, M, associated with the characteristic represented by the variable X_{jk}. The coefficients express the effects of each variable net of the effects of the other variables included in the model.

Relative risks

Relative child mortality risks, that is, the risk of having a given characteristic in relation to being in another category of the same variable, may be estimated from the regression coefficients by using the following formula:

$$r_{ij} = \frac{D + b_{ik}}{D + b_{jk}} \quad , \qquad (4)$$

where r_{ij} = mortality risk for children born to mothers in category i of variable k in relation to mortality risk of children born to mothers in category j of the same variable;

b_{ik} = regression coefficient for category i of variable k;

b_{jk} = regression coefficient for category j of variable k;

D = basic risk for an average woman, excluding the effect of the variable studied. This risk is calculated as follows:

$$D = (\mu - \sum_{l=1}^{J_k} P_{lk}\, b_{lk}) \quad , \qquad (5)$$

where μ = value of M for the total population studied;

P_{lk} = proportion of live births in each category l of variable k;

b_{lk} = regression coefficient for category l of variable k;

J_k = total number of categories of variable k.

When the relative risks are calculated with respect to the reference category, $b_{jk} = 0$, then:

$$r_{i0} = \frac{D + b_{ik}}{D} \quad . \qquad (6)$$

D. Discussion of the Methodology

The regression model used here has both advantages and limitations. Its main advantage is the fact that it can be applied to data from censuses and surveys where only questions on the total number of live births and children surviving (or children dead) are asked. The dependent variable, M, can be calculated for each ever-parous woman and can therefore be used, as in this study, as a dependent variable in a multivariate analysis.

One limitation of this model is the possibility that one of its basic assumptions may not be fulfilled. The model assumes that the cumulative probabilities of dying from birth onward, in the different socio-economic groups studied, are proportional to the probabilities of dying in the selected standard life-table, that is, the structure of mortality by age is assumed to be the same in the various population subgroups as in the total population. Indeed, M is averaged over children of a wide range of ages, so it cannot efficiently determine the factors that affect child mortality at only one age range of childhood or even identify the factors that might have effects in different directions in different age ranges. The factors that are likely to be identified as important correlates of child mortality are those which have approximately constant proportional effects at all ages of childhood (Hill, 1989).

Other limitations of the model derive from the characteristics of the dependent variable, M. The expected proportion of children dead is calculated under the assumption that distributions of children by exposure to risk do not vary systematically according to the covariates used within an age group or for a duration of marriage. When using age groups, this assumption is clearly incorrect. Women of higher socio-economic status usually bear children at later ages than do women of lower status, so that the children of higher status mothers have, on average, shorter exposure to risk periods

and thus, *ceteris paribus*, lower proportions dead than the children of lower status women. Therefore, M may be expected to be lower for women of higher status than for those of lower status, not because of lower underlying mortality risks but because of shorter exposure to such risks (Trussell and Preston, 1982). Regression analysis will thus give an exaggerated estimate of the reduction in child mortality associated with indicators of higher socio-economic status. This problem is much less severe for data classified by duration of marriage, because patterns of child-bearing vary much less by duration of marriage than by age. In fact, the effect could be reversed if higher status women were to bear children early in marriage and then stop, which would result in long average exposure of children for a given duration of marriage group, while lower status women continued to bear children steadily throughout marriage. This potential bias is a strong argument for calculating M for duration of marriage groups, where reproductive customs are such that almost all child-bearing occurs within marriage (Hill, 1989).

Yet another limitation, similar to that mentioned above, is connected with the use of M as the dependent variable. Hill (1989) points out that if child mortality has been falling at the same time as, for example, education has been rising, then the children of women in the longer exposure groups will have higher M values because they have been exposed to higher mortality risks in the past. Accordingly, at the lower educational levels, there will be a larger proportion of children who were exposed to the higher risks of the past than in the better educated groups and the regression coefficients on education will pick up spurious magnitude from the exogenous decline. This problem diminishes, at least in part, when the events included are largely fairly recent, as in most of the country studies where only women under 35 years of age are included. Another solution to the problem consists in including an exposure group dummy variable in the regression equation, to pick up trend effects not associated with the independent variables being used (Hill, 1989).

There is a fourth disadvantage connected with the asymmetrical distribution of the variable M. Most of the women have no children dead and their M value is therefore zero. In the case of women with children dead, M acquires specific values with a maximum being the reciprocal of the expected proportion dead for the exposure group (all children dead). The modal value of M is often zero. Such a distribution makes it highly unlikely that the error term, e, in the regression equation will be normally distributed, thus contravening the assumptions of linear regression, although the effects are likely to be greater on calculations of significance or variance accounted for than on the regression coefficients themselves, which are of primary interest (Hill, 1989).

The final disadvantage of the dependent variable M is the large random variability shown by this indicator at the individual level for each woman. Consequently, the proportion of the total variance that can be explained, R^2, in the regression models is generally quite low (usually no more than 5 per cent). A test of the effect of the random variation of M on the proportion of the variance explained can be found in Hill (1989).

E. Using M to estimate child mortality for population subgroups

The values of M can be used as indicators of child mortality independently of whether the regression model is used. For example, the average value of M for a group of women with a given characteristic can be calculated, and subgroups with high mortality risks can be identified. The mortality indicator M is not a conventional indicator of mortality, but it can easily be converted into the probability of dying by age 5, ${}_5q_0$. If the exposure pattern for children in a given population subgroup (represented by category j of variable k) is similar to the exposure pattern in the total population, then M_{jk} (the average value of M for that subgroup) can be converted into a conventional ${}_5q_0$ in the following manner:

$$ {}_5q_{0\ jk} = {}_5q_0 \cdot \mathrm{M_{jk}\ (adjusted)}, \qquad (7) $$

where:

$$ \mathrm{M_{jk}\ (adjusted)} = \mathrm{M_{jk}/M}. \qquad (8) $$

M is the average value for the total population; the value of M_{jk} has to be adjusted because the value of M may differ from unity. For this estimation, the value of ${}_5q_0$ for the total population is taken to be that of the national standard life-table.

In many cases, the probability of dying by age 5 for a population subgroup can be estimated using conventional indirect techniques. By using the algorithm given above, however, estimates can be derived for small groups. It should be emphasized that the regression coefficients b_{jk} constitute excesses of child mortality with respect to the reference categories, expressed in terms of M. Thus, these coefficients can also be converted into excesses of ${}_5q_0$ with respect to the reference categories. In this case, the calculation is similar to the foregoing example.

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Part Two

SOCIO-ECONOMIC DIFFERENTIALS IN CHILD MORTALITY:

COUNTRY CASE-STUDIES

III. KENYA

*Kilambi Venkatacharya**

Kenya, a sub-Saharan country of demographic diversity, has a large body of demographic data spanning two decades. It has one of the highest rates of population growth in the world, largely attributable to constant and high fertility levels and declines in mortality. The 1979 census data indicate an annual rate of growth of 3.8 per cent, with a total fertility rate of approximately eight lifetime births per woman. The 1979 expectation of life at birth for both sexes is estimated to be 57 years (Ewbank, Henin and Kekovole, 1986). Compared with the estimates for 1969 of 47 years for males and 51 years for females (Kenya, 1980/81), this level shows a significant improvement in survival during that decade. The improvement occurred primarily during infancy and childhood.

The purpose of this study is to examine differentials in child mortality for various socio-economic and cultural groups in Kenya. It is hoped that by identifying those socio-economic subgroups in which children have high risks of dying, this study may help public health planning. The data for this analysis were taken from the Kenya Fertility Survey (Kenya, 1980/81), conducted in 1977 and 1978 under the World Fertility Survey programme.

In section A of this chapter, the socio-economic characteristics of Kenya are described and the Kenyan public-health policy is outlined. The levels and trends in child mortality are also examined. Section B briefly describes the methods and presents the independent variables used here. In section C, results from a regression analysis are presented and high-risk groups are identified. Lastly, in section D, the results are discussed.

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A. SOCIO-ECONOMIC AND DEMOGRAPHIC CONTEXT

Geography and economy

Kenya is a medium-sized country with a land area of 582,646 square kilometres, of which only 17 per cent are arable. The population of Kenya was estimated in 1979 to be 15.4 million; it was estimated to have increased to 20 million by 1986 (United Nations, 1988). The high rate of population growth of the country is viewed as a key national problem.

Kenya is primarily an agricultural country, with 80 per cent of its population living in the 17 per cent of land suited for agriculture. Almost half of the population is concentrated in only 6 per cent of the land. The Nyanza, Western and Central provinces have the largest shares of arable land, leading to high population density in those provinces.

Geographically and ethnically, Kenya is diverse. Kenya has more than 70 ethnic groups, of which a dozen, including the Kikuyu, Luhya and Luo, are the most important in terms of population size. As of the 1979 census, the Bantu-speaking Kikuyu, who live mainly in Central Province, accounted for 21 per cent of the total population of the country. The Luhya, concentrated in Western Province, constituted 14 per cent of the total population; and the Luo, living primarily in Nyanza Province, accounted for 13 per cent (Kenya, n.d.). Each ethnic group usually resides on its traditional land, in regions that differ significantly in their climate and geography. The regional differences in ecological conditions include altitude and temperature, rainfall and humidity, types of soil and terrain, and population density. These variations are associated with variations in health status and therefore with variations in mortality (Blacker and others, 1987). As a consequence of these variations

and of the geographical distribution of the population by ethnic group, an association between ethnicity and health status or mortality can be expected.

Kenya has maintained relatively steady economic and social development since it attained independence in 1963. Its overall economic growth has been impressive during the two decades since that time. The annual growth rate of the gross domestic product was 6.4 per cent for the period 1965-1980 and 3.4 per cent for the period 1980-1986 (World Bank, 1988). Substantial progress has been made in agriculture, education and health.

Agriculture is the mainstay of the Kenya economy: 81 per cent of the labour force were employed in agriculture in 1980 (World Bank, 1988). The Government has formulated policies to promote small-scale agriculture, in contrast to the large-scale commercial agriculture it inherited at the time of independence, although a few large-scale farms are retained for specific purposes, such as seed production. These policies have led to an increase in agricultural output, which has in turn alleviated, to some extent, the suffering of the poor in rural areas.

The second major improvement has been in the field of education. The Government is spending, on average, 30 per cent of its recurrent expenditures on education. Free primary education has been provided and the number of educational infrastructure facilities has been steadily increasing. In 1985, 94 per cent of the appropriate age group were enrolled in primary education and 20 per cent were enrolled in secondary education (World Bank, 1988). The National Literacy Survey conducted in 1976 showed, however, a major difference in literacy levels by sex: the male literacy level for the population aged 15 or over was estimated to be 65 per cent, while the female level was estimated to be only 30 per cent (Kenya, 1980/81).

Public health policy

The public-health policy in Kenya has been instrumental in achieving reductions in child mortality. Kenya has steadily improved its health-care programme, with 6 per cent of public expenditures devoted to that purpose in 1978 (Ewbank, Henin and Kekovole, 1986). Significant preventive measures are being taken, such as those related to health education, disease eradication, protection against environmental hazards and immunization against infectious diseases. In 1989, more than 40 per cent of children aged 12-23 months had received the bacillus Calmette-Guérin (BCG), three doses of polio vaccine, three doses of diphtheria, pertussis and typhoid (DPT) vaccine and the vaccine against measles (Kenya, 1989).

The two most important aspects in the area of preventive measures are provision of safe drinking-water and nutritional programmes. Policies have been formulated to improve the quality and quantity of drinking-water in both urban and rural areas. As of 1976, most rural households had some source of potable water within a radius of two kilometres (Ewbank, Henin and Kekovole, 1986). In 1989, 47 per cent of women aged 15-49 had water piped into their house or had access to a public tap or to a well (Kenya, 1989).

The importance of food and nutrition has been recognized by the Government since the first development plan for the period 1974-1978, and it was given more prominence in subsequent plans. Provision of proper nutrition is an essential component of the development plan for 1989-1993 (Kenya, 1989). Indeed, several nutritional surveys conducted in Kenya in the late 1970s and the early 1980s indicated a high prevalence of protein-calorie malnutrition, especially among children under age 5. In 1978-1979, among children aged 6-60 months, only from 47 to 74 per cent, depending upon the province, were neither stunted nor wasted (Ewbank, Henin and Kekovole, 1986). Government efforts in the area of nutrition have been helped by increased food production and thus higher farm incomes.

In curative health also, the Government has made significant improvements in diagnostic and therapeutic services for the population through hospital-based programmes. The ratio of population per physician decreased from an estimated 13,280 in 1965 to an estimated 10,120 in 1981. In the same period, the ratio of population per nurse decreased from an estimated 1,930 to an estimated 990 (World Bank, 1988).

In spite of these positive aspects, there remain deficiencies. Health-care services are not adequate for the rural population, a problem common to many developing countries; and there is still a shortage of skilled medical personnel, medications, equipment etc.

Levels and trends in child mortality since the 1950s

The data necessary for the estimation of child mortality in Kenya are derived from a number of sources. The oldest sources are the results of various sample surveys conducted for other purposes in small, selected areas of Kenya between 1922 and 1933. These sources have provided infant mortality estimates that vary greatly, from approximately 100 to more than 400 infant deaths per 1,000 live births (Kuczynski, 1949).

Since the Second World War, Kenya has held four national population censuses in 1948, 1962, 1969 and 1979. From the 1948 census data, Martin (1953) was able to derive only a crude estimate of the infant mortality rate: 184 per 1,000. This value is considered to be plausible for Kenya in the 1940s. The probability of dying by age 5 corresponding to the mortality level implied by such an infant mortality rate is approximately 300 per 1,000.

The three most recent censuses included questions relating to women in their reproductive ages on the total number of children ever born and the number surviving. Indirect methods can be applied to such data, classified by five-year age group of women, to estimate the level of child mortality at various dates before the census. A number of demographic surveys providing data on the total number of children ever born to a woman and the number of children surviving were also taken in Kenya: the National Demographic Survey (NDS) (1977), the Kenya Fertility Survey (KFS) (1977-1978) and the Kenya Demographic and Health Survey (KDHS) (1989).

Figure I presents estimates of the probability of dying by age 5, ${}_5q_0$, derived by indirect methods for various dates before each of the three most recent censuses and the three surveys mentioned above. Each estimate is calculated from the data corresponding to one five-year age group of women. The age groups used to derive the estimates in the figure are 20-24, 25-29, 30-34, 35-39 and 40-44. In all cases, the model life-table used is the North family of the Coale and Demeny models (1966). The selection of the appropriate model life-table was based on the relationship between infant mortality, ${}_1q_0$, and the probability of dying between exact ages 1 and 5, ${}_4q_1$. The relationship between the direct estimates of ${}_1q_0$ and ${}_4q_1$ appears to be similar to the corresponding relationship in the North family of model life-tables, according to the Kenya Fertility Survey.

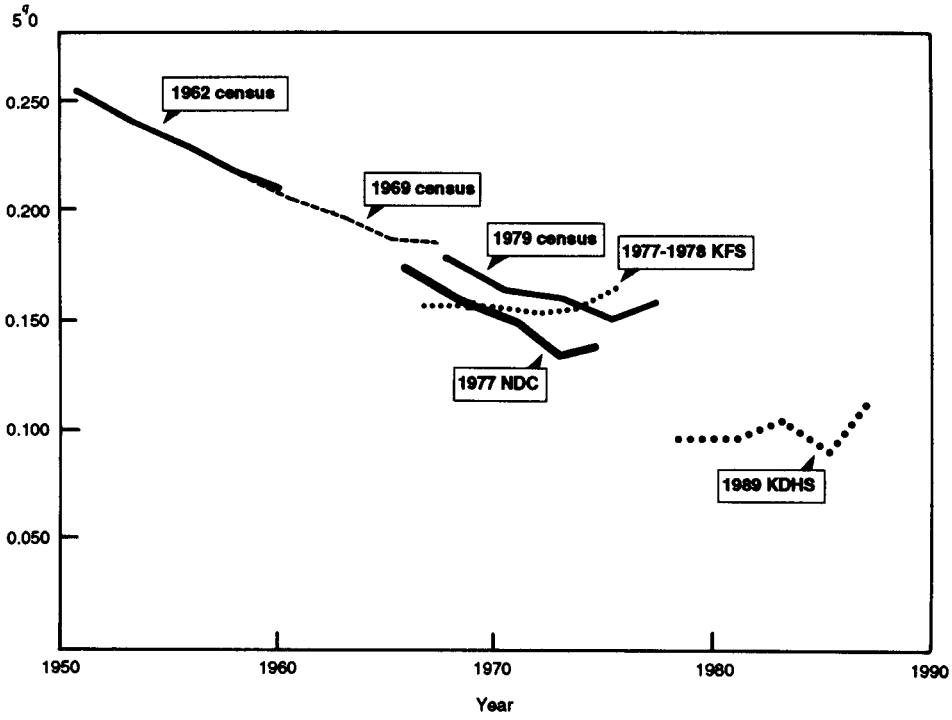
Figure I shows that since the early 1950s, ${}_5q_0$ has been declining steadily and significantly, from a level of approximately 250 deaths per 1,000 live births in 1950 to a level close to 100 in the 1980s. The figure also reveals some discrepancies in the ${}_5q_0$ estimates obtained from the censuses, on the one hand, and those obtained from the various surveys, on the other. The survey estimates of ${}_5q_0$ tend to underestimate the level of child mortality and appear not to represent the true trends. More specifically, NDS yielded ${}_5q_0$ estimates that are systematically lower than the census estimates, indicating some systematic underreporting of child deaths in that survey. In the KFS data, the implied trend in ${}_5q_0$ is inconsistent with the trend implied by the censuses and the 1977 NDS. Such inconsistency is likely to be due to incompleteness in the reporting of live births and child deaths, especially by older women, coupled with age-misreporting in KFS. In fact, the quality of age-reporting in KFS was classified as "unacceptable" by Goldman, Rutstein and Singh (1985) in their evaluation of the quality of data collected by the World Fertility Survey programme in all participating countries. The trend implied by the KDHS estimates is inconsistent with that implied by the 1979 census; again, this discrepancy may be due to incompleteness in the reporting of live births and child deaths by older women, coupled with age-misreporting.

B. DIFFERENTIALS IN CHILD MORTALITY: DATA AND METHODS

Sources of data

The data for the following regression analysis of differentials in child mortality are provided by the

Figure I. Trends in the probability of dying by age 5, Kenya, 1950-1989



Source: Estimated from Kenneth Hill, unpublished analysis based on data from the 1962, 1969 and 1979 censuses, the 1977 National Demographic Survey and the 1977-1978 Kenya Fertility Survey; and *Kenya Demographic and Health Survey, 1989* (Nairobi, Ministry of Home Affairs and National Heritage, National Council for Population and Development; and Columbia, Maryland, Institute for Resource Development/Macro Systems, Inc., 1989).

NOTE: KDHS = Kenya Demographic and Health Survey; KFS = Kenya Fertility Survey; NDS = National Demographic Survey.

Kenya Fertility Survey of 1977-1978. In this survey, 8,100 women aged 15-49 were interviewed. The KFS sample is representative of 95 per cent of the total population of Kenya, because some districts were not covered. Those areas omitted were North-Eastern Province, the districts of Marsabit and Isiolo in Eastern Province and the districts of Samburu and Turkana in Rift Valley Province. Although these districts cover a large area of Kenya, they contain only an estimated 5 per cent of the total population (Kenya, 1980/81).

The KFS questionnaire included questions on the numbers of children ever born to each woman and the number surviving. These data were used in this analysis of socio-economic differentials in child mortality. The quality of the data on children ever born and those surviving is discussed above. The evidence indicates some underreporting of live births and of deaths, especially by older women. Such underreporting leads to underestimates of child mortality, particularly when the estimates are derived from data pertaining to older women. Other studies (Goldman, Rutstein and Singh,

1985; and Mott, 1982) have examined differentials in child mortality. Even though differential underreporting cannot be totally excluded, differentials in mortality estimates by sex of the child, parity, age of the mother at birth, educational level of the mother and region appear to be internally consistent.

Methods

Estimation procedure

In order to estimate the mortality indicator, M, several steps were involved. First, indirect estimates of child mortality were derived from the data on children ever born and children surviving pertaining to all women in age groups 15-19, 20-24, 25-29, 30-34 and 35-39. The Trussell variant of the Brass method (United Nations, 1983) was used, and the North family of the Coale and Demeny model life-tables was selected as the standard pattern of mortality (Coale and Demeny, 1966). The national standard estimate of the probability of dying by age 5, ${}_5q_0$, obtained through this procedure is 149 per 1,000; this estimate roughly represents the mortality conditions prevailing around 1974.

In the second step, the expected proportions of children dead, by age group of the mother, were calculated by applying in reverse the multipliers designed to estimate probabilities of dying from proportions of children dead. Lastly, the mortality indicator, M, for each woman is derived from the ratio of the observed to the expected proportion of children dead among her children ever born. In the analyses, each observation was weighted by the total number of children ever born to the woman, in order to treat live births, rather than the woman, as the unit of analysis. The bivariate analysis, multiple regression analysis and analysis by risk group use M as the dependent variable. The analysis is based on the reports by women aged 15-39 for whom information on the covariates of interest was available.

Independent variables

In addition to the demographic data on fertility and child mortality, KFS collected a variety of background characteristics for each respondent. These characteristics include a number of socio-economic variables, some of which were selected for this study because of their major importance as determinants of child mortality: place of residence; mother's education; father's education; religion; and ethnicity. All the variables used in this analysis are categorical. The reference categories selected were those with the lowest expected child mortality. A brief description of each of these variables follows.

Place of residence is classified into three categories: rural areas (fewer than 2,000 inhabitants); urban areas (2,000 or more population, excluding Nairobi and Mombasa); and large urban areas (Nairobi and Mombasa).

The educational level of the respondents is measured in number of years of schooling. Those who reported not having had any formal schooling are classified as having no education. The remaining respondents are divided into three groups: 1-6 years of schooling, 7-10 years and 11 or more years. These groups roughly correspond to the standard primary, middle and secondary levels ordinarily used in studies of this type. The categories of educational level used here are the same for fathers and for mothers.

The people of Kenya can be divided into four religious groups, namely, Protestant, Catholic, Muslim and others. According to KFS, these groups constitute 53, 36, 5 and 6 per cent, respectively, of the sampled population.

Although there are many ethnic groups in Kenya, they may be classified into a small number of groups on the basis of cultural practices and language. For the purpose of the present study, the three largest ethnic groupings are identified: Kikuyu (25 per cent of the KFS population sample); Luo (18 per cent); and Luhya (15 per cent). The remaining ethnic groups constitute 42 per cent of the population (Kenya, 1980).

C. SOCIO-ECONOMIC DIFFERENTIALS IN CHILD MORTALITY: RESULTS

Bivariate and multivariate results

The results of the analysis of socio-economic differentials in child mortality in Kenya around 1974 are given in tables 1 and 2. Table 1 presents estimates of the probability of dying by age 5, ${}_5q_0$, for each category of each independent variable, and the relative mortality risk associated with being in a category other than the reference category for that variable. In table 1, only the gross effect of each variable is considered; there is no multivariate control. Table 2 presents the proportions of the population at risk in the KFS sample, for each category of each variable, and the multivariate regression coefficients showing the net effect of each variable, that is, the effect each variable has on child mortality after controlling for once the effects of all other variables in the model. The regression coefficients express the excess mortality risk associated with a category in relation to the risk of the reference category of the variable. The results for each factor under consideration are described below.

Place of residence

The category "large urban areas" was selected as the reference category for place of residence. Both the bivariate and the multivariate analyses show that child mortality is slightly lower in smaller towns than in large cities. In contrast, child mortality in rural areas is higher than in large urban areas, even when the effects of other factors are controlled. It should be noted that the vast majority of the population at risk is concentrated in rural areas, which constitute the place of residence with the highest mortality risks.

Mother's education

Education is measured by the number of years of schooling completed. The results presented in tables 1 and 2 point out the importance of the mother's education in determining child mortality in Kenya. Children of women with fewer than 11 years of schooling have an increased risk of dying, as there is an inverse relationship between the level of maternal education and the child's mortality risk. The gross effect of the mother's education can be seen in table 1. Children whose mothers had no schooling (half of the children in the sample) have a risk of dying that is more than twice as high as that of children whose mothers had 11 or more years. Children whose mothers had from one to six years of schooling have a mortality risk almost twice as high as that of children in the reference category, and for children whose mothers had from 7 to 10 years the risk of dying is almost one and a half times as high as that of children in the reference category. This gradient in the mortality risks for children persists in the multivariate analysis.

Father's education

Tables 1 and 2 show that in Kenya, the educational level of the father is equally determinant of child mortality. The relative risks of dying and the

TABLE 1. ESTIMATES OF THE PROBABILITY OF DYING BY AGE 5 AND RELATIVE RISKS, BY SELECTED SOCIO-ECONOMIC CHARACTERISTICS, KENYA, 1974

Socio-economic characteristic	*Probability of dying by age 5* ${}_5q_0$	*Relative risk*
Place of residence		
Rural	0.160	1.2
Urban	0.122	0.9
Large urban	0.132	1.0
Mother's education (years)		
None	0.180	2.4
1-6	0.141	1.9
7-10	0.105	1.4
11 or more	0.074	1.0
Father's education (years)		
None	0.189	2.3
1-6	0.164	2.0
7-10	0.134	1.6
11 or more	0.083	1.0
Ethnicity		
Luo	0.230	2.2
Luhya	0.171	1.6
Others	0.135	1.3
Kikuyu	0.106	1.0
Religion		
Protestant	0.142	0.9
Muslim	0.182	1.2
Others	0.163	1.1
Catholic	0.153	1.0

TABLE 2. MULTIVARIATE COEFFICIENTS AND DISTRIBUTION OF THE POPULATION AT RISK, KENYA, 1974

Socio-economic characteristic	*Regression coefficient*	*Distribution of the population at risk*
Place of residence		
Rural	0.155	0.825
Urban	-0.008	0.071
Large urban	[a]	0.104
Mother's education (years)		
None	0.329	0.498
1-6	0.129	0.323
7-10	0.077	0.162
11 or more	[a]	0.017
Father's education (years)		
None	0.348	0.269
1-6	0.239	0.308
7-10	0.136	0.345
11 or more	[a]	0.078
Ethnicity		
Luo	0.848	0.162
Luhya	0.511	0.150
Others	0.068	0.440
Kikuyu	[a]	0.248
Religion		
Protestant	-0.091	0.534
Muslim	0.095	0.045
Others	..	0.059
Catholic	[a]	0.362
$R^2 = 0.054$		

NOTE: All coefficients are significant at the 5 per cent level.
[a] Reference category.

multivariate regression coefficients for mother's and father's education show similar gradients. The magnitude of the effects is also relatively similar; however, the excess mortality associated with 1-10 years of schooling is higher in the case of paternal education than for maternal education.

Ethnicity

The association of ethnicity with infant and child mortality in Kenya is considerable and significant. The gross effects presented in table 1 show that ethnic background can largely influence the probability of dying of children; the multivariate results presented in table 2 emphasize the importance of these differentials. In fact, when the effects of the other factors are controlled, ethnicity becomes the factor exhibiting the largest differentials. Children of the Luo group have the highest mortality risks, followed by those of the Luhya group. Children of the Kikuyu group have the lowest mortality risks.

Religion

Differences in child mortality by religious groups are observed in Kenya. Children whose parents report themselves as Protestants have the lowest mortality risks, followed by children of Catholic parents and by those of Muslim parents. The multivariate results presented in table 2 show that, among the five factors under consideration in this study, this factor produces the smallest differentials.

Risk groups

Target groups for implementation of health policies can be identified by subdividing the population at risk into lower and higher risk groups according to their socio-economic characteristics. Various combinations of variables can be used to define subgroups for which average child mortality can be calculated using the mortality indicator, M. The subgroups can then be pooled into larger risk groups according to their value of, M. For this study, five risk groups were defined according to the following values of M: greater than 1.5, highest risk; 1.2-1.5, high risk; 0.8-1.2, intermediate risk; 0.5-0.8, low risk; less than 0.5, lowest risk.

Table 3 includes four of the child mortality risk groups identified using this method, according to two socio-economic characteristics: place of residence; and mother's education. For each of these risk groups, the probability of dying by age 5 corresponding to the level of the mortality indicator, M, is presented. The risk is in relation to that of the lowest risk group is also given, as well as the percentage distributions of the populations at risk (women aged 15-39 years and the live births they had had) within the total sample and within each risk group. Table 3 shows that close to one half of the live births are in the high-risk group; this group consists of children of women who had had no formal schooling and were living in rural areas. In order to be in the low-risk or lowest risk group, children must have a mother with at least seven years of schooling. The mortality risk of the high-risk group (the highest shown in table 3) is close to four times that of the lowest group, that of the

TABLE 3. CHILD MORTALITY RISK GROUPS AND POPULATION AT RISK, BY PLACE OF RESIDENCE AND MOTHER'S EDUCATION, KENYA, 1974

Socio-economic characteristic		*Child mortality*		*Percentage within country*		*Percentage within rank*	
Place of residence	*Mother's education (years)*	*Probability of dying by age 5* $_5q_0$	*Relative risk*	*Women aged 15-39*	*Live births*	*Women aged 15-39*	*Live births*
Total	-	0.149	..	100	100	-	-
High risk	-	0.183	3.7	31	44	100	100
Rural	0	..	..	..	..	100	100
Intermediate risk	-	0.144	2.9	41	38	100	100
Rural	1-6	..	..	..	..	68	71
Rural	11+	..	..	..	..	6	1
Urban	0	..	..	..	..	5	5
Urban	1-6	..	..	..	..	6	6
Large urban	0	..	..	..	..	8	10
Large urban	1-6	..	..	..	..	7	7
Low risk	-	0.105	2.1	24	16	100	100
Rural	7-10	..	..	..	..	70	67
Urban	7-10	..	..	..	..	13	15
Large urban	7-10	..	..	..	..	17	18
Lowest risk	-	0.049	1.0	3	1	100	100
Urban	11+	..	..	..	..	33	33
Large urban	11+	..	..	..	..	67	67
Residual groups	..	..	1	1	..	..	

NOTE: The highest risk group is not shown in table 3 because no group had M greater than 1.5.

intermediate-risk group is close to three times as high and that of the low-risk group is twice as high as that of the lowest group. The lowest risk group consists of children of highly educated mothers (11 or more years of schooling) who live in urban areas. This group includes only 1 per cent of the births and 3 per cent of the women. Other combinations of two variables were tested; all underscore the role of maternal and paternal education as primary determinants of child mortality in Kenya.

D. SUMMARY AND DISCUSSION

This study covers the trends and socio-economic differentials in child mortality in Kenya. Since the early 1950s, child mortality has declined substantially, from a level of approximately 250 per 1,000 in 1950 to a level close to 100 per 1,000 in the 1980s. Data from the 1977-1978 KFS were used to examine differentials in child mortality among socio-economic and cultural groups. The type of place of residence, maternal and paternal education, ethnicity and religion were found to have significant effects on child mortality. Children who live in rural areas and whose parents have little or no education are more likely to die at an early age than are children who live in urban areas and whose parents have secondary or university education.

The effects of education on child mortality are larger than the effects of place of residence. A gradient is observed in the educational differentials: each increment in educational level is associated with a lower probability of dying. Maternal education and paternal education have similar impacts on child mortality and remain significant when controlling for other factors. Thus, the effects of each parent's education are independent of one another; this finding, in turn, suggests that each factor produces its effects through a different set of proximate determinants of child mortality.

The multivariate analysis of the KFS data reveals large ethnic differentials in child mortality. These

differentials persist after controlling for the effects of such important factors as parental education and place of residence, indicating that ethnic differentials may be the product of cultural differences in child-rearing practices existing independently of educational differences among the ethnic groups. Moreover, these ethnic differentials emphasize the importance of ecological conditions in determining child mortality. Indeed, the various ethnic groups identified in this analysis tend to be concentrated in regions that differ significantly in climate and geography. Variations in mortality observed among different ethnic groups may thus reflect geographical or climatic conditions (and hence prevalence of such diseases as diarrhoea and malaria) as well as cultural factors and availability of health services.

Religious differentials in child mortality, albeit of a small magnitude, also exist in Kenya. Although religious differentials are generally not subject to policy implementation, the differentials by place of residence, parents' education and ethnicity point to the importance of taking those factors into consideration in the design and implementation of health policies for children.

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IV. COSTA RICA

Hugo Behm and Arodys Robles Soto***

This case study of Costa Rica reviews trends in mortality differentials at early ages in relation to certain social risk factors, such as place of residence, mother's and father's education and socio-occupational group, and to the populations exposed to those risks. Particular attention is paid to the relationship between those factors and the remarkable decline in child mortality in Costa Rica between 1970 and 1980. As background for the analysis, the discussion covers relevant aspects of the social and economic context in Costa Rica, as well as trends in infant and child mortality during the 1970s and 1980s and their possible determinants. Using data from the 1973 and 1984 Costa Rican censuses, the trends in child mortality are studied for various socio-economic groups. Risk groups are identified on the basis of combined socio-economic characteristics. Multiple regression analysis is then used to examine the process of change in early-age mortality by social group. The chapter ends with a discussion of the implications of the results for child survival policy.

A. ECONOMIC AND SOCIAL CONTEXT OF COSTA RICA

Population and geography

Costa Rica is a small Central American country with an area of 51,000 square kilometres and a population estimated to be 2.9 million in 1989 (Centro Latinoamericano de Demografía, 1989). The mountain chain that forms the backbone of the country from north to south gives way to a broad central valley, 1,000 metres high, which is the focus of development. It contains almost two thirds of the population and is the main centre for industrial development and for the provision of public services. The two coastal slopes, one to the Pacific and the other to the Atlantic, enjoy a tropical climate and produce the main exports, bananas, cane-sugar and cattle. Coffee, the major crop, is cultivated in most of the remaining territory.

The majority of the population are of predominantly Spanish ancestry. In the eastern province of Limón, which has a lower standard of living, a small black minority are engaged in banana-growing. Even smaller minorities of indigenous origin live in the mountainous region of the country. According to the 1984 census of Costa Rica, 37 per cent of the population were under 15 years of age.

Noticeable progress in reducing overall mortality had raised life expectancy at birth to 74.3 years by 1984, a level comparable to that of Western Europe or the United States of America. Fertility, which was cut by half between 1965 and 1975, has stabilized in the period 1980-1985, the total fertility rate was estimated to be 3.5 children per woman (CELADE, 1987). These trends have resulted in continued population growth, with an annual growth rate of 2.6 per cent for the period 1985-1990 (CELADE, 1988).

Economic and social development

This section summarizes the recent trends in the economic and social development of Costa Rica, drawn from the analyses carried out by Fallas (1982) and Rovira (1983), respectively. Table 4 presents a synthesis of socio-economic indicators for the period 1970-1980 (Rosero, 1985).

In 1948, the former agricultural-export system was replaced by an import-substitution system geared towards promoting development and modernizing the economy by diversifying production and giving priority to the industrial sector. The banks were nationalized, the army was disbanded and the country entered the Central American Common Market.

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TABLE 4. SOCIO-ECONOMIC INDICATORS, COSTA RICA, 1970-1980

Indicator	*1970*	*1980*	*Percentage change 1970-1980*
Economic			
Gross domestic product per capita (1970 dollars)	656	876	+33
Foreign trade per capita (1970 dollars)	316	553	+75
Dwellings with electricity (percentage)	65	79	+22
Communications			
Telephones per 100 inhabitants	23	70	+304
Dwellings with television (percentage)	20	79	+295
Social			
Percentage of children aged 15-19 attending primary or secondary school	61	70	+15
Illiteracy (percentage among ages 15 or over)	13	10	-23
Economically active population with social insurance	38	68	+79
Sanitation			
Percentage of population with:			
Piped water	75	84	+12
Sanitary services or latrine	86	93	+8
Health			
Life expectancy at birth (years)	65.4	72.6	+11
Public expenditure on health as percentage of gross domestic product	5.6	7.4	+32
Physicians (per 10,000 population)	5.6	7.8	+39
Physician visits per capita	2.0	2.9	+45
Institutional deliveries (percentage)	70	91	+30
Deaths with medical certificate (percentage)	71	84	+18
Population with health insurance (percentage)	39	78	+100

Source: Luis Rosero Bixby, "Determinantes del descenso de la mortalidad infantil en Costa Rica", in *Demografía y Epidemiología en Costa Rica* (San José, Costa Rica, Asociación Demografía Costarricense, 1985).

During the 1970s, after a period of marked economic and social growth, the economy entered a crisis and began to falter. This slow-down was attributed to the fact that the process of industrialization, controlled by a few, was very dependent upon external capital, input and technology. Furthermore, agricultural development was stagnating; landownership became increasingly concentrated and its productivity remained low. The situation in Costa Rica was aggravated by the oil price crisis and the worsening of the terms of trade. The servicing of an enormous external debt has seriously hampered efforts to overcome the crisis.

A firm political decision to spread the benefits of development among the population has been very successful and has facilitated the social and geographical integration of the country. Most dwellings have been provided with electricity, water and communications services. The adult population on the whole has at least completed primary education or has gone on to a higher level. Table 4 indicates that these advances continued during the decade under study.

The health sector has been particularly successful and is very germane to the issue being analysed. In 1973, laws were enacted which facilitated integration and coordination of the institutions in the health sector, extending social security coverage and increasing the funds allocated to the sector (Sáenz, 1983). The improvement in the indicators for resources, services and coverage is shown in

table 4. The Rural Health Programme merits attention for its impact on child survival: since 1973, a marked expansion of primary health care among the rural population has been achieved, especially in the most isolated areas, where infant and child mortality were relatively high (Muñoz, Rosero and Cabrera, 1985).

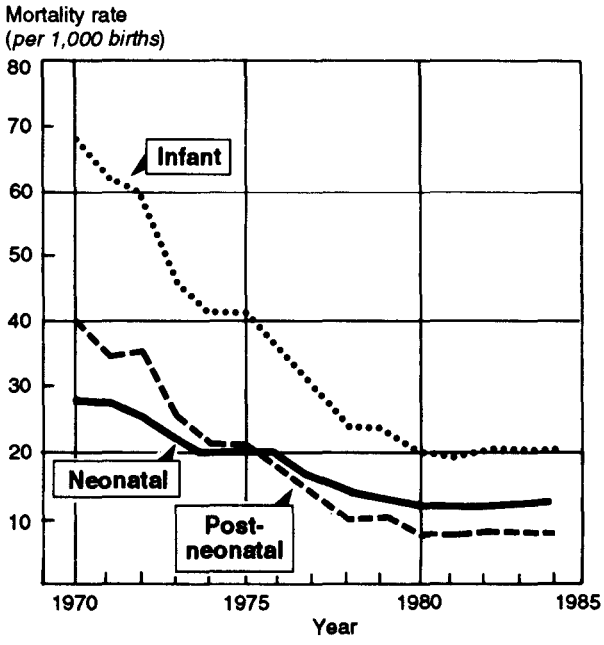
Despite all these improvements, several socio-economic differentials have persisted in child mortality. Trejos and Elizalde (1985) found that the 50 per cent of the population with lower incomes receive only 20.1 per cent of the total income, whereas the richest 20 per cent receive 51.8 per cent of the total. The poorest 20 per cent have a higher rate of unemployment and less access to social security, and of these, 64 per cent live in rural areas.

Trends in child mortality

Since 1920, the infant mortality rate has fallen by an average of 2.3 per cent per annum. In 1970 the infant mortality rate was still estimated to be over 60 per 1,000, four times that of the economically most advanced countries. The decline during the 1970s was extraordinary, averaging 12.9 per cent per annum, bringing the rate down to 20 per 1,000 in the period 1980-1984 (figure II). The average annual reduction between 1973 and 1980 was greater for post-neonatal mortality (17.2 per cent) than for neonatal mortality (8.7 per cent), as frequently happens when infant mortality declines, because post-neonatal mortality is due to more easily preventable causes (Rosero, 1985). A similar trend may be observed in the mortality of children aged 1-4 years, whose rates fell from 6.4 per 1,000 in 1965 to 2.1 per 1,000 in 1975 and to 0.7 per 1,000 in 1985 (Behm and Robles, 1988).

In a recent study (Behm, Granados and Robles, 1987), the decline in infant mortality in the 1970s is shown to have occurred in all social groups. As of 1981, however, some differentials persisted in infant mortality rates among social groups. The groups at higher risk in 1981 consisted primarily of agricultural workers, low-income farmers and manual workers. In these groups, the mother had not completed primary education. In contrast, the groups at lower risk consisted mainly of the middle class and manual workers and other farmers, but in those groups, the mother had in most cases received some secondary education. It is interesting to note that even after controlling for the effects of such characteristics as occupation and educational level, infant mortality was shown to be higher among families living in low-grade housing.

Figure II. Trends in infant mortality, Costa Rica, 1970-1984



Source: Hugo Behm Rosas, Damaris Granados Bloise and Arodys Robles Soto, *Costa Rica: los grupos sociales de riesgo para la sobrevida infantil, 1960-1984*, Series A, No. 1049 (San José, Costa Rica: Centro Latinoamericano de Demografía; Costa Rica, Ministerio de Salud; and Universidad de Costa Rica, 1987).

The study of causes of infant mortality indicates that the fall in infant mortality was brought about largely by a decline in deaths due to diarrhoea and severe respiratory infections. To a lesser degree, it was linked to reduced complications during pregnancy and childbirth, infectious diseases preventable by vaccination and improved nutrition. A comparison of the 1984 level of infant mortality with that of the United States indicates that almost 40 per cent of the infant deaths in Costa Rica were

in excess of the level found in the United States. Of this excess, 14 per cent were due to infectious diseases (principally diarrhoea), 22 per cent to severe respiratory infections and 33 per cent to diseases peculiar to the perinatal period (Behm and others, 1987).

This causal pattern indicates that the continuing excessive infant mortality in Costa Rica involves two very distinct problems. On the one hand, some high mortality persists from the past, caused largely by infections, for which effective measures for prevention and treatment are available. These causes clearly predominate among minority groups living in poor conditions, where the infant mortality rates are higher. On the other hand, some causes, such as perinatal diseases, which are also predominant in the economically more advanced countries, which are more difficult to control and require expensive medical technology. These latter causes have now become the major factors.

In a multivariate regression analysis of the decline in infant mortality between 1972 and 1980, Rosero (1985) shows that improved health care, especially primary health care, has been crucial in determining the infant mortality level. Progress in socio-economic development during that period apparently accounted for 22 per cent of the decline in infant mortality rates, while improved health care accounted for 73 per cent of the decline.

The most significant aspect of the trends since 1980, a period of economic crisis, is the lower rate of decline in infant mortality. The rates levelled off at an average of 18 per 1,000 during the period 1980-1987. The levelling-off of the decline is evident in both neonatal and post-neonatal mortality and has been recorded in all regions of the country. In 1988, however, a decline to 14.7 per 1,000 was observed (Costa Rica, 1989). This level is relatively low for Latin America but is still significantly higher than the level reached by the most highly developed countries.

B. Data and methods

Sources of data

The present study is based on two 10 per cent random samples of the national population censuses carried out in 1973 and 1984. The study focuses on women aged 15-34 years who were not residing in collective dwelling units and who reported having had at least one child. Only those women who were married to the head of household (formally or consensually) were used for the analysis, which made it possible to assume that, in most cases, the husband was the father of the children reported. The 1973 sample included 11,301 women who reported 40,077 live births; the corresponding figures for 1984 are 17,658 and 45,476.

The study population's representativeness with respect to the original sample (in which household heads also included grandfathers, uncles and others) was examined. It was found that the group selected for this study had a slight excess (fewer than 5 per cent) of children falling into the groups with higher child mortality (namely, low level of maternal education and rural residence). Therefore, the population selected for this study may have slightly higher child mortality than the average population.

Methodology

Estimation method

The mortality indicator, M, used as the dependent variable in these analyses was calculated following the general procedure outlined in chapter II. In the case of this study, some specific steps were taken.

In order to obtain a standard schedule and level of mortality for calculation of the expected proportions of children dead by age of the mother, indirect methods were used. For all women in age groups 15-19, 20-24, 25-29 and 30-34, estimates of mortality were obtained from data on children ever born and children who had died (irrespective of marital status). The West family of the Coale and Demeny (1966) model life-tables was used as the standard schedule. The level of mortality was determined by averaging the levels obtained for each age group of women, the weights being the total number of children ever born in each age group. Adjustment factors were then calculated following the method described in Trussell and Preston (1982). The expected proportions dead by age group of the women were then calculated by applying those adjustment factors in reverse to the probabilities of dying corresponding to the standard

schedule and level of mortality. For each woman currently married to the head of her household, the value of M, the mortality indicator, is the ratio of her observed proportion of children dead to her expected proportion, given her age group. Because the women selected for this study are under 35 years of age, the periods of reference for the mortality estimates obtained from the two censuses are centred on 1968 and 1979.

Throughout the presentation of the findings of this study, it is not the values of the mortality indicator that are presented but the probabilities of dying by age 5, ${}_5q_0$, corresponding to the levels of the mortality indicator. Those probabilities were obtained by adjusting the national average ${}_5q_0$ for the period under consideration, following the procedure described in chapter II. The national average probabilities, corresponding to 1968 and 1979, were obtained not from the indirect estimates described above but by interpolation of the life-tables derived directly from national vital registration data (for the life-tables, see Costa Rica, 1988).

The indirect estimates were evaluated as satisfactory for the 1973 census. For the 1984 census, a bias in the reporting of number of children ever born and number of surviving children led to an overestimation of mortality. As this bias affects both the numerator and the denominator of the mortality indicator, it is unlikely that its value is affected significantly. It is assumed that the overestimation is similar in the various population subgroups defined by the variables under study.

Independent variables

The problems involved in the analysis of the determinants of child mortality are discussed in chapter I. In studies based on population censuses, analysis is limited by the absence of information essential to its interpretation, such as social context, use of health services, morbidity and cultural factors). For this reason, the analysis is usually limited to hypotheses concerning the nature of the observed relationships between the independent variables and mortality. The socio-economic characteristics that are used as independent variables in this study of Costa Rica are father's occupation, mother's and father's education and degree of urbanization of the place of residence.

Social classes are defined by the role of the head of household in economic production. These roles differ according to both the nature of the work performed and the consumption permitted by the income thus generated. Differing material living conditions in the household are associated with social class, which influences, positively or negatively, the health-sickness process of the child. The Costa Rican census provides data on occupation; therefore, the occupational status of the household head is used as an indicator of social class. Four significantly distinct occupational categories are defined (see annex to this chapter). The first two groups consist of persons involved in agricultural production. Farmers, who work their own land without paid help, have been distinguished from agricultural wage-earners, who work on someone else's land for wages. Both groups live in an economically less developed context characterized by unfavourable living conditions; they are seldom organized as workers and experience unequal access to landownership.

Non-agricultural manual workers constitute the third and major group. They are primarily involved in industrial activities, but some are in service industries. They have a relatively high standard of living, usually live in urban areas and have high membership rates in trade union organizations. Those in the fourth group, the middle class, enjoy better socio-economic conditions; they live mainly in the cities, especially the capital. In addition to the traditional *petite bourgeoisie*, this group includes professionals and technicians, and public and private employees occupied in non-manual activities, basically in the areas of trade and services. A residual group consists of persons whose occupation could not be classified.

The roles of paternal and maternal education in determining child mortality are described in chapter I. For this study of Costa Rica, four educational categories were defined for both the mother and the father: illiterate (no schooling at all); incomplete primary education (from one to five years of schooling); complete primary education (six years); and secondary or higher education (seven or more years). For some of the analyses

TABLE 5. MORTALITY IN THE FIRST FIVE YEARS OF LIFE, BY SOCIO-ECONOMIC CHARACTERISTICS, COSTA RICA, 1968 AND 1979

Socio-economic characteristic	*Probability of dying by age 5 (per 1,000 births)*			
	1968	*1979*	*Absolute difference, 1968-1979*	*Percentage difference, 1968-1979*
Total	74.7	23.2	-51.5	-69
Father's occupation				
Agricultural wage-earner	106.4	31.9	-74.5	-70
Farmer	83.4	30.0	-53.4	-64
Manual worker	69.6	22.8	-46.8	-67
Middle class	41.4	13.5	-27.9	-67
Unclassified	77.1	28.4	-48.7	-63
Father's education (years)				
Zero to five	90.5	34.9	-55.6	-61
Six	57.5	20.9	-36.9	-64
Seven or more	34.6	13.3	-20.8	-60
Mother's education (years)				
Zero to five	91.1	36.7	-54.4	-60
Six	56.0	20.9	-35.1	-63
Seven or more	33.5	13.0	-20.5	-61
Place of residence				
Rural	87.3	27.1	-60.2	-69
Other urban	61.0	21.4	-39.6	-65
Capital	49.5	17.0	-32.5	-66

presented below, the first two categories were grouped together.

The degree of urbanization of the place of residence is the fourth socio-economic characteristic examined in this study. It is broken down into three categories: the capital of the country; other urban areas (defined as administrative centres of districts); and rural areas. These three categories represent different social and economic contexts, even in a country as small as Costa Rica. Industrial development, public services, financial and commercial activity tend to be concentrated in the urban sector, in particular, at the capital. Living conditions and access to social services are better in those urban sectors.

In the regression models, the reference category selected for each independent variable is the category with the lowest level of child mortality.

C. DIFFERENTIALS IN CHILD MORTALITY BY SOCIO-ECONOMIC GROUP

General trends

Table 5 shows the probabilities of dying by age 5 in 1968 and 1979 for each of the socio-economic groups under study. Given that the socio-economic characteristics considered here are to some extent intercorrelated, the association between each characteristic and child mortality is confounded when examined separately, as is the case in table 5.

The differentials and their trends are similar in all the subpopulations. In 1968, the national probability of dying by age 5 was estimated to be 74.7 per 1,000 live births and the contrasts between social groups were very marked. Agricultural employment of the father, low parental education and residence in rural areas are

associated with probabilities of dying by age 5 of over 80 per 1,000. The groups living in better socio-economic conditions already had, in 1968, levels of under-five mortality close to 40 per 1,000.

Eleven years later, under-five mortality had decreased to 23.2 per 1,000 at the national level. The decline took place in all groups and was greatest in the groups with the largest initial risks, so that, in absolute terms, the contrasts between social groups were reduced by 1989, even when the relative risks for different categories of the same variable remained relatively constant. Some relative differences between groups were reduced as well. For example, children of agricultural wage-earners, who in 1968 had the highest mortality, reached a level similar to that for children of farmers by 1979. The gap was also reduced between children of fathers who had completed their primary education and those whose fathers had attained higher education.

In spite of these considerable advances, the under-five mortality of the least favoured groups was still in the range of from 30 to 37 per 1,000, a level significantly higher than that reached by children of the middle class and children of more educated parents, which was about 13 per 1,000.

Risk groups

What is the epidemiological picture for child survival in Costa Rica? Which social groups are at greatest risk? What changes have taken place between 1968 and 1979? To answer these questions, 135 subpopulations were created from the cross-tabulation of the existing variables and were regrouped into five risk groups on the basis of their estimated level of mortality calculated from their mean value of M. Tables 6-8 and figure III describe those risk groups.

Table 6 presents, for each risk group, a summary of the relevant information: the estimate of the probability of dying by age 5; the relative risk of dying (in relation to the group with the lowest mortality rate); the proportion of women aged 15-34; and the proportion of live births that made up the group. It appears that the high level of early-age mortality in 1968 was a result of the existence of high risks of death in the groups that provided a majority of the births.

The two higher risk groups, in which the probability of dying by age 5 varies between 73 and 145 deaths per 1,000 births, include 50 per cent of the mothers and, because of their higher fertility, 61 per cent of the births. These groups were composed mainly of agricultural workers (wage-earners or farmers) and, to a lesser extent, of non-agricultural wage-earners in manual occupations (table 7). They are families in which both parents had very little or no education; the majority of them lived in rural communities.

The middle-class groups (professionals, technicians and non-manual wage-earners), in which one or both parents had achieved at least secondary education, had by 1968 advanced much further in the transition towards lower child mortality inasmuch as they were mainly in the lowest risk group (see table 7). Nevertheless this group represented only a minority; it included 20 per cent of the mothers, but because of their lower fertility, they had only 14 per cent of the births.

The substantial decline in child mortality that took place in the following 11 years was due to changes in all the groups and subgroups identified, with greater absolute gains in the groups at greater initial risk (table 8). As a result of the increased concentration of mortality around its mean level, the proportion of births in the highest risk and high-risk groups decreased significantly between 1968 and 1979, from 61 to 29 per cent (figure III). At the end of the 1970s, subpopulations with a probability of dying by age 5 greater than 48 per 1,000 no longer existed, although they had been a majority in the past.

The process of change in child mortality between 1968 and 1979

The multiple regression model described in chapter II was used on the Costa Rican census data to provide estimates of the relationship between mortality and each independent variable, controlling for the influence of the other variables. In this study, the regression coefficients were converted to probabilities of dying between birth and age 5 in

TABLE 6. CHILD MORTALITY RISK GROUPS, COSTA RICA, 1968 AND 1979

Risk group	1968				1979			
	Mortality		Population		Mortality		Population	
	Probability of dying by age 5 $_5q_0$ (per 1,000)	Relative risks[a]	Women aged 15-34 (percentage)	Live births (percentage)	Probability of dying by age 5 $_5q_0$ (per 1,000)	Relative risks[a]	Women aged 15-34 (percentage)	Live births (percentage)
Total	74.7	-	100	100	23.2	-	100	100
Highest	115.7	5.0	20	25	44.5	4.7	14	20
High	84.3	3.7	30	36	33.3	3.5	8	9
Intermediate	65.2	2.8	20	17	24.7	2.6	23	24
Low	49.2	2.1	10	8	16.5	1.7	24	21
Lowest	23.0	1.0	20	14	9.5	1.0	31	26

[a] In relation to the lowest risk group.

order to make them more easily interpretable. The results are presented in table 9. The socio-economic variables considered in this particular analysis are occupation and father's and mother's education.

The numbers in columns (1) and (2) of table 9 represent excess mortality (per 1,000 births) associated with each category of each variable, in relation to the reference category, that of lowest mortality (middle-class occupational group, both parents with intermediate or higher education and resident of the national capital). These estimates of excess mortality were obtained by the following transformation:

$$\text{Excess mortality} = \frac{b_{jk}}{M^T} \; {}_5q_0{}^T$$

where M^T is the mean value of M for the total population under consideration and ${}_5q_0{}^T$ is the estimated probability of dying by age 5 for that population. In order to derive the estimated ${}_5q_0$ for a particular subgroup, the relevant portions of excess mortality have to be added. For example, mortality under age 5 in 1979 for children of agricultural wage-earners, with both parents illiterate, is estimated as:

8.7 + 5.3 + 19.3 + 29.1 = 62.4 per 1,000 births,

where 8.7 is the mortality of the lowest risk group (column (2) of table 9).

The effect of the mortality differentials on the national rate depends upon the distribution of those at risk among the various social groups identified in the study. This information is provided in columns (4) and (5). Accordingly, for example, mortality in excess of 29.1 per 1,000 related to mother's illiteracy in 1979 is not highly consequential because only 5 per cent of the children born belonged to this group. The overall contribution of this group to the national rate is 29.1 x 0.05 = 1.5 per 1,000 (column (8)). It is clear that in Costa Rica, the probability of dying by age 5 is, under this model, the sum of the mortality excesses generated by each risk group, weighted by the proportion of persons exposed in each group, plus the estimated mortality of the reference group.

TABLE 7. COMPOSITION OF RISK GROUPS, COSTA RICA, 1968

Socio-economic characteristics of group				*Percentage within group*	
Place of residence	*Occupation*	*Father's education (years)*	*Mother's education (years)*	*Women aged 15-34*	*Children ever born*
		A. *Highest risk* ($_5q_0$: *91-145*)			
Rural	Agricultural wage-earner	0-5	0-5	86	88
Other	Unclassified	..	..	14	12
		B. *High risk* ($_5q_0$: *73-90*)			
Rural	Farmer	0-5	0-5	30	35
Rural	Manual worker	0-5	0-5	24	24
Urban[a]	Manual worker	0-5	0-5	18	17
Other	Unclassified	..	..	28	24
		C. *Intermediate risk* ($_5q_0$: *54-72*)			
Rural	Agricultural wage-earner	M or F: 0-5		20	20
Rural	Manual worker	M or F: 0-5		16	16
Rural	Middle class	0-5	0-5	10	14
Other urban	Manual worker	M or F: 0-5	13	14	
Other	Unclassified	..	..	41	36
		D. *Low risk* ($_5q_0$: *36-54*)			
All	Manual worker	6	6	43	41
Urban	Manual worker	6+	0-5	15	18
All	Middle class	6+	0-5	16	17
Other	Unclassified	..	..	26	24
		E. *Lowest risk* ($_5q_0$: *22-35*)			
Capital	Middle class	M,F or both: 7+		33	29
Other urban	Middle class	M,F or both: 7+		21	21
Rural	Middle class	M,F or both: 7+		10	9
Capital	Middle class	M,F or both: 0-5[b]		7	10
All	Manual worker	M,F or both: 7+		14	14
Other	Unclassified	..	..	15	17

[a] Capital and other urban areas.

[b] The mother usually had an educational level of seven years or more.

The ideal situation in Costa Rica (and any other country) would be the elimination of excess mortality in each social group, so that all groups would attain the mortality of the reference population (8.7 per 1,000 in 1979). Column (8) shows the structure of excess mortality in 1979; the total excess for that year is 23.6 - 8.7 = 14.9 per 1,000. This figure represents the difference between the observed level and the level that would be observed if the entire population had the characteristics of the reference category. This difference can be disaggregated into the effects of each of the variables included in the model so that the magnitude and structure of the excess mortality which needs to be eliminated can be estimated. These results give an idea of the task that lies ahead, even though it is clear that additional factors not included in this model should also be considered for a policy directed to reducing infant and child mortality.

TABLE 8. COMPOSITION OF RISK GROUPS, COSTA RICA, 1979

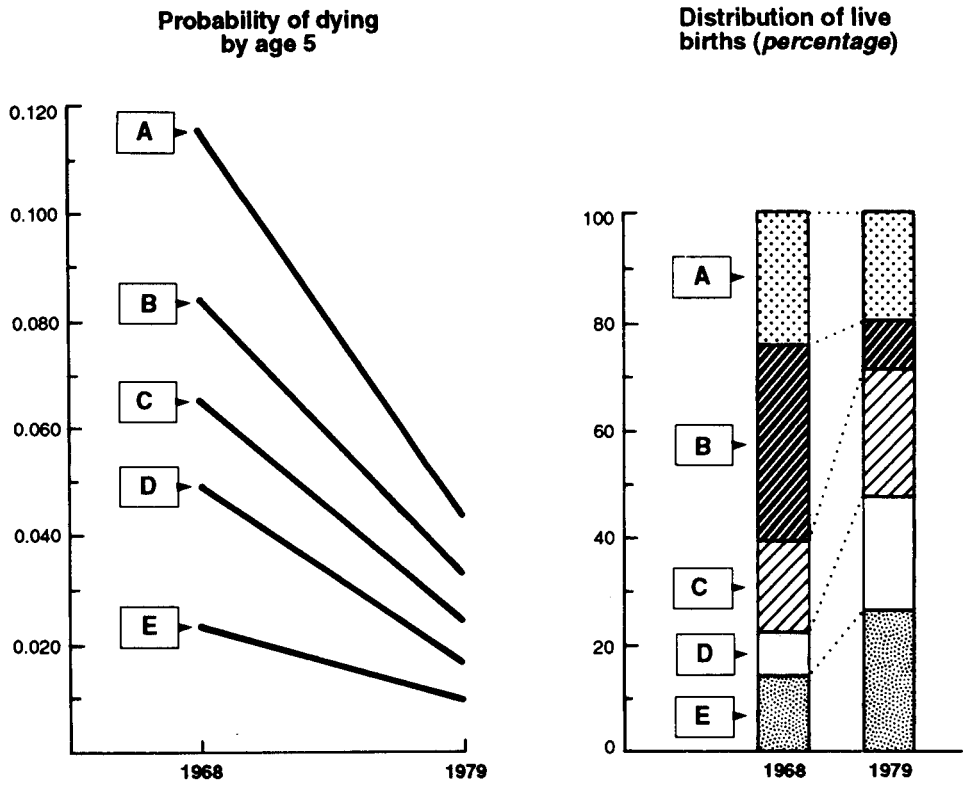
Socio-economic characteristics of group				*Percentage within group*	
Place of residence	*Occupation*	*Father's education (years)*	*Mother's education (years)*	*Women aged 15-34*	*Children ever born*
		A. *Highest risk* ($_5q_0$: *40-48*)			
Rural	Agricultural wage-earner	0-5	0-5	36	37
Rural	Farmer	0-5	0-5	20	22
Other urban	Manual worker	M or F: 0-5		12	11
Other	Unclassified	..	..	32	30
		B. *High risk* ($_5q_0$: *30-39*)			
Rural	Manual worker	M or F: 0-5		54	55
Rural	Farmer	M or F: 0-5		13	14
Capital	Manual worker	M or F: 0-5		19	20
Other				14	11
		C. *Intermediate risk* ($_5q_0$: *21-30*)			
Rural	Agricultural wage-earner	M or F: 0-5		17	18
Rural	Agricultural wage-earner	6	6	13	11
Rural	Farmer	M or F: 0-5		8	8
Rural	Farmer	6	6	9	8
Rural	Manual worker	M or F: 0-5		8	8
Other	Unclassified	..	..	45	47
		D. *Low risk* ($_5q_0$: *12-20*)			
Urban	Manual worker	Both: 6 or M or F: 7+		31	31
Rural	Agricultural wage-earner	6	0-5	7	9
Rural	Middle class	6	6	6	6
Rural	Manual worker	7	7	7	7
Capital	Middle class	M or F: 6, spouse: 7+		8	8
Other	Unclassified	..	..	41	39
		E. *Lowest risk* ($_5q_0$: *7-11*)			
Capital	Middle class	7+	7+	26	25
Other urban	Middle class	M,F or both: 6+		21	21
Rural	Middle class	M,F or both: 7+		14	13
Rural	Manual worker	M,F or both: 6+		19	20
Other	Unclassified	..	..	20	21

The changes that occurred in the epidemiological situation of child mortality between 1968 and 1979, which led to a substantial decline in the mortality rates during that period, are described below.

Father's occupation

In 1968, controlling for the effect of father's education, all occupational groups other than the middle-class group showed excess child mortality; in the case of agricultural wage-earners, it reached a level of 30.9 per 1,000. In 1979, this excess mortality had declined for all groups to an average level of 5 per 1,000. The main changes in the distribution of the population at risk were the decline in the proportion of agricultural wage-earners and the increase of the middle-class group.

Figure III. Child mortality and distribution of births according to risk groups, Costa Rica, 1968 and 1979



Source: Table 6.
NOTE: A = highest risk; B = high risk; C = intermediate risk; D = low risk; E = lowest risk.

The effect of differential risk associated with father's occupation on national child mortality in 1979 is small: 3.7 out of total excess mortality of 14.9 per 1,000. The magnitude of this effect declined by about 10 points between 1968 and 1979, mainly because of the changes in the group of agricultural wage-earners, both in the mortality rates and the proportion of exposed population. The decline in excess mortality is not uniform across categories of paternal occupation.

Father's education

Mortality differentials are larger for the father's education than for his occupation; they reached an excess level of 45 per 1,000 in the case of illiterate fathers in 1968. The decline of the risk levels for each category is notable in the following years; nevertheless, significant differentials between categories remain.

There are important changes in the distribution of exposed population. In 1968, 69 per cent of the live births occurred in families in which the father had not completed primary education, a proportion that declined to 37 per cent in 1979. This change was the main contributor to the decline of the excess mortality associated with paternal education: from 18.0 to 4.5 per 1,000.

Mother's education

The situation in 1968 with regard to the mother's education was similar to that for the father, but the

TABLE 9. MORTALITY UNDER AGE 5 ASSOCIATED WITH SOCIAL RISK FACTORS, COSTA RICA, 1968 AND 1979

Risk factor	Excess mortality			Distribution of live births			Contribution to excess mortality		
	1968 (1)	1979 (2)	Difference (3)	1968 (4)	1979 (5)	Difference (6)	1968 (7)	1979 (8)	Difference (9)
Father's occupation	-	-	-	100	100	-	13.8	3.7	-10.1
Agricultural wage-earner	30.9[a]	5.3[a]	-25.6	27	18	-9	8.3	1.0	-7.4
Farmer	6.6[a]	3.8[a]	-2.8	15	12	-3	1.0	0.5	-0.5
Manual worker	11.4[a]	4.2[a]	-6.8	30	27	-3	3.3	1.1	-2.2
Unclassified	11.4[a]	5.9[a]	-5.5	10	19	+9	1.1	1.1	0.0
Middle class	[b]	[b]	[b]	18	24	+6	0	0	-
Father's education (years)	-	-	-	100	100	-	18.0	4.5	-13.5
None	45.3[a]	19.3[a]	-26.0	18	8	-10	8.2	1.5	-6.6
One to five	16.9[a]	8.3[a]	-8.6	51	29	-22	8.6	2.4	-6.2
Six	7.3[a]	1.8	-5.5	17	31	+14	1.2	0.6	-0.7
Seven or more	[b]	[b]	[b]	14	32	+18	0	0	-
Mother's education (years)	-	-	-	100	100	-	19.5	6.8	-12.7
None	44.5[a]	29.1[a]	-15.4	14	5	-9	6.2	1.5	-4.8
One to five	22.0[a]	13.6[a]	-8.4	54	29	-25	11.9	3.9	-7.9
Six	7.2[a]	4.1[a]	-3.1	19	34	+15	1.4	1.4	0.0
Seven or more	[b]	[b]	[b]	13	32	+19	0	0	-
Lowest risk group	-	-	-	-	-	-	21.5	8.7	-12.8
Total	-	-	-	-	-	-	72.7	23.6	-49.1

[a] Significant at the 5 per cent level.
[b] Reference category.

progress up to 1979 is less noteworthy: the excess mortality for illiterate mothers in 1979 is still high at 29.1 per 1,000. By that time, however, the group had been reduced to a small proportion of the population at risk in the group with incomplete primary education that is the main source of the decline in excess mortality associated with maternal education.

Place of residence

Place of residence (urban/rural) was not included in the analysis because when controlling for the other independent variables, the coefficients for this variable were neither large nor statistically significant. In other words, the urban/rural differentials in child mortality shown in table 5 are in fact related to differences in the other socio-economic characteristics under study here.

It remains true, however, that such differences are important in defining social policies, especially health policies, which are usually formulated for geographically defined populations. In this context, excess rural mortality represents an important aspect of the problem and requires special attention in regional planning policies.

Lowest risk reference group

Table 9 shows that the socially privileged reference group—the lowest risk group—also experienced a considerable decline in under-five mortality, from 21.5 to 8.7 per 1,000.

In 1979, according to this model, 55 per cent of excess mortality over this minimum rate appeared to be related to social characteristics of the fathers (occupation, 25 per cent; education, 30 per cent), while 45 per cent was associated with the mother's education.

Components of the change in mortality, 1968-1979

As is shown in table 9, the decline in mortality under age 5 is a result of both a decline in risk differentials between the social groups and a decrease in the proportion of children belonging to the major risk groups. Both components are important, but in the case of agricultural wage-earners the mortality decline dominated, whereas in the case of mother's education, the reduction in relative size of the low-education group was a major contribution to the overall decline.

It is possible to hypothesize about the origin of the differences in the contribution of each component of the change. During the period under study, the national public-health system extended its coverage to the rural population and it is probable that the effect of this change on the risk of dying in childhood benefited especially the agricultural wage-earners, the group that had at first suffered the highest levels of child mortality. On the other hand, in the 1970s, family planning programmes reached rural areas and thus women with lower education. This factor, together with the overall increase in educational level, could explain the changes found in table 9.

D. SUMMARY AND DISCUSSION

Sufficient note has been taken of the limitations of this analysis owing to its methodology and to the absence from the models of some significant covariates of child mortality. It is equally important to keep in mind that the relationship between mortality and risk factors should be interpreted simply in terms of association, which does not necessarily imply direct causality. In spite of all the limitations, the analysis yields results that are important for policies intended to reduce mortality at early ages.

The analysis indicates that a developing country with characteristics like those of Costa Rica can achieve a significant reduction in child mortality. Within the framework of the historical process of economic and social change, two conditions that existed during this period appear to be important for this achievement: the general improvement in the economic development indicators and the existence of sustained policy directed to a more egalitarian distribution of the social and economic output of that development.

The decline in under-five mortality between 1968 and 1979 had three characteristics: (*a*) it was very sharp, from about 75 to about 23 per 1,000; (*b*) it affected all social groups; and (*c*) the absolute change was larger in the groups that had at first been at greatest risk.

The analysis has identified two components in this process of change in child survival. On the one hand, the largest declines, which occurred in the groups with highest mortality, produced a marked reduction in the absolute differences between groups with respect to child mortality. Figure III shows that the rates for all social groups in 1979 are at the same level as that which, in 1968, was experienced by only 22 per cent of the child population. This is a noteworthy advance towards the goal of more equity and justice as to the right to life for all persons born in Costa Rica.

On the other hand, the distribution of the exposed population over the various categories of each of the risk factors shows a change for the better in the sense that there is an increase in the proportion of births in groups of lower risk. This change has several explanations.

The increase in the level of education of the parents is a result of past policies that extended this social benefit, because most formal education is received prior to parenthood. It is to be hoped that the continued increase in the levels of schooling after 1970 will have a favourable effect on child survival in the 1980s and beyond, when the new generations reach child-bearing age.

The changes in occupational structure and the process of urbanization are not the result of specific policies but rather of general characteristics of the development process. In any case, they have contributed to a more favourable distribution of the population at risk.

Lastly, the decline in fertility, which began in 1965 in the urban groups with the highest education, was extended in the following decade to the vast majority of the population. In this way, it

contributed to reducing the proportion of births occurring in the social groups with the highest child mortality, which were also those with the highest fertility.

As has already been stated, it was shown that an important part of the child mortality decline between the two most recent censuses was owing to the increase of coverage of the public-health system, mainly as a result of a programme of primary health care especially geared to rural populations, in particular, those in more isolated locations. It was not possible to include this variable in the analysis.

The analysis shows that despite the notable progress described, differences in child survival linked to social determinants still persisted around 1980. Such differences reflect ever-present disparities in living conditions which affect in a variety of ways the health-sickness process of the child. These living conditions are associated with the social class to which the household belongs, even though distribution policies undoubtedly tend to decrease the differentials between the various social classes.

It is estimated that in 1979, almost 30 per cent of the births took place in populations with a probability of dying by age 5 that was four times greater than that of more favoured social groups which are in the vanguard of mortality decline. Such births occurred mainly to agricultural workers (farmers and wage-earners) and non-agricultural manual wage-earners when parents have had incomplete primary education; this population is mostly rural. Improvement of living conditions for those groups, including health care, would seem to be a priority task.

A recent study (Behm and Robles, 1988) shows the relationship between the social determinants and biological factors that are direct causes of death. In this study, the intermediate geographical subdivisions (cantons) were grouped by levels of living. It was shown that the higher mortality of the group with the lowest levels of living is mainly the result of infectious diseases, principally diarrhoeal diseases. In contrast, there was little variation in the perinatal mortality rates, which remain relatively high.

These facts underline the epidemiological duality confronting Costa Rica if it wants to continue reducing child mortality. On the one hand, it is necessary to eliminate the high levels of mortality remaining as a legacy of the past, those attributable to preventable causes and concentrated in a minority of births occurring in the less favoured social groups. On the other hand, the larger problem is the level of perinatal mortality, which exceeds that of the United States by 75 per cent. Both problems require different strategies in the public-health sector.

Together with other studies, the current analysis increases the knowledge of the process of change that has taken place with respect to social differentials in child mortality and identifies those groups which continue to experience higher risk, information that could prove useful for a discussion of the strategies necessary to solve the problem.

ANNEX

Classification of heads of households

The classification of heads of households by occupation and category of occupation in the 1973 census was as follows:

	Occupation code	*Occupational-category code*
Agricultural sector		
Agricultural workers	420-451	1
Farmers	410-417	2
Non-agricultural sector		
Middle class	000-340	1
	000-128	2
	300-340	2
Manual workers	500-954	1
	600-788	2
Craftsmen	312	2
	900-954	2
Unclassified	All remaining occupations and the occupational categories "employer" and "unpaid family member", as well as heads of household who are not part of the economically active population.	

Source: Costa Rica, *Censo de población de 1973. Población, ocupación y rama de actividad: instructivo para el codificador.* (San José: Costa Rica, Dirección de Estadística y Censos, 1973).

NOTE: Equivalent codes were used in the 1984 census.

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V. HONDURAS

*Josè Miguel Guzmán**

This chapter analyses, for Honduras, the effect on child mortality of a set of socio-economic variables that represent risk factors at young ages. For that purpose, information on children ever born and those who had died were obtained from the national population census conducted in 1974 and from the second National Demographic Survey (EDENH-II) of 1983. A similar study of the determinants of infant mortality carried out by CELADE and based on the same information (Guzmán and Santos, 1988) served as precursor of the present effort.

To set a frame of reference, the first section presents information related to the socio-economic and demographic characteristics of the population of Honduras. Specifically, it presents a summary of previous studies concerning trends in infant mortality and factors related to its decline. The second section addresses methodological issues related to this study and describes the data sources and variables used.

The study of child mortality is approached through the identification of subgroups that are exposed to the highest risks and therefore require priority attention. Differentials in child mortality are analysed through the application of a multiple regression model in which the dependent variable is an indicator of the mortality risks prevalent among the children of each mother in relation to those prevalent among all children. Lastly, the results obtained and their implications for the formulation of health policy are discussed.

A. THE SOCIO-ECONOMIC AND DEMOGRAPHIC CONTEXT

Population, geography and economic development

Honduras is a Central American country bordering on Nicaragua to the south, Guatemala to the north-east and El Salvador to the south-east. In 1985, its total population was estimated to be 4.4 million. With an area of 112,000 square kilometres, this means a population density of 39 inhabitants per square kilometre. In Central America, Honduras has the third largest population (after Guatemala and El Salvador) and covers the second largest area (after Nicaragua).

Most Hondurans live in rural areas (about 60 per cent in 1983). As in the other Latin American countries, however, there is a marked increase in urbanization. The percentage of the urban population increased from 23 in 1961 to 31 in 1974, according to the censuses held in those years, and to 40 in 1983, according to EDENH-II. Half of the urban population live in the cities of Tegucigalpa (the capital) and San Pedro Sula (the main industrial and commercial centre).

Honduras is mainly an agricultural country. According to EDENH-II, 45 per cent of the active population (60 per cent of the male population) were engaged in agriculture in 1983 (CELADE and Honduras, 1985). According to the same source, only 12 per cent of the population were employed in manufacturing industries. The percentages of gross domestic product (GDP) generated in those sectors in 1985 were 27 and 14, respectively (see table 10).

GDP per capita increased during both the 1960s and the 1970s but because of the economic crisis, which affected most Latin American countries, it declined in real terms between 1980 and 1984. At the same time, the indicators related to means of transport, communications and energy improved considerably during the period under study. It is important to point out that in 1960 there were only 384 kilometres of paved roads, compared with 1,724 in 1980 and 2,102 in 1985. Between 1970 and 1980, the production of electric energy almost trebled.

The positive trends evinced in the economic indicators, at least until 1980, were not so evident in the case of the social indicators.

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TABLE 10. SOCIO-ECONOMIC AND DEMOGRAPHIC INDICATORS, HONDURAS, 1960-1985

No.	Indicator	1960	1970	1980	1985
1.	Total population (thousands)	1 935	2 627	3 662	4 383
2.	Gross domestic product (millions of dollars)[a]	508	826	1 316	1 337[b]
3.	Per capita gross domestic product (dollars)[a]	262	315	359	305[b]
4.	Agricultural product/GDP (percentage)	34.4	32.4	28.5	27.1
5.	Industrial product/GDP (percentage)	12.3	13.8	15.4	14.2
6.	Population density (inhabitants per km^2)	17.2	23.5	32.7	39.1
7.	Percentage of urban population	22.1[c]	30.0[d]	40.0[e]	..
8.	Road network: paved roads (km)	384	722	1 724	2 102
9.	Electric energy production (millions of Kw)	..	334	899	2 425
10.	Population per physician	..	4 011	3 045	2 529[e]
11.	Hospital beds (per 1,000 population)	1.6	1.7	1.3	..
12.	Dwellings without lavatory facilities (percentage)	80[c]	68[d]	42[e]	..
13.	Dwellings with access to potable water[f] (percentage)	12[c]	15[d]	20[e]	..

Sources: **Indicators 1 and 7**: Centro Latinoamericano de Demografía, *Proyecciones de población de Honduras: revisión de 1986*. (Santiago, Chile, CELADE, 1986); **indicators 2, 4, 5, 10, 11**: Comisión Económica para América Latina y el Caribe, *Anuario Estadistico de América Latina, 1985* and *1986* (Santiago, Chile, 1985, 1986); **indicators 8 and 9**: Banco Central de Honduras, *Honduras en cifras* (Tegucigalpa, Honduras, various years); **indicators 12 and 13**: José Miguel Guzmán and Hernan Santos, *Mortality infantil: los riesgos de muerte en diferentes contextos sociales y geográficos: 1955-1985; Encuesta Demográfica Nacional de Honduras*, vol. V, Series A, 1047/V (San José, Costa Rica, Centro Latinoamericano de Demografía, 1988).

[a] At constant prices 1970 = 100.
[b] 1984.
[c] 1961.
[d] 1974.
[e] 1983.
[f] Access inside dwelling.

Health care

Although the number of physicians increased, the number of hospital beds for each thousand of population declined, possibly related to a certain deterioration in hospital care. However, social security coverage increased and health services became more diversified. The decline in formal hospital care was accompanied by a marked increase in primary care: the rural health centres developed rapidly as did the informal subsystems, made up of health attendants and midwives.

Access to basic services

There was a slight increase in access to drinking-water inside dwellings and also, apparently, an increase in access outside dwellings. There was also a marked decline in the percentage of dwellings without lavatory facilities. Despite those changes, in 1983, 80 per cent of dwellings did not have piped water and 40 per cent had no lavatory facility, which illustrates the deplorable level of hygiene of a large part of the Honduran population.

Food and nutrition[1]

According to the Nutritional Survey carried out in Honduras in 1966, about 73 per cent of Honduran children under age 5 were suffering from some degree of malnutrition, measured in terms of weight for age. Studies by the Higher Council of Economic Planning (CONSUPLANE) show that in the years 1975-1977 this figure rose to 75 per cent, which means in absolute terms that about half a million children were undernourished. The index of the physical volume of food production per capita declined during the first half of the 1970s, recovered at the end of that decade and declined again during the first half of the 1980s.

Those environmental and nutritional conditions explain the high infant and child mortality in Honduras. As a result of those circumstances, infectious and contagious diseases, especially diarrhoea, are frequent. During the 1970s, more than a third of all infant deaths were caused by infectious and parasitic diseases. If the deaths due to undefined or undetermined causes are distributed proportionately, however, that fraction rises to half of the deaths of children under age 1. During that period, deaths from diarrhoea alone constituted 25 per cent of all infant deaths. If one adds the roughly estimated corresponding proportion of deaths from unknown or undefined causes, the figure rises to about 33 per cent. In other words, one in three Honduran children died from diarrhoea, a situation that remained more or less constant during the 1960s and 1970s. Recently, however, there appears to have been a decline in infant deaths from that cause.

It is important to mention that the Ministry of Public Health has taken action against that cause of infant mortality. For example, since 1984, it has been implementing the Diarrhoeal Disease Control Programme; and since 1982, the Breast-feeding Support Programme. Favourable results have already been obtained: the duration of breast-feeding rose from 15.2 to 16.2 months during the period 1981-1984.[2] During the same period, there was a decline in hospital deaths attributable to diarrhoea, from 25 to 15 deaths for each 10,000 children. This decline could be the result of the implementation of oral rehydration therapy by the health services.[2]

Trends in overall mortality and child mortality

During the past 20 years, important changes have taken place in the level of mortality in Honduras. Between 1965 and 1985, the average life expectancy at birth increased by about 14 years (CELADE, 1989). In 1985, life expectancy at birth was estimated at 63 years; this level contrasts sharply with the estimate of 49 years that had prevailed only 20 years earlier. A decline in mortality risks at all ages, and especially in childhood, has brought about that change.

According to the same source, infant mortality rates fell by about 40 per cent during the same period. More recent data show that the decline in infant mortality has been even sharper in the past decade: the rate was only slightly above 60 per 1,000 in 1985-1987 (Honduras, 1989). Despite those changes, which are undoubtedly important, Honduras still has high mortality rates compared with other Latin American countries, especially its neighbour, Costa Rica.

Differences in infant mortality in different contexts

The infant mortality rates mentioned above are national averages derived from a fairly heterogeneous mix. In a recent study based on data from EDENH-II and from the population census of 1974, infant mortality rates were calculated for 1970 and 1980 in different geographical and socio-economic contexts (Guzmán and Santos, 1988). The results of this study are summarized below.

As concerns the geographical context, the risks of dying, as to be expected, are greater in rural areas than in urban areas. Within the urban areas, there is a large difference between the mortality risks of children born in one of the two major cities (Tegucigalpa and San Pedro Sula) and children born in other towns or urban communities. Mortality rates were also calculated for planning regions. In 1980, the highest rates (over 100 per 1,000) occurred in the western region, which includes the departments bordering on El Salvador and Guatemala, and the lowest rates (63 per 1,000) in the central-southern region surrounding the city of Tegucigalpa.

There are even sharper differentials according to socio-economic strata of the population. The agricultural sector has infant mortality rates close to or slightly higher than 100 per 1,000. Within this sector, wage-earners have the highest rates: many of them are landless peasants who constitute the poorest agricultural class. After them comes the non-agricultural lower class, consisting of workers and other essentially urban wage-earners; and lastly, the middle and upper classes, which have the lowest rates (44 per 1,000).

Like other studies on the subject, this study also reveals major differences in infant mortality

according to parental education. In 1980 in Honduras, the child of an illiterate mother was three times more likely to die before age 1 than the child of a mother with seven or more years of education.

Important differences in infant mortality also appear when one breaks down the population by access to piped water and sewerage facilities. The rates are close to 100 per 1,000 when the children live in dwellings not connected to the public water-supply or without lavatory facilities (there is a close relationship between those two variables). On the other hand, the rates are about 50 per 1,000 when dwellings have access to public water-supply and a private lavatory.

An analysis was made of infant mortality rates within the various social groups with regard to place of residence. It was noted that the socially and economically most disadvantaged groups (poorly educated or uneducated, unskilled and lacking drinking-water and lavatory facilities) had similar infant mortality rates, regardless of where they lived; living in a town did not lessen the risks of infant mortality.

The differences found in infant mortality were important not only because of their magnitude but because of the size of the groups exposed to the highest mortality risks. Depending upon the socio-economic characteristic chosen, those differences range from 30 to 60 per cent.

However, the decline in infant mortality, which has occurred in all social groups, is encouraging. During the 1970s, there were sharp decreases (about 20 per cent) in the high-mortality groups.

Some factors associated with the decline in infant mortality

The study mentioned above (Guzmán and Santos, 1988) discusses some of the factors that brought about the decline in infant mortality. These factors include:

(*a*) Better medical coverage through a steady increase in rural health centres, directed essentially to residents of rural areas and focused on primary health facilities and increased social security coverage and private care in general;

(*b*) Increased vaccination coverage combined with sustained growth in the production, importation and mass consumption of pharmaceutical supplies;

(*c*) Improvement in basic sanitation;

(*d*) Important changes in education and communication, resulting in new behaviour with respect to the health of infants, especially as concerns the prevention and treatment of children's diseases.

B. SOURCES OF DATA AND METHODOLOGY

Basic information

A recent study (Guzmán and Santos, 1988) notes that among the sources of recent data existing in Honduras, the population census of 1974 and EDENH-II, conducted in 1983, have the greatest consistency in their indirect estimates of child mortality. Hence, the basic information used in the present study was taken from those two sources.[3]

The 10 per cent sample used was obtained from the 1974 census. The sample includes 278,442 persons and 49,079 households. Although this census is considered to be of better quality than the censuses of 1950 and 1960, it is estimated to have a total omission of 10 per cent (Camisa and Rincón, 1981).

EDENH-II was carried out between July 1983 and January 1984 by CONSUPLANE, with the technical and financial support of CELADE. It was a retrospective survey based on a single round of visits to 11,103 households selected as representative sample of Honduras. The departments of Gracias a Dios and Islas de la Bahiá were excluded from the survey because of their sparse population and difficult access.

The population under study

The population under study is made up of women aged 15-34 years who were wives or companions of heads of households or women who were heads of

households with partners living in the household, and who had had at least one child born alive; they were interviewed in the census of 1974 and in EDENH-II. The sample sizes for this study are 15,750 and 3,602 women, respectively.

Age group 15-34 was chosen because the data provided by those women—specifically, the proportion of children dead—relate to a recent period: approximately four years prior to the survey or census. They also provide good estimates of mortality. Therefore, the child mortality estimates given here refer to periods centred on 1970 and 1979.

The study was confined to the women described above because of the inclusion in the model of the variable for paternal education, which could only be obtained from that group. It was found that the restriction, like a similar limitation in a study of Costa Rica (Behm and Robles, 1988), produces a slight overrepresentation (between 2 and 6 per cent) of the most poorly educated groups, rural residents etc.

Methodology

This study uses a regression model, which is explained in detail in chapter II. The relationship between an indicator of child mortality, M, and a set of socio-economic and geographical variables is investigated. The data obtained from the population census and EDENH-II are used for this purpose. Certain specific points arising in the application of this methodology to the case of Honduras are discussed below.

Estimation procedure

In order to calculate the mortality indicators used in this study and to obtain the dependent variable of the regression model, the following steps were taken. First, indirect estimates of child mortality were obtained based on information on the number of children ever born and the number of children surviving among women aged 15-34. The estimates were derived by applying the Brass method with the modification introduced by Trussell and using the Latin American pattern of the United Nations model life-tables (United Nations, 1982 and 1983). An average level of mortality was calculated by weighting the estimates derived from each age group of women by the number of children born alive to that age group.

For the average level and in accordance with the model mortality pattern, the probabilities of dying were estimated for the ages between 0 and X (X = 1, 2, 3 and 5). The estimates gave a set of four expected proportions of children dead (one for each maternal age group: 15-19, 20-24, 25-29 and 30-34), by applying the Brass method inversely. For that purpose, as is explained in chapter II, the probabilities of dying were divided by the respective multipliers ordinarily used to convert the proportions dead into probabilities of dying.

The mortality indicator, M, which is the dependent variable used in the regression analysis, was calculated for each woman as the ratio between the observed proportion of children dead and the expected proportion of children dead given her age group. For the regressions, each woman was weighted by the number of live births she had had, so that children are the units of analysis.

The values of M were averaged for each subgroup defined by the different categories of variables studied. Those values were converted into probabilities of dying between birth and age 5, ${}_5q_0$, as explained in chapter II. For the entire country, the estimated probabilities of dying were 166 per 1,000 and 117 per 1,000 in 1970 and 1979, respectively.[4]

Variables affecting child mortality

The living conditions of a population are determined by a series of environmental factors which are also closely linked to the causes of child mortality. Data concerning those factors are readily available in some cases or may be obtained from censuses and demographic surveys: place of residence; social class; education of the mother and father; quality of housing; and lavatory facilities. It was precisely those variables, available in the sources described above, which formed the basis of the analysis.

In the regressions, for each of the variables, one of the categories is taken as a reference category.

In all cases, the reference categories chosen are those for which the lowest risks of dying are expected: middle class; residence in large cities; seven years or more of education; piped water in the dwelling; and private lavatory.

The categories pertaining to each variable are listed below:

(a) *Social class*:[5]

(i) *Non-agricultural sector*: middle class;[6] lower middle class; skilled workers; unskilled workers;

(ii) *Agricultural sector*: farmers; agricultural workers; unclassified;

(b) *Mother's education*: none; from one to three years; from four to five years; six years; seven years or more;[6]

(c) *Father's education*: same classification as mother's;

(d) *Place of residence*: large cities: Tegucigalpa and San Pedro Sula;[6] other urban communities; rural;

(e) *Water-supply*: public supply within the dwelling;[6] public supply outside the dwelling; river, stream, well etc.;

(f) *Lavatory facility*: private lavatory;[6] private latrine; communal lavatory or latrine; none.

A comparison of the major variables obtained from the two sources indicates the following differences.

Place of residence

In the 1974 census all communities with 2,000 population or more were considered urban areas provided they had: (*a*) piped water; (*b*) regular land or sea communications; (*c*) full primary school or higher; (*d*) postal and telegraph services and at least one of the following: electric light, sewerage facilities or health centre. For EDENH-II, the same criteria were used.

Level of education

The 1974 census listed the question on illiteracy before the question on level of education. This order of questions may have led to an exaggeration of the group of persons with no education. The general report on EDENH-II notes that there is a large difference between the educational distribution of the 1974 census and that of EDENH-II. The increase shown in the educational level does not appear to be solely attributable to changes that occurred during the intervening period. Another explanation may be that EDENH-II tended to overrepresent the better educated groups, although it is not known exactly how this happened (CELADE and Honduras, 1985).

Occupation and occupational category

The questions on occupation, which determine the social class of a person, were the same in both sources, as were the reference periods used to define them (one week). There are some differences, however, between the two sources: (*a*) since EDENH-II was carried out over a longer period and at a different time of the year, the seasonal nature of work in some areas may have had some effect on the breakdown of the active population by occupation and occupational category; (*b*) in the census, there were more details on occupation than in the survey (three digits in the census and only one digit in the survey);[7] (*c*) there is a slight difference in the occupational category: the census has no "employer" category, as does EDENH-II. The census divides "self-employed" into two groups: those "with employees or workers" (equivalent to the "employer" category in the survey) and "with no employees or workers" (equivalent to the "self-employed" category). The other categories are similar. In any case, in forming the variable for social class, the maximum comparability between both sources was sought, as shown in the annex to this chapter.

C. Mortality of children under age 5

Differential trends in mortality according to socio-economic variables

Table 11 presents the probabilities of dying by age 5 in the different contexts defined by the

TABLE 11. PROBABILITY OF DYING BY AGE 5 IN DIFFERENT SOCIO-ECONOMIC AND GEOGRAPHICAL CONTEXTS, HONDURAS, 1970 AND 1979

Variable	Probability of dying by age 5 ‰		Relative risks	
	1970	1979	1970	1979
Social class				
Agricultural workers	192.1	150.2	2.4	2.5
Farmers	180.7	133.9	2.2	2.2
Unskilled workers	181.5	105.5	2.2	1.7
Skilled workers	130.3	84.1	1.6	1.4
Lower middle class	121.0	96.0	1.5	1.6
Middle class	80.6	61.1	1.0	1.0
Others	154.5	81.5	1.9	1.3
Mother's education (years)				
None	205.5	169.9	4.6	3.7
One to three	152.0	116.1	3.4	2.5
Four to five	131.7	11.7	2.9	2.5
Six	101.9	94.7	2.3	2.0
Seven or more	44.8	46.3	1.0	1.0
Father's education (years)				
None	199.9	147.7	3.9	2.8
One to three	157.2	119.7	3.1	2.3
Four to five	139.6	128.6	2.7	2.4
Six	112.2	91.3	2.2	1.7
Seven or more	50.9	52.5	1.0	1.0
Place of residence				
Rural	181.3	130.5	1.7	1.9
Urban community	144.2	109.0	1.4	1.6
Large city	104.8	69.1	1.0	1.0
Total	166.0	117.3	-	-

variables studied, for which there is information in both sources concerning social class, mother's and father's education and place of residence. The procedure for calculating those probabilities has already been explained.

Social class

The social class to which the individual members of a society belong has been considered a category of basic analysis in the study of social inequality before death. It expresses differences in living conditions, in income, in the ability to reach a higher educational level and, in general, in differential access to the social product.

Despite the conceptual richness of this type of analysis, there is a certain consensus about the difficulties of its application to the information obtained from censuses and surveys. However, considering its explanatory importance of social class, census information is used to define social groups that can serve at least as approximate indicators of social class. In this study, seven groups were defined on the basis of information on the occupation and occupational category of the head of household or senior economically active person.[7] The breakdown of each group is given in the annex to this chapter.

If trends in the categories of social class are analysed, it is observed that absolute declines occur in all groups. The decline is smallest in the middle class and greatest among the unskilled, mainly urban workers. In relative terms, if the middle class is taken as the reference

category, there is a tendency for the differences between classes to remain, with the exception of unskilled workers, for whom the differences with the groups having the lowest mortality become smaller.

Mother's and father's education

The effect of parental educational levels on child mortality is important because it is closely linked to several proximate determinants of mortality. Better educated parents are more favourably disposed to benefit from modern preventive and curative medicine and to provide better child care. They are also likely to have better habits of child nutrition and hygiene. Some studies have shown that the effects of education remain even when other socio-economic variables are controlled, which indicates that the education variable has an independent influence (United Nations, 1985).

The differences in child mortality due to the mother's education may also result from the effect of other socio-economic variables associated with education. For example, better educated women are likely to be economically active in the industrial and service sectors. They will have access to social security and earn more money. Hence, educational differences may indicate better living conditions and easier access to health services.

For Honduras, the analysis according to mother's and father's education shows that various population groups are exposed to very different risks of mortality: children of mothers with no education have about four times as great a risk of dying as the children of the better educated group. Four groups were identified: women with no education; those with incomplete primary (from one to five years); those with complete primary (six years); and those with intermediate or higher education. During the period studied, the better educated groups did not show any favourable trend. Among the less educated, child mortality declined substantially. With respect to both the mother's and the father's educational levels, the relative differences with the category of lowest mortality (seven or more) tend to narrow, essentially because mortality of this category remains stable over time.

Place of residence

The study of child mortality in relation to place of residence indicates the geographical location of the groups exposed to the greatest risks of dying. Such a study is important because resources are not distributed uniformly throughout a country. Following a pattern of development that has prevailed in Latin America, the rural areas and small communities usually remain on the periphery of important economic and social changes. Educational, energy and health resources tend to be concentrated in the urban areas in general and in the capital and large cities.

Mortality by place of residence also showed important differences, which tended to increase in relative terms in the period under study. Given the heterogeneous nature of the population by area of residence, the relative differences for those variables were smaller than for the variables previously discussed.

Identification of child mortality risk groups

The data analysed make it possible to identify the social sectors where children are exposed to the highest risks of death. For this purpose, five risk groups were established, based on the different categories formed by the combination of three of the variables included (place of residence, social class and mother's education). Only those three variables were chosen because of the considerable fragmentation that would have resulted if all the variables had been used and the consequent reduction in the number of cases (in particular for data from EDENH-II). The risk groups established were as follows, according to the relative risk of the group with respect to the national average: (*a*) highest, 1.30 and above; (*b*) high, 1.00-1.30; (*c*) intermediate, 0.70-1.00; (*d*) low, 0.40-0.70; (*e*) lowest, less than 0.40.

Table 12 summarizes the results for the five risk groups; and tables 13 and 14 present, for the two years studied, the composition of each risk group, the absolute and relative levels of child mortality and the proportions of women and live births in each category. Given the small number of observations in some subgroups and in order to

TABLE 12. CHILD MORTALITY RISK GROUPS, HONDURAS, 1970 AND 1979

Risk group	Mortality: Probability of dying by age 5, $_5q_0$ (per 1,000)		Mortality: Relative risks		Percentage distribution of the population exposed: Women aged 15-34		Percentage distribution of the population exposed: Live births	
	1970	1979	1970	1979	1970	1979	1970	1979
Highest	222.5	178.5	5.7	5.1	10.8	16.2	11.8	19.4
High	198.7	125.5	5.1	3.6	32.5	36.7	36.9	42.2
Intermediate ...	146.1	97.7	3.7	2.8	34.1	18.8	32.5	17.6
Low	95.1	66.4	2.4	1.9	9.7	13.6	8.2	11.1
Lowest	39.1	35.0	1.0	1.0	6.7	10.4	4.6	6.4
Remainder	..	..	..	..	6.2	4.3	6.0	3.3
Total	166.0	117.3	4.2	3.4	100.0	100.0	100.0	100.0

facilitate the presentation of the results, some of the categories were regrouped.

Persons in the highest risk and high-risk groups are the most important in terms of policies: they require priority attention; and the main efforts in terms of health programmes and actions must be directed towards them. In 1979, those groups contained half the total number of women. Three out of every five children born in Honduras were exposed to the highest or high risks of mortality in the first five years of life. Those risks were close to 200 per 1,000 in 1970 but declined to about 140 per 1,000 in 1979. Doubtless, this decline is important. However, the magnitude of those estimates in 1979 and their relative differences (up to over five times higher) with respect to the lowest mortality groups show clearly that there is much to be done, especially if one remembers that in 1979 the high-risk groups were much larger, in relative terms, than they had been in 1970.

Who are the members of those high-risk and highest risk groups? They are mainly agricultural workers and farmers who live in the rural areas. They have no education or perhaps they have begun primary education without completing it. Those two social sectors make up 80 per cent of the total live births in those groups and half the births that occur in Honduras.

The remaining 20 per cent of the births in the high-risk and highest risk groups belong to the low and intermediate socio-economic categories: poorly educated persons living in urban areas, especially in other urban communities.

At the other extreme are the intermediate-risk, low-risk and lowest risk groups, for which in 1979 the probabilities of dying by age 5 were 98, 66 and 35 per 1,000, respectively. Those estimates are below the national average. The intermediate group, despite its relatively low mortality, has rates that may still be considered high.

The percentage of children exposed to low or very low risks is still small (17 per cent). Their parents belong to the middle class, lower middle class and skilled workers, usually living in the urban areas, especially the large cities. Their educational level is generally above seven years.

Multivariate analysis: results of the regression model

The model studied here is represented in an equation which considers the variable M to be a dependent variable. M represents the mortality risk of the children of a given woman in relation to the national average mortality level. The result

TABLE 13. COMPOSITION OF CHILD MORTALITY RISK GROUPS, HONDURAS, 1970

Socio-economic composition of group			*Mortality*		*Percentage distribution of population exposed*	
Place of residence	*Social class*[a]	*Mother's education (years)*	*Probability of dying by age 5 $_5q_0$ (per 1,000)*	*Relative risks*[b]	*Women aged 15-34*	*Live births*
			A. *Highest risk*			
Large cities	Agricultural workers	0-5	226	5.8	2.6	2.3
Other urban communities	Unskilled workers	0	223	5.7	5.6	8.0
Rural	Unskilled workers	0	217	5.6	12.5	12.1
	Agricultural workers	0	224	5.7	79.3	77.6
			B. *High risk*			
Large cities	Unskilled workers	0-3	199	5.1	3.9	3.1
Other urban communities	Lower middle class and skilled workers	0	180	4.6	3.0	4.4
	Unskilled workers	1-3	207	5.3	2.0	2.2
	Farmers	0-3	194	5.0	2.4	4.1
	Agricultural workers	0-5	199	5.1	5.0	6.3
Rural	Middle class	1-3	170	4.4	1.3	1.2
	Lower middle class skilled workers	0	187	4.8	3.7	3.8
	Unskilled workers	1-5	168	4.3	4.7	4.1
	Farmers	0	204	5.2	74.0	70.8
			C. *Intermediate risk*			
Large cities	Lower middle class and skilled workers	0-3	136	3.5	9.9	9.6
Other urban communities	Lower middle class and skilled workers	1-3	133	3.4	3.7	5.0
	Unskilled workers	4-6	122	3.1	2.0	2.0
Rural	Lower middle class and skilled workers	1-5	148	3.8	7.1	7.4
	Unskilled workers	6	124	3.2	1.1	0.8
	Farmers	1-6	149	3.8	55.0	54.7
	Agricultural workers	1-6	149	3.8	21.2	20.5
			D. *Low risk*			
Large cities	Middle class	1-5	95	2.4	9.8	8.9
	Lower middle class and skilled workers	4-6	83	2.1	32.5	27.4
	Unskilled workers	4-6	112	2.9	7.7	6.3

(Table 13 continued)

TABLE 13 (*continued*)

Socio-economic commposition of group			*Mortality*		*Percentage distribution of population exposed*	
Place of residence	*Social class*[a]	*Mother's education (years)*	*Probability of dying by age 5* $_5q_0$ *(per 1,000)*	*Relative risks*[b]	*Women aged 15-34*	*Live births*
Other urban communities	Middle class	1-5	95	2.4	6.1	8.9
	Lower middle class and unskilled workers	4-6	99	2.5	20.3	25.2
	Farmers	4-6	105	2.7	2.8	5.2
Rural	Middle class	4+	99	2.5	9.4	8.1
	Lower middle class and skilled workers	6	112	2.9	8.6	7.5
	Farmers	7+	85	2.2	2.8	2.5
			E. *Lowest risk*			
Large cities	Middle class	6+	34	0.9	58.8	50.6
	Lower middle class and skilled workers	7+	49	1.3	16.1	14.5
Other urban communities	Middle class	6+	44	1.1	17.2	23.3
	Lower middle class and skilled workers	7+	41	1.1	7.9	11.6

[a] Lower middle class was grouped with skilled workers.
[b] With respect to mortality in the lowest risk group.

of the application of this model is a regression equation in which the coefficients of the variables represent the amount by which mortality measured in terms of the value of M for a specific category exceeds that of the reference category, once the effects of other variables included in the analysis have been controlled.

In the first step, the model is applied using the following variables: social class; mother's education; father's education; and place of residence. The results, which are shown in table 15, disclose certain important facts.

Concerning social class, in contrast to the bivariate analysis, only two groups show in 1970 significant differences with respect to the reference category: unskilled workers; and agricultural workers. Both within and outside the agricultural sector, they are in the worst position—the agricultural workers as farmers without land and the unskilled workers without means of production and a very precarious income. It is striking that there is no significant difference between farmers and the middle class once the effects of mother's and father's education and place of residence are controlled. In the two agricultural classes, the differences in mortality in relation to the middle class were greater in 1979, but only the agricultural workers maintained a significant difference.

Do those results mean that social class is not important as a cause of child mortality? The interpretation given in this study is that they may be explained by two possible factors: (*a*) because of the limitations of the available data, the classes established may not represent homogeneous groups; (*b*) one of the ways, perhaps the most important, in which social class affects child mortality is education; the effects of the social class variable tend to disappear when the education variable is introduced. Education apparently is a very

TABLE 14. COMPOSITION OF CHILD MORTALITY RISK GROUPS, HONDURAS, 1979

Socio-economic composition of group			*Mortality*		*Percentage distribution of population exposed*	
Place of residence	*Social class*[a]	*Mother's education (years)*	*Probability of dying by age 5 $_5q_0$ (per 1,000)*	*Relative risks*[b]	*Women aged 15-34*	*Live births*
			A. *Highest risk*			
Large cities	Unskilled workers	0	189	5.4	2.2	2.0
Other urban communities	Unskilled workers	0	249	7.1	1.7	1.6
	Farmers	0	270	7.7	1.9	1.7
Agricultural workers		0-3	239	6.8	4.5	4.2
Rural	Farmers	0	170	4.4	65.4	67.7
	Agricultural workers	0	182	5.2	24.3	22.8
			B. *High risk*			
Large cities	Lower middle class and skilled workers	0	119	3.4	1.4	1.3
Other urban communities	Middle class	1-6	117	3.3	3.0	2.0
	Lower middle class and skilled workers	0	141	4.0	1.8	1.7
	Unskilled workers	1-5	119	3.4	3.7	3.3
	Farmers	1-5	129	3.7	2.5	2.9
Rural	Lower middle class and skilled worker	0-6	123	3.5	14.0	13.2
	Farmers	1-5	122	3.5	57.2	59.1
	Agricultural workers	1-5	140	4.0	16.4	16.5
			C. *Intermediate risk*			
Large cities	Unskilled workers	1-6	92	2.6	13.8	13.1
Other urban communities	Lower middle class and skilled workers	1-5	100	2.9	15.7	17.0
	Unskilled workers	6	112	3.2	3.6	3.2
	Farmers	6+	86	2.5	3.2	3.3
Rural	Middle class	1-6	89	2.5	6.8	6.4
	Unskilled workers	0-6	100	2.9	24.8	26.5
	Farmers	6	101	2.9	24.4	23.2
	Agricultural workers	6	88	2.5	7.7	7.3
			D. *Low risk*			
Large cities	Middle class	1-6	49	1.4	12.0	10.5
	Lower middle class and skilled workers	1-6	74	2.1	45.0	49.4

(Table 14 continued)

TABLE 14 (*continued*)

Socio-economic composition of group			*Mortality*		*Percentage distribution of population exposed*	
Place of residence	*Social class*[a]	*Mother's education (years)*	*Probability of dying by age 5 $_5q_0$ (per 1,000)*	*Relative risks*[b]	*Women aged 15-34*	*Live births*
Other urban communities	Lower middle class and skilled workers	6+	64	1.8	30.7	28.4
Rural	Middle class	7+	83	2.4	3.3	3.5
	Lower middle class and skilled workers	7+	47	1.3	4.3	3.7
	Farmers	7+	51	1.5	4.7	4.5
			E. *Lowest risk*			
Large cities	Middle class	7+	34	1.0	48.8	46.8
	Lower middle class	7+	35	1.0	25.3	27.3
Other urban communities	Middle class	7+	39	1.1	25.9	25.9

[a] Lower middle class was grouped with skilled workers.
[b] With respect to mortality in the lowest risk group.

important redistributive social mechanism because it helps provide different segments of the population with equal access to the benefits available in the society.

An analysis of the coefficients for the mother's and father's education shows clearly that the differential risks of child mortality in all the categories studied with respect to the reference category (seven years or more of education) are significant.

Maternal education has a major influence on child mortality. As the level of education rises, the risks of dying steadily decline. In the no education category, the differences with the group with seven years or more are the highest. When the mother has only from one to three years of education, those differences diminish by about one half. There is not much of a gain between the groups with from one to three and from four to five, but there is a significant decline in mortality when mothers have completed primary education.

Between 1970 and 1979, an increase is shown in nearly all coefficients. In other words, there is greater social inequality in child mortality: the gap between the low-education groups and the group with seven or more years has grown wider.

The father's education is linked with child mortality independently of the mother's education. Although the coefficients are nearly always smaller than those for the mother's education, in most cases they are significantly different from zero. For 1970, the differences with the reference group are substantial and decline with higher levels of education. There is little change in passing from the category of from one to three to that of from four to five. For 1979, the results are not so clear. But the differences with the group with seven or more are considerable for up to five years of paternal education. The coefficients for the group with from four to five are higher than those for the group with from one to three years. That point had also been observed in the bivariate analysis and may be explained by problems with the basic data.

TABLE 15. MEANS AND REGRESSION COEFFICIENTS FOR THE CATEGORIES OF THE VARIABLES STUDIED, HONDURAS, 1970 AND 1979

Variable	Mean[a]		Regression coefficients	
	1970	1979	1970	1979
Social class				
Agricultural workers	0.187	0.141	0.138[b]	0.235[b]
Farmers	0.462	0.449	0.052	0.130
Unskilled workers	0.074	0.108	0.209[b]	0.039
Skilled workers	0.088	0.101	0.029	-0.080
Lower middle class	0.077	0.106	-0.018	-0.002
Middle class	0.068	0.085	0.000	0.000
Remainder	0.044	0.010	0.056	0.001
Mother's education (years)				
None	0.474	0.222	0.563[b]	0.704[b]
One to three	0.297	0.363	0.311[b]	0.305[b]
Four to five	0.094	0.150	0.242[b]	0.358[b]
Six	0.088	0.157	0.151[b]	0.240[b]
Seven or more	0.047	0.108	0.000	0.000
Father's education (years)				
None	0.467	0.293	0.402[b]	0.312[b]
One to three	0.313	0.348	0.255[b]	0.189[b]
Four to five	0.090	0.110	0.234[b]	0.332[b]
Six	0.070	0.134	0.155[b]	0.103
Seven or more	0.006	0.115	0.000	0.000
Place of residence				
Rural	0.716	0.684	0.087[b]	0.070
Other urban communities	0.163	0.156	0.053[b]	0.200[b]
Large cities	0.121	0.160	0.000	0.000
M	0.9773	0.9723	-	-
Constant	-	-	0.142	0.240
R^2	-	-	0.048	0.045
Number of cases[c]	64020	12991	-	-

[a] Averages represent the relative distribution of live births in the different categories of the variables, since in the regressions the categories are taken as independent variables.

[b] Significantly different from zero at the 5 per cent level.

[c] Number of live-born children.

Possibly, the cultural and ideological effects of education on child mortality are best represented by the mother's education, while the effects of the relationship between education and income are best represented by the father's education.

In short, if the effects of both maternal and paternal education on mortality are analysed, it can be concluded that: (*a*) the mother's education is more important, as expected, because during the early months when the risk of dying is highest, the mother is closest to the child; (*b*) in any case, the fact that the coefficients of both variables are significant shows the importance of both maternal and paternal education; (*c*) the greatest differences in the two coefficients occur at the lowest educational levels (no education and from one to three years). In other words, although the father's illiteracy adds appreciably to the risk of child mortality, that of the mother is a much greater determining factor. Generally speaking, the fact that the father is poorly educated is important, but not so important as lack of education of the mother.

Interaction between place of residence and other independent variables

Given the special characteristics of each place of residence, it was hypothesized that the effects of the independent variables on child mortality could be different in the various types of places. To examine that hypothesis, new regression equations were obtained separately for each type of place,[8] taking into account the variables related to social class and to mother's and father's education.[9] The results of those regression analyses are presented in table 16. Table 17 shows the relative distribution of live-born children among the female population studied in each of the categories of the variables.

There is no evidence of significant interaction in the case of the variable for social class. This point is very difficult to establish because the distribution of that variable by area of residence is asymmetrical. However, the case of unskilled workers is important. For this group, the mortality risks are higher when they live in urban areas. This finding suggests that urban unskilled workers are worse off, compared with the urban middle class, than are unskilled workers in rural areas, compared with the rural middle class.

As concerns mother's education, the census data clearly show the interaction between that variable and the place of residence. At the lower educational levels, the coefficients are smaller as the level of rurality increases. In other words, the effect of poor education on child mortality is greater in urban areas than in rural areas. Because of the small number of observations in EDENH-II, it is difficult to ascertain whether the difference persists in 1979.

This situation may be interpreted as follows. Urban residents with a poor education are less likely than rural residents to obtain the benefits of society. In rural areas, there is greater homogeneity and, in relative terms, a poor education is not such a great disadvantage. In other words, in the rural areas it is more normal to have a poor education, and this factor plays a lesser role in the integration of persons into the labour market, which is agricultural and unskilled. It is this integration which allows the different members of the family to obtain the benefits of the social product, in particular, direct income, necessary for access to non-public health services, better food and better housing.

In the case of paternal education, the results are not so clear but, at least in the 1974 census, they are similar to those encountered for maternal education.

Housing conditions as factors associated with child mortality

The likelihood of contracting certain diseases, especially infectious and contagious diseases, and their persistence are directly associated with the material conditions of life in which the child is born and reared and specifically with the levels of protection of the surrounding habitat. Adequate housing, clean drinking-water within the dwelling and good lavatory facilities favour the creation of a hygienic environment which helps prevent disease and allows the child to survive. Generally speaking, poor housing reflects a rural, marginal residence, low income and disadvantaged social class. Those factors interact with other variables which also affect child mortality.

The bivariate analysis showed that the availability of drinking-water and lavatory facilities leads to important differences in child mortality. The question is to what extent those risks are merely the result of the relationship between housing conditions and other factors, such as education, social class or place of residence. To clarify that point, new regression equations were calculated incorporating all the independent variables previously included and also the availability of lavatory facilities and the type of water-supply. For those regression analyses, only the information from EDENH-II could be used.

The results of the regressions (see table 18) show that the availability of water and lavatory facilities still has an important effect on child mortality, even when the effect of socio-economic and geographical variables have been controlled. The absence of those facilities is just as dangerous for children as having an illiterate father.

An analysis of the coefficients for type of water-supply shows that the most important factor is not so much access to a public water-supply as access inside the dwelling. Those findings might be

TABLE 16. REGRESSION COEFFICIENTS FOR THE CATEGORIES OF THE VARIABLES STUDIED, BY PLACE OF RESIDENCE, HONDURAS, 1970 AND 1979

Variable	Regression coefficients					
	1970			1979		
	Large cities	Other urban communities	Rural	Large cities	Other urban communities	Rural
Social class						
Agricultural workers	0.741[a]	0.219[a]	0.042	[b]	0.495[a]	0.046
Farmers	[b]	0.194[a]	-0.030	[b]	0.198	-0.037
Unskilled workers	0.398[a]	0.337[a]	0.056	0.454[a]	0.059	-0.020
Skilled workers	-0.052	0.080	0.017	0.081	-0.220	-0.178
Lower middle class	-0.035	0.036	-0.090	0.162	-0.235	-0.018
Middle class	[c]	[c]	[c]	[c]	[c]	[c]
Remainder	0.107	-0.020	0.036	[b]	[b]	[b]
Mother's education (years)						
None	0.914[a]	0.650[a]	0.486[a]	1.023[a]	1.417[a]	0.604[a]
One to three	0.538[a]	0.484[a]	0.231[a]	0.311[a]	0.407[a]	0.289[a]
Four to five	0.332[a]	0.218[a]	0.227[a]	0.115	0.823[a]	0.316[a]
Six	0.131[a]	0.152[a]	0.179[a]	0.303[a]	0.241[a]	0.270[a]
Seven or more	[c]	[c]	[c]	[c]	[c]	[c]
Father's education (years)						
None	0.363[a]	0.369[a]	0.356[a]	0.014	0.135	0.401[a]
One to three	0.600[a]	0.184[a]	0.197[a]	0.254	0.136	0.298[a]
Four to five	0.292[a]	0.087	0.246[a]	0.373[a]	0.255	0.389[a]
Six	0.215[a]	0.159[a]	0.088	0.427[a]	0.114	0.385[a]
Seven or more	[c]	[c]	[c]	[c]	[c]	[c]
Constant	0.210	0.184	0.347	0.298	0.491	0.314
R^2	0.092	0.070	0.023	0.047	0.093	0.027
M	0.9655	0.9235	0.9896	0.8626	0.9751	0.9657
Number of cases[d]	7 757	10 442	45 821	2 085	2 022	8 884

[a] Significantly different from zero at the 5 per cent level.
[b] Coefficient not given because the number of cases is very low (fewer than 100 live births).
[c] Reference category.
[d] Live births.

attributable to the transport of water and its contaminating effect, which may affect the quality of water and influence child mortality. The coefficients of private lavatory facility show that the absence of lavatory facilities and access to only a collective latrine or lavatory are just as important as the absence of water-supply within the dwelling. Absence of lavatory facilities has a definite negative impact on child survival.

Those results are important for health programmes. They show that improvements in basic sanitation must be closely linked with other more direct approaches. The risk of contracting infectious diseases may be lessened by, *inter alia*, creating a healthier environment which would allow children to grow with fewer infections that could undermine their resistance and cause their death.

D. DISCUSSION OF RESULTS

Several points that emerged from this study are important in the formulation of health policies designed to reduce child mortality.

TABLE 17. PROPORTION OF LIVE-BORN CHILDREN AMONG THE CATEGORIES OF THE VARIABLES STUDIED, BY PLACE OF RESIDENCE, HONDURAS, 1970 AND 1979

	Proportion of live births					
	1970			*1979*		
Variable	*Large cities*	*Other urban communities*	*Rural*	*Large cities*	*Other urban communities*	*Rural*
Social class	1.000	1.000	1.000	1.000	1.000	1.000
Agricultural workers	0.024	0.156	0.222	0.007	0.077	0.187
Farmers	0.006	0.128	0.616	0.005	0.136	0.624
Unskilled workers	0.144	0.149	0.046	0.212	0.156	0.072
Skilled workers	0.309	0.179	0.029	0.273	0.211	0.036
Lower middle class	0.190	0.180	0.034	0.212	0.232	0.052
Middle class	0.265	0.127	0.020	0.267	0.173	0.024
Remainder	0.062	0.081	0.033	0.024	0.015	0.005
Mother's education (years)	1.000	1.000	1.000	1.000	1.000	1.000
None	0.182	0.342	0.554	0.071	0.115	0.281
One to three	0.268	0.283	0.306	0.217	0.269	0.418
Four to five	0.140	0.130	0.077	0.131	0.175	0.149
Six	0.212	0.151	0.053	0.217	0.226	0.127
Seven or more	0.198	0.094	0.010	0.364	0.215	0.025
Father's education (years)	1.000	1.000	1.000	1.000	1.000	1.000
None	0.122	0.300	0.564	0.081	0.134	0.379
One to three	0.280	0.303	0.320	0.231	0.262	0.395
Four to five	0.143	0.147	0.068	0.115	0.130	0.104
Six	0.183	0.131	0.037	0.211	0.238	0.093
Seven or more	0.272	0.119	0.011	0.362	0.236	0.029
Number of cases[a]	7 757	10 442	45 821	2 085	2 022	8 884

[a] Live births.

In the first place, it is clear that the decline in mortality in the early years of life has been fairly general in all socio-economic contexts, although for some groups the decline in child mortality was not very important. At the same time, it is evident that mortality levels are still so high that continued efforts with regard to health care are required.

Another important point concerns the identification of the risk groups, on the basis of the variables area of residence, social class and mother's education. In 1979, three out of five children born in Honduras were exposed to the highest risk or a high risk of mortality in the first five years of life. Those risks were close to 200 per 1,000 in 1970 but declined to about 140 per 1,000 in 1979. It is estimated that they are currently somewhat lower.

The majority of children belong to the highest risk and the high-risk groups, which shows the magnitude of the problem. Those groups are the most important in terms of health policies because they need priority attention and must be the main targets of health programmes and activities. They consist mainly of children of agricultural workers and farmers who live in rural areas and who have no education or incomplete primary education. These children account for 80 per cent of all live births in the highest risk and high-risk groups, and for half of all the births occurring in Honduras. The other 20 per cent of live births in the highest

TABLE 18. MEANS AND REGRESSION COEFFICIENTS FOR THE CATEGORIES OF THE VARIABLES STUDIED, HONDURAS, 1979

Variables	*Mean*[a]	*Regression coefficient*
Social class	1.000	-
Agricultural workers	0.134	0.118
Farmers	0.452	0.026
Unskilled workers	0.107	-0.051
Skilled workers	0.100	-0.129
Lower middle class	0.107	-0.037
Middle class	0.090	0.000
Remainder	0.010	0.057
Mother's education (years)	1.000	-
None	0.219	0.562[b]
One to three	0.363	0.166[b]
Four to five	0.152	0.227[b]
Six	0.158	0.172[b]
Seven or more	0.108	[c]
Father's education (years)	1.000	-
None	0.292	0.243[b]
One to three	0.349	0.151[b]
Four to five	0.110	0.300[b]
Six	0.134	0.065
Seven or more	0.115	[c]
Place of residence	1.000	-
Rural	0.686	0.221[b]
Other urban communities	0.156	0.018
Large cities	0.158	[c]
Type of water-supply	1.000	-
Other (river, well etc.)	0.508	0.252[b]
Public supply outside dwelling	0.367	0.197[b]
Public supply inside dwelling	0.125	[c]
Lavatory facility	1.000	-
None	0.505	0.241[b]
Collective lavatory or latrine	0.100	0.186[b]
Private latrine	0.251	0.110
Private lavatory	0.144	[c]
Constant	-	0.138
R^2	-	0.049
M	0.9698	-
Number of cases	12 652	-

[a] Represents proportion of live births in each category, since in the regression analysis the categories are independent variables.
[b] Significantly different from zero at the 5 per cent level.
[c] Reference category.

risk and high-risk groups are mainly those to unskilled workers and other low and intermediate socio-economic groups in urban areas.

Undoubtedly, the decline in absolute levels of mortality of those groups was significant during the period studied. However, the high levels and large differentials, in relation to those for the lowest risk groups, up to five times higher, show clearly that much remains to be done, especially if it is remembered that in 1979 the highest risk and high-risk groups were larger, in relative terms, than they had been in 1970.

The application of the multiple regression model made it possible to calculate the degree of association of the variables included with the relative levels of child mortality. In terms of social class, in 1970 only two groups showed significant differences with respect to the reference category: unskilled workers; and agricultural workers. In the two agricultural classes, the differences in mortality with respect to the middle class were greater in 1979 but only the agricultural workers maintained a significant difference. This may mean that the effect of social class on child mortality operates through certain variables, such as education.

Both the mother's and the father's education were found to have an effect on mortality, even after controlling for social class and place of residence. It has been suggested that the variable for mother's education possibly represents the cultural or ideological effects of education on child mortality while the father's education indicates the income level of the household.

The results of the regression analyses show also that both water-supply and availability of lavatory facilities maintain a strong association with child mortality, even after controlling for the effect of the socio-economic and geographical variables. The effect of basic lavatory facilities is independent of the other characteristics of the parents. Those results, as already pointed out, are important for social policies. With a view to achieving a steady decline in child mortality, especially in certain socially and economically underdeveloped sectors, basic sanitation programmes must be developed in addition to more direct health activities. Not only must the child be prevented from dying of diarrhoea, he must be prevented from contracting it. In this situation, the existence of a healthy environment plays a determining role.

Two final points must be stressed in this summary. First, the scope of health policies must be determined within the framework of the variables used here. They include variables that can be influenced by direct action, such as the availability of lavatory facilities and the type of water-supply, which have an almost immediate effect on child mortality.

In the case of education, however, the situation is more complex. Not only does it fall beyond the field of action of health ministries but its effect takes much longer to operate. However, there is a point to be discussed here. When one considers the education variable, especially the mother's education, one seeks to represent a quality acquired by individuals. It provides them with the information that ensures that child-bearing and child-rearing shall take place in the best possible manner. Obviously, it is not necessary for the entire population to reach the secondary level of education in order to obtain this information. An educational health programme, implemented over a much shorter period of time, could produce the same, or even better, results.

The last point becomes important in the context of the economic crisis currently affecting most of the Latin American countries. That crisis is likely to place serious difficulties in the way of access to better living conditions. As the most recent data show, there have been positive changes in primary health services in Honduras, which will doubtless have an important influence on child survival. At the same time, however, there are negative economic and social indicators which give grounds for concern.

In terms of the possibilities of reducing child mortality, the negative trend can only be stopped by a health policy that gives priority to the sectors identified here as those with the highest risks and to high-yield policies in terms of cost effectiveness.

NOTES

[1] The data presented here are derived from the National Food and Nutrition Plan, 1979-1983, prepared by the Consejo Superior de Planificación Económica (CONSUPLANE) and from estimates by the Department of Health of the Technical Secretariat of CONSUPLANE.

[2] Data prepared by CONSUPLANE.

[3] It should be emphasized, however, that the Epidemiology and Family Health Survey of 1987 (see Honduras, 1989) indicates that child mortality in recent years was slightly lower than that indicated in EDENH-II. If the more recent estimates are correct, the results of this study based on EDENH-II could slightly overestimate child mortality. Data from the 1988 census were not available at the time the study was carried out.

[4] To ensure consistency with previous estimates for Honduras (Guzmán and Santos, 1988), the values of ${}_5q_0$ were obtained by

applying the Trussell method (United Nations, 1983) to the data for all the women aged 15-34. The levels obtained for each age group, according to the West family of the Coale-Demeny model life-tables, were weighted by the total number of children ever born in each age group. From the average level thus obtained, the values of ${}_5q_0$ cited in the text were estimated.

[5] This refers to the social class of the head of household or the senior economically active member of the household if the head is inactive.

[6] These categories are those chosen as reference groups for the lowest mortality indicted in the bivariate analysis.

[7] In defining social class categories only one digit was used in order to maintain compatibility among the sources.

[8] For this purpose, new values of M were calculated separately for each area. In this case, the values of M represent the relationship between the observed mortality of children of a woman and the expected mortality in that area.

[9] In some instances, especially for data from EDENH-II, the number of observations in some categories is very small and hence the coefficients are unstable. It is the case, for example, with unskilled workers in the rural areas.

ANNEX

Definition of socio-economic strata

The criteria for the formation of the social classes are based on the questions on the occupation and occupational category of the head of household or the senior economically active person in the household. The classification of occupations, both in the 1974 census and in EDENH-II, used the Occupational Classification COTA 1960, revised for the 1970 American Census Programme and applied by the Inter-American Statistical Institute (1971). The one-digit occupational groups are as follows:

Code *Group*

0. Professionals, technicians and similar persons
1. Managers, administrators and executive officials
2. Office employees and persons in similar occupations
3. Traders, sales personnel and persons in similar occupations
4. Farmers, gamekeepers, fishermen, hunters, forestry workers and persons in similar occupations
5. Transport drivers and persons in similar occupations
6. Artisans and machinists concerned with textiles, manufacture of clothing and shoes, carpentry, construction and mechanical engineering
7. Other artisans and machinists
8. Workers and labourers not classified in other groups
9. Workers in services and similar occupations

x. New worker

I. Unknown

The occupational category is defined as the position occupied by a person in an activity or employment. Those positions were classified as follows:

Code *Group*

1. Employer
2. Self-employed worker
3. Wage-earner
4. Unpaid worker
9. Unknown

Six social groups were classified and distributed as follows:

Social class	Occupation	Occupational category
Middle class	0, 1, 2 and 3	3
Lower middle class	0, 1, 2	2, 4, 9
	3, 5, 6	1, 2, 4, 9
	9, 1	3
Unskilled workers	7, 8, 9	2, 3, 4, 9
Farmers	4	1, 2, 4, 9
Agricultural workers	4	3
Remainder	All the remaining combinations of occupation and occupational categories	

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VI. PARAGUAY: URBAN AREAS

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This chapter examines trends in socio-economic differentials in child mortality in urban Paraguay, using data from the two most recent national censuses, those of 1972 and 1982. The relationships between early-age mortality and various indicators of socio-economic conditions are analysed, following the framework and methodology discussed in chapters I and II. After a brief overview of the socio-economic and demographic context of Paraguay since the late 1950s, the population under study and the specific methods and socio-economic indicators used in the study are described. Analyses of the 1972 and 1982 census data are then presented in the following order: (*a*) differentials observed for each socio-economic characteristic under study; (*b*) composition of risk groups with respect to the probability of dying by age 5; and (*c*) results from multivariate regression models applied to the census data. Lastly, the findings are discussed in the light of their implications for public-health policies.

A. SOCIO-ECONOMIC AND DEMOGRAPHIC CONTEXT

Population, geography and economic development

Paraguay has an area of 406,752 square kilometres, with a population of 3,029,830 according to the 1982 census. It must be stressed that the population distribution is very uneven, for the eastern region covers only 39 per cent of the land but comprises 98.2 per cent of the population, because it offers a much more favourable environment for all economic activities.

Paraguay is a predominantly rural country. The urban population has grown only slowly in recent years. The degree of urbanization increased from 36 to 43 per cent of the total population between 1962 and 1982, according to the census data, indicating an urban proportion well below the average for Latin America in 1980 (65 per cent) (CELADE and Paraguay, 1986).

Asunción, with 457,210 inhabitants in 1982, is the only large town. It is surrounded by a metropolitan area made up of other towns of various sizes. Other smaller towns have gained in importance in recent years; by reason of their frontier location, they belong to regional development areas in which major infrastructure projects are being carried out.

Although Asunción is the country's most dynamic centre and contains in its vicinity, both urban and rural, the majority of the Paraguayan population, it has not been an important target for internal migration. Owing to the shortage of industrial jobs, migrants can find work only in the service sector. This factor and the high cost of urban housing have meant that most of the internal migration flows have been towards the peripheral towns. According to some authors, the main migratory flows have consisted of impoverished mid-scale farmers, part-time workers and others from small urban nuclei close to the capital. Those same groups also accounted for migratory flows to the new settlement areas established by the State at the end of 1950 and to Argentina in the 1970s (Galeano and Fogel, 1979).

The Paraguayan economy is based primarily on agricultural and livestock production. Its few industrial activities, found mainly in small industries and handicrafts, did not permit the import substitution that occurred in other Latin American countries. Although economic growth in Paraguay was very slow up to around 1970, it has since expanded significantly as a result of the accelerated development of the Brazilian economy, which not only required new markets for its own expansion but provoked the displacement of small and medium-sized farms. To this factor must be added the growth of agro-industry connected with the establishment of modern farms using advanced technology and little labour.

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It can thus be said, in general terms, that Paraguay has an economy based primarily on agricultural and livestock production, with slow urban development and a mainly rural population. Within this context, infant mortality is, on average, relatively moderate at the national level, but the imbalances observed in the estimates of infant mortality have pointed out clear inequalities in the distribution of national wealth (CELADE and Paraguay, 1986).

Although there is no reliable information about relevant social changes or programmes to improve the people's living conditions, the census data do show, for example, an improvement in educational levels and a decline in the relative proportion of less educated groups. Advances can also be seen in living conditions in terms of the availability of water supply within the household and of sewerage. Those advances, however, have been on a small scale and limited to a small part of the population. The absence of economic and social changes that could have improved the living conditions of the most underprivileged population segments is consistent with some of the results of this study, which indicate that socio-economic differentials in child mortality may have increased between the two most recent censuses.

Levels and trends in child mortality

Because of the poor quality of vital statistics in Paraguay, estimates of early-age mortality have to be derived from population censuses using indirect methods (CELADE and Paraguay, 1986).

Table 19 presents estimates of infant mortality for the entire country and by place of residence. Between 1955 and 1980, infant mortality declined from approximately 69 to 53 deaths per 1,000 births. That decline of 16 deaths per 1,000 live births in 20 years (23 per cent) occurred at a regular pace in all the five-year periods except for the first period, when the decline was slightly slower. During the period 1975-1980, Paraguay was one of the countries of Latin America with moderately low infant mortality rates, even though the Paraguayan rates were higher than those for Argentina, Chile, Costa Rica, Cuba, Panama, Uruguay and Venezuela (CELADE, 1984). Although the Paraguayan pattern conforms to the general downward trend in infant mortality in all countries of Latin America between 1950 and 1980, Paraguay is one of the countries with the slowest rate of decline (Guzmán, 1984), possibly because of the less favourable living conditions in some areas of the country.

An analysis of the differentials in infant mortality by degree of urbanization of the place of residence (CELADE and Paraguay, 1986) shows that infant mortality rates were higher in less urbanized places of residence for each of the five-year periods between 1955 and 1980. Infant mortality rates decline over time for all types of place of residence; however, a lesser degree of urbanization is associated with a slower rate of decline. The relative slowness of the rates of decline in the less urbanized areas may be due to an accentuation of regional imbalances in favour of Asunción and the more heavily populated towns, which have better developed urban infrastructure (housing, drinking-water and sewerage) and a heavier concentration of resources and health workers.

An analysis of infant mortality according to socio-economic and cultural characteristics shows that differentials exist in the expected directions: lower mortality rates are associated with better living conditions. Social inequality appears to have been increasing. Declines in the infant mortality rates are found, almost without exception, in the most privileged groups. In contrast, the data show little change in infant mortality rates for the lowest social groups. The same analyses also show that although there are some differences between the infant mortality rates in the same social group in different places of residence, they are not as large as the differences observed for different groups within each of the areas of residence (CELADE and Paraguay, 1986).

These analyses also show that Asunción, the largest urban centre and the capital of Paraguay, where the majority of the resources and the largest incomes are concentrated, is the area with the sharpest contrasts in infant mortality rates. Those results may indicate that urban life tends to magnify social differences rather than to standardize living conditions, not only by enhancing the position of the highest social groups but by accentuating the social, economic and cultural deprivation of the poorest

TABLE 19. INFANT MORTALITY RATES, BY DEGREE OF URBANIZATION OF PLACE OF RESIDENCE, PARAGUAY, 1955-1980
(Per 1,000)

Period	*Total*	*Degree of urbanization of place of residence*			
		Asunción	*Larger towns*	*Other urban*	*Rural*[a]
1955-1960	68.7	59.1	62.1	68.0	72.7
1960-1965	66.4	51.8	57.9	66.0	70.7
1965-1970	62.2	46.4	55.3	64.6	65.8
1970-1975	57.5	45.8	52.6	61.8	66.0
1975-1980	53.2	40.2	46.1	59.8	60.7
Percentage decline	22.6	32.0	25.6	12.1	16.5

Source: Centro Latinoamericano de Demografía and Paraguay, Ministerio de Salud Pública y Bienestar Social, *Paraguay: la mortalidad infantil según variables socio-económicas y geográficas, 1955-1980.* (Santiago, Chile, CELADE, 1986), p. 68.

[a] Adjusted for underreporting.

sectors, which presumably consist mainly of immigrants from rural areas or small towns who have settled in marginal districts.

Generally speaking, the data have demonstrated that although the level of infant mortality in Paraguay is fairly low, in the Latin American context, major differences exist among population groups.

B. DATA AND METHODS

The population under study

The data for this study were obtained from samples of the national population censuses carried out on 9 July 1972 and on 11 July 1982.

Earlier studies of child mortality using information from Paraguayan censuses (CELADE and Paraguay, 1986) evaluated the basic data for both the whole country and by degree of urbanization of place of residence. It was concluded that for the population defined as urban, the data from the two censuses were of roughly comparable quality, which is a requirement for the present study. The urban population accounts for 37 and 43 per cent of the total population in each census, respectively.

The evaluation of the data on children ever born and children who had died disclosed differential underreporting of dead children by place of residence. The underreporting was greater in 1982 for the rural areas of Paraguay; those areas were therefore eliminated from the present study. Some underreporting was also found for the urban areas in 1982, but this distortion remains in the acceptable range for the purpose of this research.

The study universe is composed of women aged 15-34 years who were the spouses of the head of household or female heads of household with a spouse identifiable in the census. Using indirect methods on the data for women under age 35 ensures that the mortality estimates shall refer to periods relatively close to the census years. In this case, the probabilities of dying by age 5 are centred on 1968 and 1978, respectively. It is assumed that the mother's spouse, in most cases the head of household, is the father of the children.

It should be noted that limiting the sample to women with an identifiable spouse causes a

TABLE 20. TOTAL NUMBER OF WOMEN, NUMBER OF WOMEN WHO REPORTED DEAD CHILDREN AND NUMBER OF CHILDREN WHO HAD DIED, BY DEGREE OF URBANIZATION OF PLACE OF RESIDENCE, URBAN PARAGUAY, 1972 AND 1982 CENSUSES

	1972 census			*1982 census*		
	Total number of women[a]	*Women who reported dead children*	*Number of children who had died*	*Total number of women*[a]	*Women who reported dead children*	*Number of children who had died*
Asunción	1 631	185	247	1 459	154	199
Larger towns	902	135	183	2 294	272	336
Other urban	1 317	261	345	1 965	279	372
Total	3 850	581	775	5 718	705	907

[a] Total number of women aged 15-34, with an identified spouse, who had at least one child.

selection bias with respect to the total sample of women aged 15-34 years. In this case, the population under study: (*a*) is older than the total group under age 35, with a larger proportion of women between 25 and 34 years of age; (*b*) slightly underrepresents the women of Asunción; and (*c*) has a higher level of education for both mothers and fathers. Despite the differences between the two populations, the analysis of the regression results both for all women and for currently married women does not reveal any differences that can be considered significant.

The sample from the 1972 census contained 3,850 women aged 15-34 who were currently married and had had at least one child. In the 1982 sample, that group consisted of 5,718 women. As can be seen in table 20, when the samples are broken down by place of residence, the strata become quite small, which may make it difficult to obtain statistically significant results.

Methodology

Estimation procedure

In this analysis, the methodology described in chapter II was used on the 1972 and 1982 census data to calculate the mortality indicator. More specifically, the following steps were taken. First, indirect mortality estimates were obtained from the data on the total number of children ever born and children who had died for all women in age groups 15-19, 20-24, 25-29 and 30-34. The Latin American pattern of the United Nations model life-tables (United Nations, 1982) was selected as the standard schedule of mortality. The level of mortality was determined by taking the weighted average of the levels identified for each age group, the weights being the total number of children ever born in each age group.

The expected proportions of children dead, by age group of mother, were then calculated by applying in reverse the multipliers designed to estimate the probabilities of dying from the proportions of children who had died. The equation for calculating the multipliers used in the case of Paraguay are given in Palloni and Heligman (1985). The probabilities of dying by age 5 corresponding to the Latin American pattern for the average mortality level in the population under consideration are given in section C (tables 21-24).

Lastly, for each currently married woman, the mortality index, M, the dependent variable of the model, was calculated as the ratio of her observed proportion of children dead to her expected proportion. Each observation was weighted by the total number of children ever born to the woman in order to treat the live birth, rather than the woman, as the unit of analysis.

Covariates of child mortality

This study analyses differentials in child mortality according to several social, economic and geographical characteristics described in chapter I. Those characteristics were chosen from among all the variables included in the censuses for their effectiveness as a means of identifying population groups with different mortality rates. For each

variable, categories considered significant for identifying differentials were determined. Those variables are: degree of urbanization; socio-occupational status of the head of household; mother's and father's level of education; material living conditions, as reflected in the quality of building materials, availability of drinking-water, lavatory facility and type of refuse disposal; and language spoken by the mother. Each of the variables is described below. Similarity between questions in the two censuses allows the use of the same definitions of variables and thus ensures comparability between the two sets of data.

Degree of urbanization of the place of residence

In the Paraguayan censuses, the definition of urban population is based on a political-administrative criterion which classifies as urban "all the towns which are official seats of districts of the Republic, regardless of any special characteristics" (Paraguay, 1982).

In spite of the heterogeneity of the urban areas so defined, it is possible, in practice, to differentiate localities according to their size. This produced three categories of place of residence. The first is the city of Asunción, the capital. The second includes the larger towns, which are, according to the most recent census, the 11 largest towns after the capital, although they are not of comparable size (between 19,000 and 75,000 inhabitants). Lastly, the other urban areas include the small towns and rural populations living in settlements of fewer than 5,000 inhabitants but identified as urban by the census. This last category thus has semi-rural characteristics.

Socio-occupational status of the head of household

In this study, the female population was classified by socio-occupational group on the basis of the occupation or occupational category of the head of household (or of the oldest active adult when the head was inactive). It is assumed that this classification represents the type of household living conditions that affect children exposed to the risk of dying in the first five years of life.

It is assumed that those groups, determined in part by the limitations of the census data and by the need to establish a small number of categories, reflect an average hierarchical scale of economic and social power which in turn determines different degrees of access to social benefits (education, housing, health and consumption in general) and helps identify groups with different standards of living. It is assumed that standard of living has a close relationship with health and that the socio-occupational variable so defined adequately describes the relationship between the national economic structure and mortality.

Four groups were established, two were obtained grouping predominantly urban activities; the other two resulted from grouping occupations usually found in the rural sector. Because of the small size of the sample, the urban middle and upper categories were grouped together. The rural occupations are uncommon in those urban populations; they accounted for only 17.1 per cent of the observations in 1972 and 12.5 per cent in 1982.

The urban occupations include, first, the middle/upper group, which comprises professionals and technicians, managers, administrators, civil servants, public employees, office workers, self-employed traders, merchants, travelling sales representatives and insurance agents. It is assumed that this group includes the types of employment that generally require the most education and have the highest income levels.

Secondly, the lower urban group, which is the largest, includes all manual activities in industry, handicrafts and services. The category includes salaried workers and wage-earners (the majority) and self-employed workers regardless of whether they are skilled workers. The sector includes the lowest income workers among those performing non-farm activities.

The next two groups are the self-employed farmers and the farm workers. The owners of large landholdings, numerically a very small group, were excluded from the analysis. Because of the agrarian structure in Paraguay, self-employed farmers consist mainly of small landholders whose production is

mostly for self-consumption. The farm workers are a relatively small group because waged work in the countryside is a supplementary and temporary activity performed by the same small landholders or members of their families for the sole purpose of augmenting the meagre family income.

The last two groups, although small because the sample is urban, are considered to represent the lowest levels on the social scale. They represent the subsistence sector of the economy and live on the extreme of rural marginality (Fogel, 1972). All the other types of occupation are grouped together.

Mother's and father's education

In many studies, the mother's educational level, measured by the number of years of schooling, has proved very useful for identifying subsectors of the population with different levels of infant and child mortality.

Five categories were defined for the analysis of the mother's and the father's educational level, with a view to identifying the differences between persons with only the first years of schooling, persons who had completed primary education and those with higher educational levels, that is, seven years or more. It must be stressed that, as for some other variables, the reference category, although formally the same, can in fact have slightly different characteristics from one year to another because of changes in its internal composition caused by the expansion of the education system.

Material living conditions

The census items included as variables representing material living conditions in this analysis are: quality of housing; water-supply; lavatory facility; and means of disposal of domestic refuse.

In order to develop an indicator of quality of housing, the data on the materials of the roof, walls and floor were combined. Three main housing groups emerged: good (and very good); average; and poor. To qualify as good, the dwelling must have brick, adobe or stone walls; a tile, wood or straw roof; and a brick, stone tile or cement floor. At the other extreme, poor housing designates all dwellings with earth floors, irrespective of the material of the walls and roof. Average housing includes dwellings built with other combinations of materials.

Four categories of water-supply were established: (*a*) public system inside the house or patio; (*b*) public system outside the house or patio; (*c*) well, standpipe or tank; and (*d*) river, stream or other source. Those categories assume, on average, a progressively lower degree of purity of the drinking-water. For individual cases, however, it is possible that when public water is transported over a considerable distance to the dwelling, it is more likely to be contaminated than is water from a properly constructed well or tank close to the dwelling.

The type of lavatory facility available in the dwelling is also an indicator of the quality of living conditions; and when this facility is inadequate, it is a major source of environmental pollution and contamination. The census categories distinguish the following types of lavatory facilities: (*a*) lavatory connected to the public sewer or to some other system (septic tank or cesspool); (*b*) municipal lavatory in which the pit is topped with bricks and has an earthenware cover or cement or wooden slab, and which is protected by an adobe or wooden booth; and (*c*) latrine or no-lavatory facility. A latrine is simply a pit covered with logs or planks.

With regard to the method of domestic refuse disposal, another variable that indicates the family's material living conditions, the population census includes three possibilities: (*a*) public collection; (*b*) incineration or burial in pits; and (*c*) other methods.

Language spoken by the mother

Since the 1972 census did not investigate the language spoken by individuals or households, this information is only available for 1982. Therefore, this variable must be excluded from the analyses that seek to describe the changes in mortality differentials over time. As this factor is of great interest, however, it is described for the most recent census sample.

Although it has been asserted that in Paraguay the contact between the indigenous people and the Spanish population has produced an irreversible process of integration (Rivarola and Heisecke, 1969), Guarani, the indigenous language, is still widely spoken by the mixed-race population, which is predominantly rural, and by an indigenous minority. In many cases, this language is also learned at older ages, as a requirement of trade and economic activity in general.

The study of Paraguayan bilingualism indicates that social class determines the acquisition of Spanish or Guarani. The existence of a cultural duality has been postulated, which, rather than representing the traditional dichotomy of whites versus Indians, is an expression of the distribution of the population in urban and rural areas (Corvalón, 1976). In broad terms it can be said that the middle and upper sectors, which are predominantly urban, learn Spanish as their first language, but the lower sectors, which are mainly rural, have Guarani as their mother tongue. However, Spanish is a means of upward social mobility and a channel for the transmission of urban culture, so that the school is the starting-point for bilingualism in Paraguay (Corvalón, 1981). Children whose mothers speak another language (other native languages, Japanese, German or Portuguese) account for a very small part of the population studied.

C. SOCIO-ECONOMIC DIFFERENTIALS IN CHILD MORTALITY

Differentials by important socio-economic characteristics

Bivariate regression shows that each socio-economic characteristic selected for this analysis, taken individually, is associated with differentials in the index of child mortality. For each characteristic, the reference category selected for the regression analyses is that with the lowest child mortality.

As is shown in table 21, the degree of urbanization of the place of residence is significantly associated with differences in the risks of dying in 1968 and in 1978. The degree of urbanization has a high level of internal heterogeneity with respect to the proximate determinants of mortality. As a result, the effect of being in one category rather than another remains modest.

In 1968, the risk of dying of children of currently married mothers aged 15-34 was higher in the other urban areas and in the larger towns than at Asunción. Ten years later, the mortality differentials had fallen for the other urban areas and for the larger towns, no more significant differences were observed in comparison with the capital.

The socio-occupational status of the household head appears to be highly associated with early-age mortality. In particular, it can be seen that farm workers and self-employed farmers have the highest regression coefficients for both periods. It should be noted, however, that because this is an urban population sample, those two groups produce only a small proportion of the total number of children. The differentials in child mortality for those groups appear to have remained relatively constant between the two censuses.

The lower urban group, made up basically of manual workers and artisans in all branches of economic activity, also differs significantly from the reference category. The differentials, however, may have narrowed between the two censuses. This group provides the highest proportion of live births in the subpopulation under study.

Mother's education is strongly associated with child mortality: children of mothers without any formal schooling have a significantly higher risk of dying than children of mothers with seven or more years of schooling. As expected, when the duration of formal education increases, the differentials in child mortality with respect to the lowest risk group decline for both years.

The father's educational level is also strongly associated with the risk of dying during childhood. The differentials are of a magnitude comparable to those found for the mother's educational level. As concerns the father also, there is a gradient in the differential risk of dying: longer formal education is more protective for the child.

To sum up, parental education identifies subgroups exposed to greater relative risks of dying

TABLE 21. BIVARIATE REGRESSION COEFFICIENTS OF CHILD MORTALITY, BY SOCIO-ECONOMIC CHARACTERISTICS, URBAN PARAGUAY, 1968 AND 1978

Characteristic	1968		1978	
	Mean	Regression coefficient	Mean	Regression coefficient
M	0.918	-	1.051	-
$_5q_0$	0.082	-	0.063	-
Degree of urbanization				
Other urban	0.396	0.258[a]	0.378	0.150[a]
Larger towns	0.228	0.179[a]	0.391	0.007
Asuncion	0.376	0.000	0.231	0.000
Constant	-	0.775	-	0.991
Socio-occupational status				
Farm worker	0.060	0.646[a]	0.040	0.630[a]
Self-employed farmer	0.111	0.468[a]	0.085	0.536[a]
Lower urban	0.491	0.350[a]	0.552	0.264[a]
Middle/upper urban	0.244	0.000	0.196	0.000
Other	0.094	0.237	0.127	0.079
Constant	-	0.634	-	0.824
Mother's education (years)				
None	0.078	1.026[a]	0.057	1.435[a]
One to three	0.266	0.754[a]	0.170	0.860[a]
Four to five	0.232	0.363[a]	0.191	0.391[a]
Six	0.208	0.127[a]	0.274	0.220[a]
Seven or more	0.217	0.000	0.309	0.000
Constant	-	0.528	-	0.688
Father's education (years)				
None	0.044	0.842[a]	0.037	1.115[a]
One to three	0.267	0.700[a]	0.161	0.809[a]
Four to five	0.221	0.308[a]	0.199	0.659[a]
Six	0.177	0.190[a]	0.261	0.303[a]
Seven or more	0.292	0.000	0.343	0.000
Constant	-	0.593	-	0.672
Quality of housing				
Poor	0.352	0.569[a]	0.248	0.681[a]
Average	0.175	0.226[a]	0.286	0.350[a]
Good	0.473	0.000	0.466	0.000
Constant	-	0.678	-	0.782
Water supply				
River	0.074	0.570[a]	0.137	0.617[a]
Well	0.707	0.303[a]	0.541	0.417[a]
Piped, outside	0.070	0.139[a]	0.057	0.505[a]
Piped, inside	0.149	0.000	0.265	0.000
Constant	-	0.651	-	0.712

(Table 21 continued)

TABLE 21 (*continued*)

Characteristic	1968 Mean	1968 Regression coefficient	1978 Mean	1978 Regression coefficient
Lavatory facility				
Latrine/none	0.550	0.610[a]	0.438	0.510[a]
Municipal lavatory	0.194	0.378[a]	0.167	0.134[a]
Sewerage	0.257	0.000	0.395	0.000
Constant	-	0.510	-	0.805
Refuse disposal				
Other method	0.086	0.357[a]	0.058	0.443[a]
Incineration	0.779	0.345[a]	0.734	0.333[a]
Public collection	0.135	0.000	0.208	0.000
Constant	-	0.618	-	0.781
Mother's language				
Only Guarani	..	..	0.182	1.026[a]
Other language	..	..	0.013	0.711[a]
Spanish and Guarani	..	..	0.702	0.514[a]
Only Spanish	..	..	0.102	0.000
Constant	-	..	-	0.494
Total number of cases	11 464	-	15 053	-

[a] Significantly different from zero at the 5 per cent level.

in comparison with the reference category. Table 21 also indicates that the mortality gaps between the various educational categories and the reference category increased between the two censuses.

All indicators of material living conditions indicate an association with early-age mortality levels. The differentials indicated by the regression coefficients are statistically significant, but their magnitude is lower than that of the differentials observed in the case of parental education.

Among those variables, the larger differentials are found for the quality of housing, the type of water-supply and the type of lavatory facility. Better living conditions are systematically associated with lower mortality at early ages. The differentials seem to have increased over time according to quality of housing and type of water-supply.

As in other studies in which the effect of language has been analysed, significant differences are found here between the mortality of the children of mothers speaking only Guarani, only another language, or Spanish and Guarani, in comparison with those speaking only Spanish. The differences are greatest for children whose mothers speak only Guarani: they are reduced but still large in the case of the bilingual population.

Child mortality levels by risk groups

In order to identify the groups with the greatest and lowest risks of dying by age 5, mortality rates were calculated from the 1982 census data for groups determined by three combined characteristics: degree of urbanization of the place of residence, quality of housing; and educational level of the mother. Those variables were chosen because they seemed to be the most strongly associated with child mortality and were thought to allow the identification of target groups for child health policies. The mortality indicator was calculated for each group and was converted into a probability of dying by age 5.

Five risk groups were then constituted according to their child mortality levels. Homogeneity of levels within each of the five risk groups was the guiding criterion for group formation.

Table 22 provides estimates of probabilities of dying by age 5 corresponding to the five risk groups identified. In general, the same categories of the socio-economic characteristics used in the bivariate regression analyses were retained, except with respect to quality of housing, where the categories "average" and "poor" were systematically grouped together. It was assumed that the estimates given in table 22, based on the data collected from women aged 15-34, represent the mortality risks of children of all women of child-bearing age.

The estimates given in table 22 show the wide spread in the probability of dying by age 5, varying from 19 to 181 deaths per 1,000 births. This spread indicates the existence of very different standards of living throughout the urban population of Paraguay, but the phenomenon is most extreme at Asunción.

The mother's education is the characteristic most clearly associated with child mortality. In contrast, housing quality is less clearly associated with child mortality, perhaps because of the regrouping of the categories for this variable.

The highest risk group (137 deaths under age 5 per 1,000 births) includes a small proportion of women aged 15-49 (2.6 per cent of the total) who had had formal education and were living in housing characterized as "bad" at Asunción and in other urban areas. At Asunción, in particular, child mortality under age 5 is extraordinarily high for those women (181 deaths per 1,000 births), as compared with women at the opposite end of the scale. This first risk group represents only 4.5 per cent of the births, and the average risk of dying in that group is 4.7 times that of the lowest risk group, showing clearly the great social contrasts existing in Paraguay, particularly at Asunción.

The high-risk group (92 deaths per 1,000 births) mainly consists of women who were illiterate or had very low levels of education. It is interesting to note that in the case of Asunción, the highest risk and high-risk groups include all women with less than six years of schooling, regardless of the type of housing. The high-risk group, in which the average probability of dying by age 5 is more than three times that of the lowest risk group, has the highest fertility. It includes 17.8 per cent of the women aged 15-49 and 24.2 per cent of the live births. In that group, child mortality varies from 81 to 110 deaths under age 5 per 1,000 births.

The intermediate risk group (64 deaths under age 5 per 1,000 births) consists of women with levels of schooling higher than that of the high-risk group—predominantly between four and six years—who were living, with some exceptions, in housing classified as average or poor. With a probability of a child dying by age 5 varying between 61 and 67 deaths per 1,000, this group accounts for 25.4 per cent of the births and 24.0 per cent of the women. Their average probability of dying by age 5 is 2.21 times greater than that of the lowest risk group.

Lastly, there are the groups classified as low risk and lowest risk, which have an average probability of dying by age 5 of 49 and 29 per 1,000, respectively. The low-risk group accounts for 15.9 per cent of the women and includes 13.6 per cent of the live births, while the lowest risk group accounts for 21.3 per cent of the women and 15.6 per cent of the births. The risk of dying by age 5 in the low-risk group is nearly double that of the lowest risk group.

It may be inferred from the foregoing discussion that approximately 30 per cent of all births to women aged 15-49 were, around 1978, subject to a probability of dying by age 5 of over 80 per 1,000, which is 25 per cent above the national average. Those groups of high mortality risk should be regarded as priority targets in any campaign to reduce child mortality levels. They are mainly concentrated, first, in the smaller cities and towns; and, secondly, at Asunción.

Multivariate regression analysis

Multivariate regression models were applied to the 1972 and 1982 census data to study the effects on mortality of each of the socio-economic

TABLE 22. CHILD MORTALITY AND POPULATION EXPOSED, BY SOCIO-ECONOMIC VARIABLES, URBAN PARAGUAY, 1978

Characteristics of group			*Probability of dying by age 5 (per 1,000)*		*1982 Census sample (percentage)*	
Place of residence	*Quality of housing*[a]	*Mother's education (years of schooling)*	$_5q_0$	*Relative risks*	*Women aged 15-49*	*Live births*
Total	-	-	63	-	100.0	100.0
Highest risk	-	-	137	4.72	2.6	4.5
Asunción	Poor	0	181	..	0.5	0.8
Other urban	Poor	0	128	..	2.1	3.7
High risk	-	-	9	3.17	17.8	24.2
Larger towns	Good	0-5	110	..	0.5	0.8
Asunción	Poor	1-3	107	..	1.2	1.7
Asunción	Good	0	107	..	0.7	0.8
Other urban	Good	0	98	..	0.4	0.7
Larger towns	Poor	0	100	..	1.5	2.4
Larger towns	Poor	1-3	99	..	0.9	4.1
Other urban	Good	1-3	88	..	1.7	2.5
Asunción	Good	4-5	86	..	2.1	2.2
Asunción	Poor	4-5	86	..	1.3	1.5
Other urban	Poor	1-3	85	..	3.8	5.9
Asunción	Good	1-3	81	..	1.6	1.8
Intermediate risk	-	-	64	2.21	24.0	25.4
Larger towns	Good	1-3	67	..	1.7	2.1
Other urban	Poor	6	66	..	3.6	3.5
Larger towns	Good	4-5	65	..	2.7	2.9
Larger towns	Poor	7+	65	..	2.5	1.7
Larger towns	Poor	4-5	64	..	2.9	3.3
Larger towns	Poor	6	63	..	3.2	3.0
Other urban	Poor	4-5	62	..	3.7	4.8
Asunción	Poor	6	62	..	1.6	1.5
Other urban	Good	4-5	61	..	2.1	2.5
Low risk	-	-	49	1.69	15.9	13.6
Other urban	Poor	7+	54	..	2.1	1.6
Asunción	Good	6	49	..	5.6	4.7
Other urban	Good	6	49	..	3.4	3.0
Larger towns	Good	6	47	..	4.8	4.3
Lowest risk	-	-	29	1.00	21.3	15.6
Other urban	Good	7+	33	..	3.5	2.6
Larger towns	Good	7+	31	..	5.9	4.3
Asunción	Good	7+	27	..	10.7	8.1
Asunción	Poor	7+	19	..	1.2	0.7
Not included	-	-	-	-	18.5	16.5

NOTE: Although the mortality estimates were based on data for women aged 15-34, they were assumed to represent all women of reproductive ages.

[a] Poor and average qualities of housing were grouped together for this analysis.

characteristics independently after controlling for the effects of all other characteristics.

The regression analyses were carried out in two stages. The first set of models includes the degree of urbanization of the place of residence and variables related to socio-cultural characteristics usually established prior to the child's birth, such as the mother's and the father's education and the socio-occupational status of the head of the household. The second set of models includes, in addition to those variables, the indicators of current material living conditions.

The results of the first set of regression equations are presented in table 23. As expected, the coefficients obtained in the multivariate models are lower than those in the bivariate models since the various socio-economic characteristics are somewhat correlated with one another. In particular, the association of child mortality with the socio-occupational status of the household head disappears. The relationship with mother's and father's education remains strong, while the relationship with the degree of urbanization of the place of residence shows an interesting change.

For 1968, the effects of the degree of urbanization on child mortality appear to be non-existent once the effects of the other variables are controlled. For 1978, however, the direction of those effects is the opposite of what is observed in the bivariate models, indicating that child mortality in the other urban areas and the larger towns was lower than at Asunción after controlling for mother's and father's education and socio-occupational status. In other words, holding other characteristics constant, living at Asunción has a negative effect on the child's survival.

The socio-occupational status of the household head does not show any strong association with child mortality when the other variables are controlled. This finding indicates that the relationship between socio-occupational status and child mortality is not direct but operates through other variables, such as parental educational level.

Maternal educational level remains the most important variable for identification of the risk of dying in early age; the children whose mothers have no schooling have the highest risks of dying. It should be noted that children whose mothers have six years of schooling do not have significantly different mortality risks from the children of the best educated group.

Paternal educational level also maintains its association with child mortality, even though the effects are smaller than those of the mother's education. The differentials appear to increase over time for all categories of the variable.

In the second stage of the regression analysis, indicators of material living conditions were incorporated in the equations with the previously studied variables. The results are shown in table 24. Again, with additional refinement, fewer categories of the first four factors were found to be significantly different from the most favoured group with respect to child mortality, and most coefficients are smaller than in the previous models.

Compared with the previous models, however, the coefficients for degree of urbanization are larger for 1978; all other urban areas appear to be more favourable to child survival than Asunción.

The coefficients obtained for socio-occupational status of the household head show, as in the previous regression, that no differentials in child mortality exist with regard to that characteristic.

The mother's educational level remains the most important variable in the model. It is striking that after more variables are controlled (that is, increasingly isolating the independent effect of a given risk factor), what emerges is a clear pattern of relative worsening over time of the relative effects of having the most and the least educated parents. It must be stressed that this effect is due not to an absolute increase in mortality over time, but rather to a relatively larger decline of the risk of dying in the group having the lowest risk.

As the independent effects of education appear more clearly, it is interesting to note that giving only three years of formal schooling to each woman could considerably lower child mortality.

With respect to the father's educational level, it should be noted that there is an increase in the mortality differentials between 1968 and 1978. Again, this relative increase should perhaps be

TABLE 23. MULTIVARIATE REGRESSION COEFFICIENTS OF CHILD MORTALITY, BY SELECTED SOCIO-ECONOMIC CHARACTERISTICS, URBAN PARAGUAY, 1968 AND 1978

Characteristic	*1968*	*1978*
M	0.918	1.051
$_5q_0$	0.082	0.063
Degree of urbanization		
Other urban	0.025	-0.127[a]
Larger towns	0.056	-0.118[a]
Asunción	[b]	0.000
Socio-occupational status		
Farm worker	0.129	0.138
Self-employed farmer	0.020	0.090
Lower urban	0.099	0.050
Middle/upper urban	[b]	0.000
Other	0.020	-0.097
Mother's education (years)		
None	0.760[a]	1.103[a]
One to three	0.550[a]	0.578[a]
Four to five	0.218[a]	0.155[a]
Six	0.052	0.095
Seven or more	[b]	0.000
Father's education (years)		
None	0.294[a]	0.533[a]
One to three	0.313[a]	0.463[a]
Four to five	0.032	0.445[a]
Six	0.018	0.205[a]
Seven or more	[b]	[b]
Constant	0.462	0.664
R^2	0.034	0.030
Number of cases	11 464	15 053

[a] Significantly different from zero at the 5 per cent level.
[b] Reference category.

interpreted as the result of a relatively larger decline over time in the probabilities of dying for the children with the best educated fathers.

For most of the additional variables incorporated at this stage, the coefficients are less easily interpreted than for the first four variables. Quality of housing is one variable that has relatively large and significant coefficients, although they are lower than those for education. Living in a dwelling of poor quality is detrimental to the survival of the child. The differentials increase slightly for the intercensal period.

Table 24 also includes a regression model in which the language spoken by the mother was incorporated for 1978. This characteristic appears to be strongly related to child mortality. The disadvantage for child survival of having a Guarani-speaking mother or a bilingual mother is great and significant. It can also be seen that the inclusion of maternal language scarcely alters the values of the other regression coefficients previously discussed.

In summary, in the multiple regression analyses, the variables showing consistent association with child mortality are: mother's education; father's education; quality of housing; and language spoken by the mother.

Because the influence of socio-economic factors on child mortality may vary according to the degree

TABLE 24. MULTIVARIATE REGRESSION COEFFICIENTS OF CHILD MORTALITY, BY SOCIO-ECONOMIC CHARACTERISTICS, URBAN PARAGUAY, 1968 AND 1978, AND INCLUDING MOTHER'S LANGUAGE FOR 1978

Characteristic	*1968*	*1978*	*1978 including mother's language*
M	0.918	1.051	1.051
$_5q_0$	0.082	0.063	0.063
Degree of urbanization			
Other urban	-0.085	-0.240[a]	-0.244[a]
Larger towns	-0.025	-0.209[a]	-0.211[a]
Asunción	[b]	[b]	[b]
Socio-occupational status			
Farm worker	0.046	0.025	0.005
Self-employed farmer	-0.074	-0.030	-0.051
Lower urban	0.060	-0.013	-0.020
Middle/upper urban	[b]	[b]	[b]
Others	-0.017	-0.149[a]	-0.142
Mother's education (years)			
None	0.657[a]	0.974[a]	0.931[a]
One to three	0.451[a]	0.453[a]	0.409[a]
Four to five	0.149[a]	0.056	0.018
Six	0.012	0.034	0.006
Seven or more	[b]	[b]	[b]
Father's education (years)			
None	0.163	0.396[a]	0.381[a]
One to three	0.216[a]	0.379[a]	0.364[a]
Four to five	-0.041	0.367[a]	0.345[a]
Six	-0.030	0.169[a]	0.157[a]
Seven or more	[b]	[b]	[b]
Quality of housing			
Poor	0.211[a]	0.273[a]	0.255[a]
Average	0.023	0.115[a]	0.123[a]
Good	[b]	[b]	[b]
Water supply			
River, stream etc.	0.053	0.254[a]	0.234[a]
Well, tank etc.	-0.126	0.097	0.078
Piped, outside	-0.309	0.146	0.138
Piped, inside	[b]	[b]	[b]
Lavatory facility			
Latrine/none	0.325[a]	0.075	0.053
Municipal lavatory	0.296[a]	-0.112	-0.127[a]
Sewerage	[b]	[b]	[b]
Refuse disposal			
Other method	-0.123	0.187	0.166
Incineration	-0.002	0.179[a]	0.165[a]
Public collection	[b]	[b]	[b]

(Table 24 continued)

TABLE 24 (*continued*)

Characteristic	*1968*	*1978*	*1978 including mother's language*
Mother's language			
Only Guarani	..	-	0.401[a]
Spanish and Guarani	..	-	0.319[a]
Other language	..	-	0.222
Only Spanish	..	-	[b]
Constant	0.482	0.554	0.335
R^2	0.041	0.035	0.036
Number of cases	11 464	15 053	15 053

[a] Significantly different from zero at the 5 per cent level.
[b] Reference category.

of urbanization of the place of residence, the sample was divided into three subsamples to examine possible interactions. The three subsamples are: Asunción; larger towns; and other urban areas. For each subsample, the mortality indicator was recalculated following the procedure described above in section B. It should be noted that when the population in those three groups is broken down by categories of the independent variables, the sample sizes may become too small to obtain reliable results. Regression coefficients are presented only for cells containing at least 100 observations. Table 25 shows the relative distribution of live births by category for each independent variable. Table 26 presents the multivariate regression coefficients.

It should be noted that as before, the mother's education is the variable that determines the largest differentials in child mortality in all the subsamples.

In comparing the three areas, one observes that the differentials associated with educational attainment of the mother are larger at Asunción than in larger towns or in other urban areas. Also, between 1968 and 1978, differentials in early-age mortality by mother's educational level increased considerably at Asunción, while no clear changes in the effects of that characteristic took place in the other two types of areas.

At Asunción, each additional amount of schooling for the mother up to completion of primary school will improve the chance of survival of the child. In the other two types of areas, only mothers with less than four years of schooling have greater child mortality risks. Those results may probably be attributed to the fact that the absolute mortality levels of children of the most educated women declined more at Asunción than in other areas between the two censuses. This factor in turn greatly increased the social contrasts between the highly educated groups and the least privileged sectors in the capital (immigrants from the countryside and small towns, who predominantly speak Guarani, live in settlements with low-quality housing and have no formal education).

The effects on child mortality of the father's educational level appear to be greater at Asunción than in the other areas, and the differentials also seem to be increasing over time in all three types of areas.

The regression coefficients obtained for the other characteristics under study are very difficult to interpret as their magnitude, sign and significance vary greatly from one subsample to another.

D. SUMMARY AND DISCUSSION

The purpose of this study was to analyse the changes in early-age mortality differentials over time in the urban areas of Paraguay using data from the two most recent censuses and a multiple regression model. This final section summarizes

TABLE 25. DISTRIBUTION OF LIVE BIRTHS, BY SOCIO-ECONOMIC CHARACTERISTICS, URBAN PARAGUAY, 1972 AND 1982 CENSUSES

Variable and category	*1968*			*1978*		
	Asunción	*Larger towns*	*Other urban*	*Asunción*	*Larger towns*	*Other urban*
Socio-occupational status						
Farm worker	0.60	3.64	12.59	0.37	2.60	7.66
Self-employed farmer	1.16	4.82	24.20	1.56	2.21	19.35
Lower	51.77	60.49	39.94	49.57	63.47	50.09
Middle/upper	38.57	18.11	14.43	29.60	20.37	12.58
Other	7.90	12.94	8.84	18.90	11.35	10.32
Mother's education (years)						
None	4.08	8.27	11.06	4.01	5.36	7.01
One to three	19.44	25.84	33.79	11.47	15.20	22.34
Four to five	19.93	24.58	25.44	12.94	18.34	23.53
Six	22.92	22.24	17.88	26.28	29.00	26.36
Seven or more	33.63	19.07	11.83	45.30	32.10	20.76
Father's education (years)						
None	2.20	2.34	7.58	1.87	3.80	4.57
One to three	16.27	25.50	37.18	9.48	13.71	22.53
Four to five	16.43	24.23	26.18	14.64	18.33	24.60
Six	20.02	20.79	13.73	21.64	27.95	26.89
Seven or more	45.08	27.14	15.33	52.37	36.21	21.41
Quality of housing						
Poor	23.31	30.86	49.11	11.35	20.07	37.80
Average	12.40	26.34	17.15	23.20	32.00	28.47
Good	64.29	42.80	33.74	65.45	47.93	33.73
Water-supply						
River, stream	7.44	8.19	6.88	18.07	15.90	8.73
Well, tank	40.58	86.83	90.13	14.27	57.85	74.43
Piped, outside	17.57	1.19	0.35	11.33	3.67	4.41
Piped, inside	34.41	3.79	2.64	56.33	22.58	12.43
Lavatory facility						
Latrine/none	33.02	60.41	72.67	27.78	41.12	56.43
Municipal lavatory	15.62	21.21	21.82	6.20	14.14	25.64
Sewerage	51.36	18.38	5.51	66.02	44.74	17.93
Refuse disposal						
Other method	9.32	5.28	9.94	8.21	4.87	5.20
Incineration	61.32	87.90	87.79	38.24	77.45	90.74
Public collection	29.36	6.82	2.27	53.55	17.68	4.06
Number of cases	4 315	2 612	4 537	3 470	5 893	5 690

and interprets some of the questions that arose in this investigation.

The statistical model used here made it possible to analyse the census data with simultaneous control of several variables and allowed the study of the association between early-age mortality and some important socio-economic and cultural factors as well as its changes over time. Other procedures used have also permitted identification of child mortality risk groups.

Because the socio-economic factors available for this study are those used in the censuses and their

TABLE 26. MULTIVARIATE REGRESSION COEFFICIENTS OF CHILD MORTALITY, BY SOCIO-ECONOMIC CHARACTERISTICS, URBAN PARAGUAY, BY DEGREE OF URBANIZATION, 1968 AND 1978

Risk factor	*1968*			*1978*		
	Asunción	*Larger towns*	*Other urban*	*Asunción*	*Larger towns*	*Other urban*
M	0.907	0.996	0.899	1.147	0.981	1.032
$_5q_0$	0.069	0.078	0.095	0.054	0.064	0.070
Socio-occupational status						
Farm worker	[a]	[a]	0.138	[a]	-0.141	0.047
Self employed farmer	[a]	-0.060	0.005	[a]	0.043	-0.009
Low	0.010	0.162	0.061	-0.013	0.043	-0.088
Middle/upper	[b]	[b]	[b]	[b]	[b]	[b]
Other	-0.556[c]	0.388[c]	0.096	-0.018	-0.227	-0.134
Mother's education (years)						
None	1.203[c]	0.464[c]	0.441[c]	2.603[a]	0.169	0.902[a]
One to three	0.720[a]	0.273	0.343[a]	1.170[a]	0.374[a]	0.284[a]
Four to five	0.360[a]	0.126	0.014	0.577[a]	-0.009	-0.045
Six	0.155	-0.073	-0.055	0.188	-0.058	0.044
Seven or more	[b]	[b]	[b]	[b]	[b]	[b]
Father's education (years)						
None	[a]	[a]	0.176	[a]	1.037[a]	0.357[a]
One to three	0.430[a]	-0.006	0.203[a]	0.832[a]	0.297[a]	0.319[a]
Four to five	-0.190	-0.008	0.017	0.183	0.289[a]	0.429[a]
Six	0.183	-0.078	-0.213[a]	0.183	0.056	0.253[a]
Seven or more	[b]	[b]	[b]	[b]	[b]	[b]
Quality of housing						
Poor	0.254[a]	0.146	0.265[a]	0.017	0.414[a]	0.190[a]
Fair	-0.486[a]	0.027	0.171[a]	0.116	0.260[a]	-0.010
Good	[b]	[b]	[b]	[b]	[b]	[b]
Water-supply						
River, stream	0.791[a]	[a]	0.293	0.376	-0.017	0.331[a]
Well, tank	-0.218	[a]	0.177	0.570[a]	-0.082	0.104
Piped, outside	-0.494[a]	[a]	[a]	0.240	0.034	0.104
Piped, inside	[b]	[a]	[b]	[b]	[b]	[b]
Lavatory facility						
Latrine/none	0.566[a]	0.328[a]	-0.019	0.049	-0.089	0.255[a]
Municipal lavatory	0.413[a]	0.195	0.052	-0.501[a]	-0.163	0.059
Sewerage	[b]	[b]	[b]	[b]	[b]	[b]
Refuse disposal						
Other method	-0.274	0.158	0.147	0.677[a]	0.091	-0.207
Incineration	-0.196	0.166	0.403[a]	0.277[a]	0.140	-0.062
Public collection	[b]	[b]	[b]	[b]	[b]	[b]
Constant	0.592	0.895	-0.813	0.337	0.617	0.427
R^2	0.075	0.020	0.047	0.100	0.025	0.036
Number of cases	4 315	2 612	4 537	3 470	5 893	5 690

[a] Very small number of cases, leading to a very large sampling variation.

[b] Reference category.

[c] Significantly different from zero at the 5 per cent level.

relationship with early-age mortality is not necessarily one of a direct causal nature, it cannot be claimed that this model has established a causal explanation of the changes in child mortality. This study has, however, brought out the strength of the relationships between a set of important socio-economic variables and child mortality. Because of the poor quality of the census data pertaining to the rural areas of Paraguay, the study was done only for the urban part of the country.

The degree of urbanization of place of residence is associated with early-age mortality in urban Paraguay. The results indicate that other factors being equal, living at Asunción or in other large cities can be detrimental to the child's survival, even though the absolute levels of mortality are actually lower in those cities than in the other urban areas of the country.

The results of this study underscore the primary role of the mother's education in determining her child's chances of survival. This is, of course, a frequent finding in studies of child mortality. The close association of maternal education with early-age mortality, expressed in persistently high regression coefficients when other factors are controlled, shows that this variable is in turn associated with factors more directly related to the child's welfare, which are not included in this analysis. Of course, the number of years of formal schooling is only an indicator of the capacities, knowledge and skills that are acquired through education and that are crucial for the child's survival. At Asunción, any additional amount of schooling for the mother (up to completion of primary school) reduces the risk of dying for the child.

The father's education is secondary in importance to the mother's educational level. Its effects on early-age mortality increased between the two censuses. The interpretation of those effects is difficult, as paternal education may be an indicator of a series of factors ranging from income and social class to living conditions and attitudes towards child health. The increase over time in child mortality differentials by level of the father's education may be connected with the influence of this factor on decisions about the children's health. The relatively greater decline in child mortality in the group of best educated fathers between 1968 and 1978 points to a possible change of attitude towards more responsible fatherhood among persons with higher education.

With regard to the socio-occupational status of the head of household, supposedly an indicator of the household's socio-economic standing, the results indicate the effects of this factor operate mainly through the other factors included in the models, mainly the educational level of the parents.

The results with respect to the indicators of material living conditions are inconsistent, perhaps because of the high degree of collinearity between those factors. Nevertheless, housing of poor quality is negatively associated with child survival.

The important role played by maternal language in determining the child's chance of survival points out the disadvantaged position in the social structure that Guarani-speaking and bilingual mothers may have. An example of the additional disadvantage that such mothers may have, once their educational level and other characteristics are taken into account, is their more limited access to health services, which are primarily delivered in Spanish in urban Paraguay. Different cultural practices may also exist in the Guarani-speaking group, which could be worth investigating.

It was also possible in this study to identify groups with higher risks of early-age mortality. Such groups were constituted on the basis of the place of residence, quality of housing and education of the mother. It is clear from this analysis that the mothers for whom social policies, and in particular, health policies can be oriented in order to reduce mortality in early ages of life are those with the lowest educational level, that is, mothers with less than four years of formal schooling.

Despite its limitations, this study has once again underscored the predominant role of maternal education in determining the risk of dying at an early age. It has also shown that in Paraguay, paternal education is playing an increasingly large role in determining child survival. Disadvantages linked to cultural factors are indicated by the child mortality differentials observed by linguistic grouping.

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VII. JORDAN

*Kenneth Hill**

This study of socio-economic differentials in child mortality in Jordan[1] is intended to identify categories of children at high risk of early-age mortality, to investigate patterns of differentials in child mortality and to see how such patterns are changing over time. Rapid social and economic changes have been taking place over the past two decades in Jordan. Child mortality has fallen rapidly since the 1950s, and it is of considerable interest to examine the extent to which this decline can be accounted for by largely social and economic factors and the extent to which the decline has occurred independently of socio-economic change.

The data for this study come from two broadly similar household surveys conducted, respectively, in 1976 and 1981, both of which collected information on child mortality and on a range of household and individual characteristics.

The first section of this chapter describes the socio-economic and demographic context of Jordan. Levels and trends of child mortality in Jordan are examined. In section B, the data sets used in this study are described in detail, and data quality is assessed. The methodology used to examine the relationships between child mortality and selected socio-economic variables is then described briefly, concentrating mainly on the differences between the model used here and those used in other studies in this publication. Section C presents the results of the regression model, discusses time trends and identifies risk groups. In the last section, the implications of the major findings, particularly for policy, are considered.

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A. SOCIO-ECONOMIC AND DEMOGRAPHIC CONTEXT

Geography, society and economy

Jordan is situated on the banks of the Jordan river. In this study of the population of Jordan, the occupied West Bank[1] is excluded. An area of about 90,000 square kilometres, bordering on the Syrian Arab Republic to the north, Iraq to the east and Saudi Arabia to the east and south is covered in the study.

Ecologically, Jordan can be divided into three regions: an area of sparsely populated, largely pastoral semi-desert to the east; the more populated central uplands supporting cereal and vegetable cultivation and incorporating the major urban centres of Amman, Zarka and Irbid; and the low-lying Jordan River-Dead Sea depression area, which has rapidly expanding irrigated production of fruits and vegetables.

Demographic, social and economic indicators for Jordan since the early 1960s are shown in table 27. The population of Jordan has grown rapidly over the past two or three decades, as fertility has remained high and mortality has declined rapidly. The 1961 population census enumerated 901,000 people (excluding the West Bank); by the 1979 census, the total had increased to 2,011,000. Urbanization increased gradually over the same period, from 52 per cent urban in 1961 to 59 per cent in 1979. The population is overwhelmingly Muslim, with a small Greek Orthodox segment and other Christian minorities. The traditional household structure is the extended family, although increasing urbanization is changing the traditional pattern.

The economy is based on the principle of free enterprise in combination with government initiatives and incentives. Economic growth was rapid through the 1960s and 1970s, averaging about 10 per cent per annum throughout the period.

TABLE 27. DEMOGRAPHIC, SOCIAL AND ECONOMIC INDICATORS, JORDAN, 1960-1985

Indicator	*Year*				
	1961	*1969*	*1975*	*1979*	*1981*
Population					
Total (thousands)	901	..	..	2 011	..
Density (km²)	9	..	..	21	..
Percentage urban	52	..	..	59	..
Fertility					
Total fertility	7.99[a]	7.99[b]	7.79[c]	7.38[d]	7.28[e]
Mortality					
Expectation of life at birth, e_0	48.2[a]	51.7[b]	56.6[c]	61.2[d]	63.7[e]
Probability of dying by age 5, ${}_5q_0$	0.197[a]	0.150[b]	0.116[c]	0.088[d]	0.072[e]
Education					
Percentage aged 15+ with schooling	..	..	52	..	57
Percentage enrolment[e]					
Primary	..	95[f]	..	..	99[g]
Secondary	..	38[f]	..	..	79[g]
Tertiary	..	2[f]	..	..	37[g]
Health services (per 10,000 population)					
Physicians	..	6	4	..	8
Authorized nurses	..	2	2	..	3
Midwives	..	1	1	..	1
Hospital beds	..	11	13	..	12
Economy					
Gross domestic product per capita (1970 dollars)	..	..	538	..	1 494

Sources: The sources for table 27 are given below by category:

Population: *1961*: Jordan, *First Census of Population and Housing 1961* (Amman, Department of Statistics, 1964); *1979*: Jordan, *Housing and Population Census 1979* (Amman, Department of Statistics, 1983).

Fertility: *World Population Prospects, 1988* (United Nations publication, Sales No. E.88.XIII.7).

Mortality: for expectation of life at birth, *World Population Prospects, 1988* (United Nations publication, Sales No. E.88.XIII.7); for probability of dying by age 5, *Mortality of Children Under Age 5: World Estimates and Porjections, 1950-2025* (United Nations publication, Sales No. E.88.XIII.4).

Education: for percentage enrolment, World Bank, *World Development Report 1988* (New York, Oxford University Press for the World Bank, 1988).

Health Services: *1969, 1975*: Jordan, *Statistical Yearbook 1978* (Amman, Department of Statistics, 1978); *1981*: Jordan, *Statistical Yearbook 1983* (Amman, Department of Statistics, 1983).

Economy: Jordan, *Statistical Yearbook 1983* (Amman, Department of Statistics, 1983).

[a] 1960-1965.
[b] 1965-1970.
[c] 1970-1975.
[d] 1975-1980.
[e] 1980-1985.
[f] 1965.
[g] 1985.

Growth was somewhat less rapid in the 1980s, however, with an average annual growth rate of only about 5 per cent. Gross domestic product per capita increased from about $540 in 1975 to nearly $1,500 in 1985, both in constant 1970 dollars. The economy is largely a service economy: for 1986, the World Bank estimated that the service sector generated 63 per cent of GDP, compared with only 8 per cent from the agriculture sector and 28 per cent from the industry sector. In external accounts, a chronic trade deficit is approximately balanced by a large inflow of remittances, though balance-of-payments problems slowed the pace of development in the 1980s.

Social development has also been rapid over the past two decades. As is shown in table 27, primary school enrolment was essentially complete by 1965; but secondary enrolment levels increased from 38 per cent of the appropriate age group in 1965 to 79 per cent in 1985, with particularly strong changes for females, and tertiary enrolment increased from a mere 2 per cent in 1965 to a healthy 37 per cent in 1985. Expansion in the education sector has thus been extremely rapid. Changes in the health sector, however, have been less dramatic. On a per capita basis, the numbers of physicians, nurses and hospital beds have remained essentially constant since the late 1960s. At the same time, mortality has fallen dramatically: the probability of dying by age 5 declined from about 200 per 1,000 in the early 1960s to approximately 70 per 1,000 in the early 1980s; and expectation of life at birth increased from about 48 years to about 64 years over the same period.

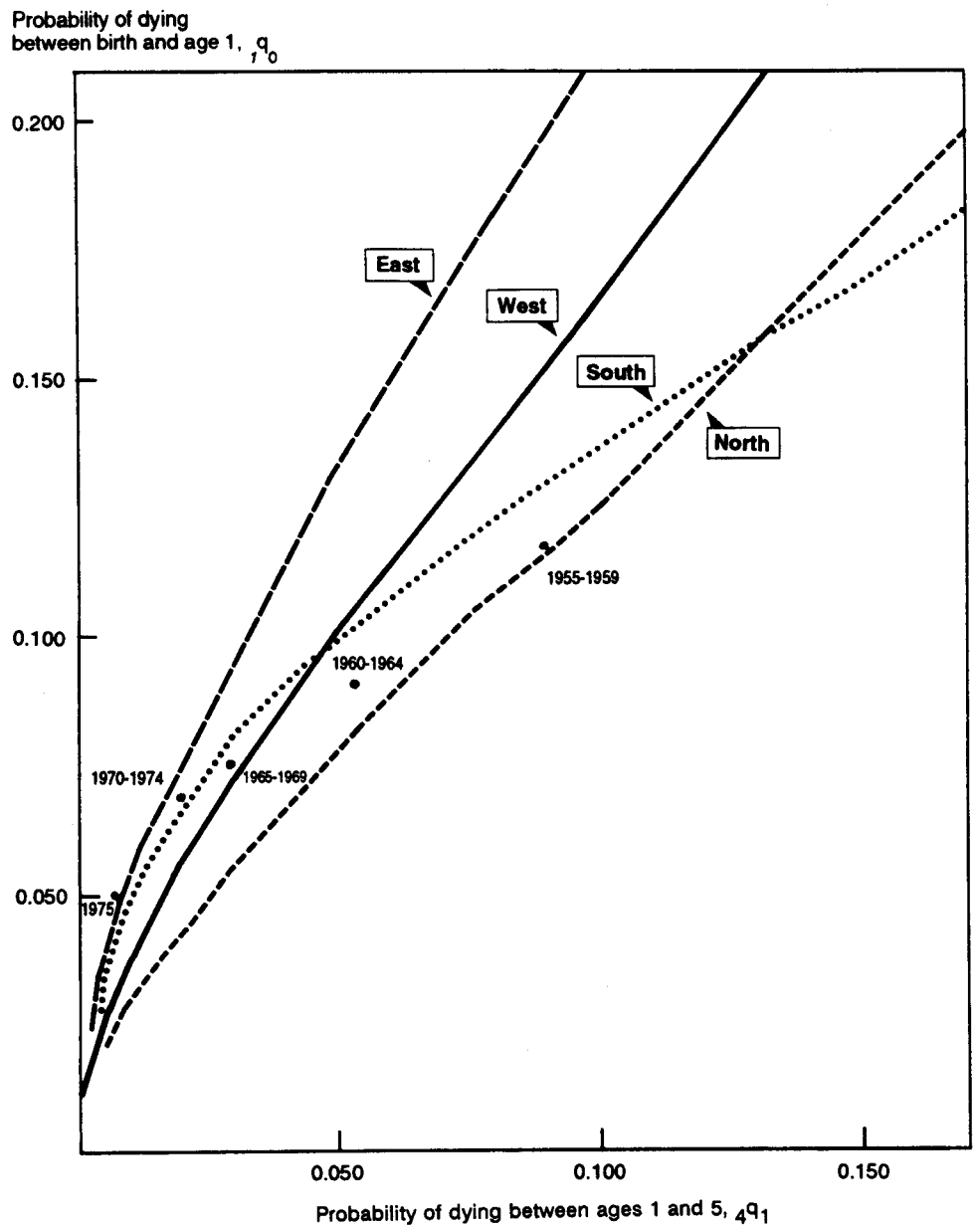
Levels and trends in child mortality

Birth and death registration in Jordan is not sufficiently complete to provide a satisfactory basis for measuring either levels or trends in infant and child mortality. Child mortality estimates for Jordan must therefore be derived from census and survey data. Fortunately, a number of censuses and surveys have been carried out since the early 1960s, so it is possible to track levels and trends of child mortality from the 1950s to the late 1970s with some confidence.

Both the 1961 and the 1979 census collected information on children ever born and children surviving for all ever-married women. The proportions dead of children ever born, classified either by five-year age group (15-19, 20-24 etc.) or by five-year duration of marriage group (from zero to four years, from five to nine years etc.), provide estimates of probabilities of dying by exact ages of childhood and approximate point reference dates for those estimates (Brass, 1964; and United Nations, 1983). Similar data were also collected in 1976 by the Jordan Fertility Survey (JFS), part of the World Fertility Survey programme, and in 1981 by the Jordan Demographic Survey (JDS). Two additional surveys, the National Fertility Survey in 1972 and the Fertility and Family Health Survey in 1983, also collected the necessary data. Those sources, however, give rise to unacceptably low estimates of child mortality and have therefore not been used further. JFS also collected complete maternity histories from each ever-married woman, including the date of each live birth and the age at death of any children who had subsequently died. Such data permit the calculation of direct estimates of child mortality through life-table methods.

The United Nations methods (United Nations, 1983) for estimating child mortality from the proportions of children who had died among those ever born require the prior selection of an appropriate pattern of child mortality from the Coale and Demeny (1966) families of model life-tables. For Jordan, the selection has been guided by the life-table estimates of child mortality available from JFS for five-year calendar periods (Rutstein, 1983). Figure IV shows the relationship between the probability of dying by age 1 (the life-table infant mortality rate, ${}_1q_0$) and the probability of dying between exact ages 1 and 5, ${}_4q_1$, for each five-year period. Also shown are the corresponding relationships for each Coale and Demeny family of model life-tables. At first sight, the JFS relationships appear to change from a North pattern in the period 1955-1959 to a South or East pattern in the early 1970s. However, maternity history estimates of ${}_1q_0$ and ${}_4q_1$ are strongly affected by the heaping of age at death on age 1. Such heaping certainly affected the JFS maternity histories, and assuming that some part of the heaping results from ages at death below age 1 were reported as one year, the resulting ${}_1q_0'$ will be biased downward while the resulting ${}_4q_1$ will be biased upward. If the points in figure IV were moved

Figure IV. Age patterns of child mortality as observed by the 1976 Jordan Fertility Survey, compared with patterns from the Coale and Demeny model life-tables, Jordan



Sources: Based on Ansley J. Coale and Paul Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, New Jersey, Princeton University Press, 1966); and Shea Oscar Rutstein, *Infant and Child Mortality: Levels, Trends and Demographic Differentials*, World Fertility Survey Comparative Studies, No. 24 (Voorburg, Netherlands, International Statistical Institute, 1983).

upward and to the left to adjust for such bias, they would follow a pattern very similar to that of the South family as mortality declines from period to period. The South pattern has therefore been chosen for the analysis of the proportions dead among children ever born. Each proportion dead is then converted into a probability of dying by an exact age of childhood, and a point time reference is estimated for each such probability. To simplify presentation and comparison, each probability of dying is then converted into a standard form, the probability of dying by exact age 5, ${}_5q_0$, again using the South family of model life-tables.

Figure V shows the resulting estimates of ${}_5q_0$ from each data source, using the proportions dead calculated by age group of mother, plotted against time. Also shown are the direct estimates of ${}_5q_0$ by time period obtained from JFS. The resulting indirect estimates show a high degree of consistency, indicating satisfactory data comparability between surveys and in all probability reasonable data accuracy also. The direct estimates from JFS indicate somewhat lower child mortality than the indirect estimates; it is possible that the former figures are somewhat too low, as a result of overstating of age at death in the maternity histories, or that the latter estimates are somewhat too high, as a result of misspecification of the age pattern of fertility through the use of ratios of average parities for successive age groups. Nevertheless, there can be no doubt that child mortality has fallen sharply in Jordan since the early 1950s, the decline in ${}_5q_0$ being approximately linear through the 1950s, the 1960s and the first half of the 1970s. The probability of dying by age 5 fell from approximately 270 per 1,000 live births around 1950 to about 90 per 1,000 live births by 1975, a decline of two thirds in a period of 25 years. Some indication from figure V of a slow-down in the pace of decline in the late 1970s may be due more to shortcomings in the indirect methodology being used than to an actual slow-down in the pace of child mortality decline.

B. DATA AND METHODS

Data sources

As indicated earlier, this study uses data on child mortality and family and household factors expected to influence such mortality from two sample surveys: the Jordan Fertility Survey (1976) and the Jordan Demographic Survey (1981). Alhough rather similar data sets have been extracted from these surveys, the two have some important differences in survey procedures (see Jordan, 1979 and 1983a).

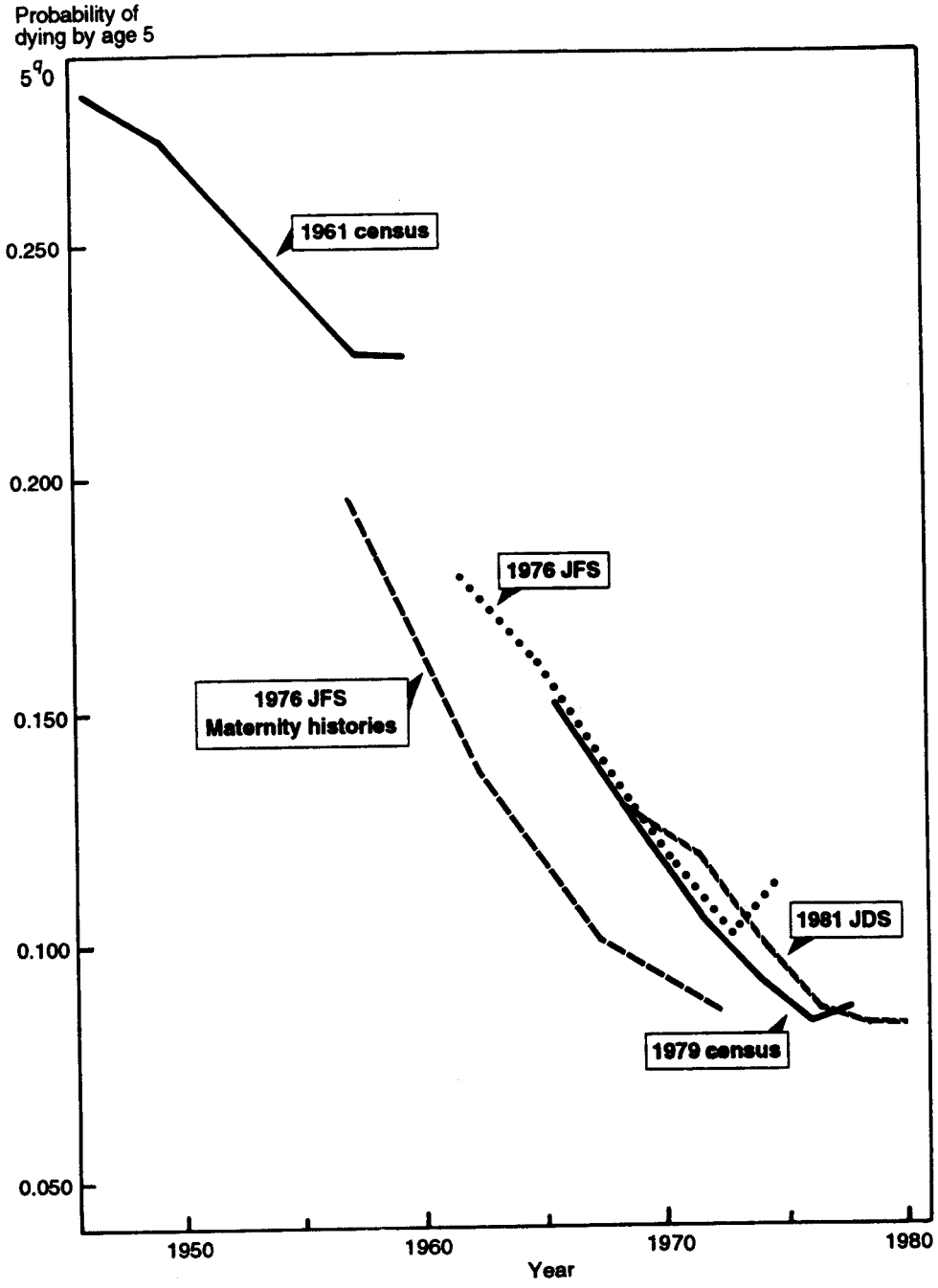
Sampling

The JFS sample was intended to cover 5 per cent of households, in one in four of which ever-married women aged 15-49 would be selected for detailed interview, including a full maternity history. The design was intended to produce some 4,000 completed detailed interviews. The data set used here is based on the responses to the detailed interviews. The sampling frame was based on the agricultural census of 1975, for want of a recent complete population census, involving seven strata reflecting varying degrees of locality size. Serious problems were encountered with the sample frame in urban areas, and *ex post facto* weights (also allowing for non-response) were used to try to adjust for the deficiencies of the frame. By comparison with the results of the 1979 population census, the weighted JFS data appear to overrepresent urban areas other than Amman, at the expense of both Amman and rural areas. Such sampling problems may affect estimates of aggregate levels of child mortality but should have little effect on estimates of relative differentials.

The JDS sample was based on the results of the 1979 population census, using a self-weighting, replicated, multi-stage design. The master design consists of 21 independent replicates, each intended to produce a sample of approximately 1,000 households; JDS used 14 of the replicates, for an expected sample of about 14,000 households. No problems with the sampling procedure have been reported.

The criteria for inclusion in the survey varied slightly between the two surveys. In 1976, JFS was carried out in two stages: in the first stage, a household questionnaire was used in all sample households on a *de facto* basis, including all those who had slept in the household the night before the interview; in the second stage, from four to six weeks later, the detailed questionnaire for women

Figure V. Estimates of the probability of dying by age 5, Jordan



Sources: Based on Jordan, *First Census of Population and Housing 1961* (Amman, Department of Statistics, 1964); *Jordan Fertility Survey 1976: Principal Report* (Amman, Department of Statistics, 1979); *Jordan Demographic Survey 1981: Principal Report* (Amman, Department of Statistics, 1983); Jordan, *Housing and Population Census 1979* (Amman, Department of Statistics, 1984); and Shea Oscar Rutstein, *Infant and Child Mortality: Levels, Trends and Demographic Differentials*, World Fertility Survey Comparative Studies, No. 24 (Voorburg, Netherlands, International Statistical Institute, 1983).

was administered to a 25 per cent sample selected in advance from the household listings of eligible women (ever-married and aged 15-49) included *de facto* in the household listing. The data used in this study come from the questionnaires for individual women, and inevitably there was some loss to follow-up from the household to the individual stages of the survey. JDS, in contrast, was conducted in 1981 in one step, but on a combined *de facto* and *de jure* basis, including both those who had slept in the household the night before the survey and those who were normally resident in the household but were temporarily absent at the time of the survey. The data used in this study include both the *de jure* and the *de facto* populations.

Questionnaires

The main difference between the 1976 and 1981 questionnaires, from the perspective of this study, was the use of a full maternity history in 1976 (JFS). Both surveys included questions to ever-married women (aged 15-49 in JFS, 13 and over in JDS) on the numbers of sons and daughters living with the mother and living elsewhere; JDS also asked about the numbers of sons and daughters who had died, whereas JFS asked the number of children, of both sexes combined, who had died. Although both surveys used rather similar question sequences to obtain data on lifetime fertility, in 1976, JFS then went on to collect a full maternity history, with the date of birth and, if relevant, the age at death of each child; the maternity history and the lifetime summary data would then be reconciled if there was any discrepancy between the two. This reconciliation process, which was used for JFS but not for JDS, might result in some differences between the two data sets.

One area where the questionnaires differed substantially was in the collection of information on economic activity. JFS collected data in 1976 on the occupation and work status of both the husband and the mother. JDS, on the other hand, collected data on the source of income of the family by sector (public, private, agriculture etc.), but no specific information on occupation. Indicators of economic activity comparable across the two surveys could thus not be constructed, and the basic model excludes those important variables. Separate models for data from each survey, however, do include occupation and source of income variables.

Both surveys included questions about date of first marriage, though the JFS question referred to the month and year when the respondent began living with her first (second, third, ...) husband, whereas the JDS question referred to the month and year of first marriage. If marriage and cohabitation do not coincide, those two question forms could give systematically different results; in general, in Jordan, the marriage ceremony and cohabitation do essentially coincide. If a respondent could not provide the information requested as to month and year, both surveys asked for age at first marriage instead. If this information also was not known, JFS (1976) asked the number of years since the marriage took place, whereas JDS (1981) required the interviewer to arrive at an estimate of age at first marriage.

Most of the other questions from which data are used in this study differed only trivially if at all between the two surveys. Questions on age, education and type of lighting were essentially the same. Both surveys collected data on water-supply: the JFS categories were running water in the household, running water outside the household, well water and other sources; JDS used broadly similar categories, private tap, common tap, tanker, well and other, but apparently the Arabic form of the pre-coded answers would include a tap inside a household compound but physically outside the house itself as a common tap, and the word used for tanker was unclear.

One further minor difference of relevance to the study should be noted. In 1976, JFS distinguished between Amman, the city of Zarka, the city of Irbid, other towns, large villages, medium-sized villages and small villages. JDS, on the other hand, used only three classifications in 1981: the cities of Amman, Zarka and Irbid; other urban areas; and rural areas. In order to have consistent definitions between the two surveys, a single urban/rural distinction was used for this study, with urban including the three cities and all towns and rural including villages of all sizes up to a 10,000 population.

TABLE 28. AVERAGE PARITY AND AVERAGE NUMBER OF CHILDREN DEAD, BY AGE AND FIRST MARRIAGE COHORTS, JORDAN, 1976 AND 1981

Age group	Average parity			Average number of children dead		
	1976	1981	Cohort increment	1976	1981	Cohort increment
		A. *Age cohorts*				
15-19	0.173	0.108	0.108	0.014	0.007	0.007
20-24	1.546	1.199	1.026	0.124	0.080	0.066
25-29	3.703	3.395	1.849	0.322	0.254	0.130
30-34	5.690	5.469	1.766	0.562	0.447	0.125
35-39	7.123	7.150	1.460	0.820	0.697	0.135
40-44	8.428	8.256	1.133	1.429	1.005	0.185
45-49	8.602	8.610	0.182	1.445	1.235	-0.194
		B. *First-marriage cohorts*				
0-4	1.088	1.119	1.119	0.070	0.058	0.058
5-9	3.223	3.385	2.297	0.243	0.217	0.147
10-14	5.270	5.543	2.320	0.522	0.442	0.199
15-19	6.917	7.229	1.959	0.713	0.704	0.182
20-24	8.111	8.623	1.706	1.065	0.963	0.250
25-29	9.110	9.350	1.239	1.554	1.261	0.196
30-34	9.613	9.580	0.470	1.809	1.473	-0.081

Data quality

Since this study is concerned with differentials in child mortality, the quality of the information on child mortality is of particular concern. It has already been shown that the child mortality estimates derived from the data collected by JFS in 1976 and JDS in 1981 are highly consistent, both with each other and with the estimates from the censuses of 1961 and 1979. This consistency argues strongly for high data quality. Because the two surveys were carried out five years apart, however, further consistency checks can be applied by examining the plausibility of cohort changes from one survey to the next. For this purpose, cohorts can be defined either in terms of age group at the first survey (for example, the women aged 20-24 in 1976 survive to become the women aged 25-29 in 1981) or in terms of duration of marriage at the first survey (for example, those first married from five to nine years prior to the 1976 survey survive to become the women first married from 10 to 14 years prior to the second survey). Such comparisons can be made both for the average number of children ever born by women of each cohort and also for the average number of those women's children who had died, providing an extremely sensitive consistency check on the reporting of both lifetime fertility and child deaths. The comparisons are shown in table 28.

The average parities given in table 28 show some interesting features. By age group, the 1981 average parities for younger women are considerably lower than the corresponding values from 1976, whereas for groups with short duration of marriage the 1981 average parities are higher than the corresponding 1976 values. Age at marriage clearly rose sharply between 1976 and 1981, reducing lifetime fertility at young ages, whereas marital fertility probably rose. From a data evaluation viewpoint, however, interest centres on the cohort increments of parity and child deaths. Those increments should always be positive, since for the same women neither the average number of children ever born nor the average number of children who have died can decline.[2]

Both the cohort parity increments and the cohort child death increments should also approximately follow age- or duration-specific patterns of fertility. This is true for parity because each

increment represents the additional fertility apparently contributed by five years of additional exposure. It is also approximately true for child deaths because the probability of a child death is greatest by far in infancy and early childhood; average numbers of children dead thus follow average parity fairly closely.

With a couple of exceptions at high ages or durations, the cohort increments follow expected patterns very closely. For age cohorts, the parity increments behave exactly as expected and sum to 7.5, an estimate of total fertility for the period 1976-1981 that agrees closely with other estimates of total fertility for the period. Similarly, the average parity increments by marriage cohort show high marital fertility until duration 10-14 years, after which marital fertility gradually declines; the sum of the cohort increments is over 11, indicating extremely high fertility within marriage. The increments for children dead behave more or less as expected by both age and duration of marriage, except for the negative increase for the highest age and duration cohorts and for the large increase for the cohort aged 35-39 in 1976 in relation to the cohort's parity increment. The cohort increments suggest that there may have been some omission of child deaths by the oldest women in 1981, but that up to age 35, or duration of marriage 20, the 1976 and 1981 data are remarkably consistent, and in all probability remarkably accurate.

There are, however, some clear data deficiencies. Age-misreporting in 1976, and in all probability reporting on duration of marriage as well, suffered from very substantial heaping on ages ending in digits 0 and 5 (Jordan, 1979); age-heaping in 1981 was much less pronounced. Such heaping probably has only minor effects on the analysis described here; systematic bias, for which there are no clear measures, would be potentially more serious. No doubt many other pieces of data used in this study, such as educational level, occupation or work status, suffer from deficiencies to a greater or lesser extent. However, sensitive techniques for the detection of such errors are not as well developed as they are for mortality indicators, and a thorough evaluation is not possible.

Overall data quality for the dependent variable for this analysis, namely, child mortality, appears to be excellent. Known problems affect classifications by place of residence, age and, by implication, duration of marriage; and problems of unknown magnitude no doubt affect all the other variables used. However, a soundly measured dependent variable is a good beginning, and problems with the other variables are probably no worse than those usually encountered in data sets for developing countries. In general, the definitions used in 1976 and 1981 appear to be highly consistent.

Methods

Estimation procedure

In this study, a multivariate model is used to estimate the relationships between a set of socio-economic indicators and an indicator, standardized for exposure to risk of death, of the child mortality experience of the children of each currently married woman (the study was limited to currently married women in order to be able to include variables relating to fathers as well as to mothers). Similar models are estimated using ordinary least squares regression on both the 1976 and 1981 data sets in order to explore possible changes in the relationships over time. The basic form of the model assumes that a linear relationship exists between the dependent variable, the standardized indicator of child mortality experience at the individual level, M, and a number of independent variables representing individual socio-economic characteristics of the women. The roles of those independent variables have already been reviewed in the conceptual framework; they are often proxies for a number of possible social, economic and cultural factors that are not directly observed, of which household income may be the most important. Further, the model can give no guidance as to the actual effects of such indirectly captured factors. A number of potentially important factors, particularly community-level factors, may not be captured at all. The model must therefore be regarded as limited and simplified, although even so it should help in disentangling some of the factors associated with child mortality.

TABLE 29. STANDARD VALUES OF THE PROBABILITY OF DYING BY AGE 5, AND EXPECTED PROPORTIONS DEAD, BY DURATION OF MARRIAGE, JORDAN, 1976 AND 1981

Measure	Duration of marriage (years) 0-4	5-9	10-14	15-19
Jordan 1976				
Probability of dying by age 5, $_5q_0$	——— 0.093 ———			
Expected proportion dead	0.067	0.081	0.088	0.093
Jordan 1981				
Probability of dying by age 5, $_5q_0$	——— 0.077 ———			
Expected proportion dead	0.056	0.068	0.072	0.076

The data sets used here provide information on the number of children ever born and the number of children who had died, for each currently married woman in the sample. Thus, for each woman, the proportion dead of children ever born can be calculated. In order to minimize the potential bias, discussed in chapter II, associated with the use of data classified by age of the women, it was decided for this analysis to calculate the dependent variable *M* for duration of marriage groups, since in Jordan, reproductive customs are such that almost all child-bearing occurs within marriage. *M* is thus calculated for currently married women classified by years since first marriage.

Values of *M* were calculated for each survey as follows. First, an estimate of the probability of dying by age 5, $_5q_0$, was obtained by averaging the national level mortality estimates derived from the proportions dead of children ever born by duration of marriage groups 0-4, 5-9 and 10-14, using the Coale-Demeny South family mortality pattern. The values of $_2q_0$, $_3q_0$, $_5q_0$ and $_{10}q_0$ corresponding to the estimated $_5q_0$ were then found. The estimation equations were then used in reverse, using the observed ratios of average parity by duration group, to estimate expected proportions dead in each duration group. The results are shown in table 29. For each woman, the expected proportion of children dead, given her duration of marriage, was then multiplied by her number of children ever born to obtain the expected number of children dead. *M* is then calculated as the ratio of actual number of children dead divided by the expected number.

Independent variables

The independent variables used in this analysis were categorized as follows (the deleted or reference category was the category expected to show the lowest child mortality):

(a) *Urban/rural residence*. Rural residence was defined as residence in small, medium or large villages of up to 10,000 population. The reference category, urban residence, thus includes Amman; the cities of Zarka and Irbid, and towns with populations ranging upward from 10,000;

(b) *Mother's and father's education*. The education variables for both parents were categorized into five categories by years of schooling: as zero; 1-5 years; 6-8 years; 9-11 years; and the reference category of 12 years or more;

(c) *Mother's age at first marriage*. The four categories used were under age 16, 16 or 17, 18 or 19 and 20 or over, the reference category;

(d) *Source of water*. Three categories were used, the reference category being households with a private tap, the second category being households obtaining water from a common tap and the third category being all other sources, including tankers, wells and so on;

(e) *Source of light*. Two categories were used: the reference category, which was households lit by electricity; the other category covered houses lit by all other means;

(f) *Duration of marriage*. As an attempted control on the trend effects described in chapter II, the analysis was limited to durations of marriage of under 20 years (a limitation that has the added advantage of excluding information of doubtful quality from the women of long marital duration), and it also used dummy variables for duration of marriage. The four categories used were 0-4 years

(the reference category), 5-9 years, 10-14 years and 15-19 years.

C. SOCIO-ECONOMIC DIFFERENTIALS IN CHILD MORTALITY

Multivariate regression results

The multivariate regression results are summarized in table 30, which shows for each survey the proportion of the reported children falling in the category and its coefficient in the regression equation.

Many of the results are in line with expectations. Rural residence is associated with higher child mortality risks; the coefficients on rural residence are significant for both 1976 and 1981 and are of broadly similar magnitude. Thus, even after allowing for differences in education and housing characteristics, child mortality is significantly, though not greatly, higher in rural areas than in urban areas.

Education is clearly strongly related to child mortality. The children of mothers or fathers with less than six years of education definitely have higher mortality risks than do children with well-educated parents, and those higher risks extend to children of parents with primary and even some secondary schooling, in an attenuated form. The regression coefficients are similar for both surveys and suggest that: (*a*) a small amount of education has little effect on lowering mortality (the coefficients for the categories of no education and from one to five years are similar for both mothers and fathers); (*b*) education of mothers and education of fathers have independent effects of similar size; (*c*) there is no clear evidence that the relationship between child mortality and parental education has changed in the recent past; (*d*) perhaps maternal education of between 6-11 years has a slightly greater effect on reducing child mortality than does paternal education in the same range.

The remaining variables included in the model are either not significant, are not consistent between surveys, are of mixed sign or are in the reverse of the expected direction. The method of lighting, an indicator of access to electricity, has absolutely no relation to child mortality risks. An age at first marriage of 20 or over is associated with higher child mortality risks in the 1976 data than earlier ages at first marriage; in the 1981 data it is only the children of women who married before age 16 that have significantly higher mortality risks than the children of women marrying at 20 or over. Those results could be due to birth interval effects related to age at first marriage. The children of households obtaining water from wells, tankers, streams and so forth apparently have the same mortality risks as the children of households having a private tap, though the children of households that obtain water from a public tap have lower mortality risks than either, the difference being significant in both 1976 and 1981. The duration of marriage variable, introduced to capture possible exogenous trends in child mortality over time, is never significant, but in five out of six cases it is negative. This result may be due to a concentration of high-risk first births in the reference duration group (from zero to four years); or it may suggest that the underlying mortality level, independent of the factors explicitly included in the model, was possibly rising throughout the past 20 years. However, the coefficients are quite small and do not show any consistent pattern over time, so no reliance can be put upon this latter observation.

It may be noticed that the constant term decreases somewhat between the 1976 and 1981 data. The children of mothers in the supposedly lowest risk reference categories have relatively lower risks in the 1981 data than in the 1976 data, suggesting a widening of the child mortality differentials associated with socio-economic differentials over the recent past. It should also be noticed that the R^2 for both equations is very low, 2.8 and 2.6 per cent in 1976 and 1981, respectively. The low proportion of variance of M accounted for by the variables in the equation is partially a characteristic of M, as pointed out in chapter II, but it also suggests that factors not included or proxied in the equation may have a substantial impact on levels of child mortality.

The basic model thus identifies two factors that are significantly associated with child mortality in the expected direction, parental education and urban versus rural residence; and one factor, water-supply from outside the house or compound, that is

TABLE 30. SUMMARY RESULTS OF MULTIVARIATE REGRESSIONS, JORDAN, 1976 AND 1981

Variable	1976 survey		1981 survey	
	Mean	Regression coefficient	Mean	Regression coefficient
M	1.031	..	1.132	..
Residence				
Rural	0.247	0.139[a]	0.298	0.081[a]
Urban	0.753	[b]	0.702	[b]
Mother's education (years)				
None	0.547	0.402[a]	0.456	0.505[a]
1-5	0.151	0.398[a]	0.183	0.486[a]
6-8	0.200	0.053	0.194	0.247[a]
9-11	0.048	0.070	0.090	0.114[a]
12 or more	0.054	[b]	0.077	[b]
Father's education (years)				
None	0.141	0.354[a]	0.191	0.392[a]
1-5	0.279	0.383[a]	0.221	0.362[a]
6-8	0.296	0.293[a]	0.255	0.299[a]
9-11	0.121	0.078	0.140	0.216[a]
12 or more	0.163	[b]	0.193	[b]
Mother's age at first marriage				
Under 16	0.192	-0.094	0.087	0.135[a]
16 or 17	0.405	-0.065	0.333	-0.109[a]
18 or 19	0.195	-0.192[a]	0.237	0.014
20 or over	0.208	[b]	0.343	[b]
Source of water				
Other	0.175	0.027	0.168	-0.025
Public tap	0.115	-0.135[a]	0.098	-0.088[a]
Private tap	0.710	[b]	0.734	[b]
Method of lighting				
Other	0.258	-0.000	0.192	0.000
Electricity	0.742	[b]	0.808	[b]
Duration of marriage (years)				
15-19	0.395	-0.136	0.399	0.057
10-14	0.313	-0.028	0.333	-0.029
5-9	0.224	-0.142	0.201	-0.086
0-4	0.068	[b]	0.067	[b]
Constant	-	0.638	-	0.506
R^2	-	0.028	-	0.026
Number of cases (births)	-	9 771	-	33 154

[a] Significantly different from zero at the 5 per cent level.
[b] Reference category.

significantly associated with child mortality in an unexpected direction. The actual roles of place of residence and parental education *per se* are not clear, however, because a number of potentially important variables likely to be proxied by residence and parental education are not included in the model. The most obvious of such variables is household income, for which data are not available from either survey. Both surveys did, however, collect information related to occupation and work

TABLE 31. REGRESSION COEFFICIENTS FOR MODELS INCLUDING PLACE OF RESIDENCE AND EDUCATION, INCLUDING AND EXCLUDING OCCUPATION VARIABLES, JORDAN, 1976 AND 1981

Variable	1976				1986			
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 1*	*Model 2*	*Model 3*	*Model 4*
Residence								
Rural	0.154[a]	0.126[a]	[b]	[b]	0.084[a]	0.035	[b]	[b]
Urban	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]
Education (years)	*Mother*		*Father*		*Mother*		*Father*	
Zero	0.601[a]	0.398[a]	0.596[a]	0.376[a]	0.792[a]	0.778[a]	0.721[a]	0.693[a]
1-5	0.583[a]	0.409[a]	0.583[a]	0.376[a]	0.708[a]	0.715[a]	0.634[a]	0.646[a]
6-8	0.190[a]	0.054	0.448[a]	0.275[a]	0.398[a]	0.403[a]	0.488[a]	0.508[a]
9-11	0.101	0.047	0.188[a]	0.027	0.187[a]	0.194[a]	0.358[a]	0.375[a]
12 or more	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]
Father's occupation								
Professional	[b]	-0.420[a]	[b]	-0.425[a]	..	..	..	..
Clerical	[b]	-0.254[a]	[b]	-0.223[a]	..	..	..	..
Sales	[b]	-0.122	[b]	-0.189[a]	..	..	..	..
Skilled manual	[b]	-0.086	[b]	-0.184[a]	..	..	..	..
Services	[b]	-0.024	[b]	-0.006	..	..	..	..
No work, household	[b]	0.067	[b]	0.021	..	..	..	..
Agriculture, unskilled	[b]	[c]	[b]	[c]	..	..	..	..
Source of income								
Other	..	..	..	..	[b]	0.386[a]	[b]	0.434[a]
Agriculture	..	..	..	..	[b]	0.115[a]	[b]	0.138[a]
Private, self-employed	..	..	..	..	[b]	0.050[a]	[b]	0.133[a]
Public sector	..	..	..	..	[b]	[c]	[b]	[c]
Constant	0.534	0.810	0.629	0.925	0.523	0.493	0.679	0.590
R^2	0.021	0.025	0.017	0.021	0.020	0.022	0.016	0.019

[a] Indicates coefficient significantly different from zero at the 5 per cent level.
[b] Variable not included in equation.
[c] Reference category.

status, but those variables have not been included in the basic model because the nature of the information varied greatly between the two surveys. The variables can clearly be included in survey-specific models, and the effect of including the variables on the coefficients of education and residence can be examined.

Table 31 shows the regression coefficients for models including residence and education variables, and for those including and excluding, respectively, occupation indicators. For 1976, these occupation indicators are of the type of work done by the father, for example, professional, clerical or skilled manual work. Those indicators are likely to be quite strongly associated with father's income and thus be related strongly to the economic position of the family. The indicators used in 1981, however, are sectoral rather than occupational, distinguishing between public and private sector sources of household income. Those indicators may be associated with stability of income flow but are unlikely to be closely related to the financial circumstances of each household.

Despite the shortcomings of the indicators, some interesting patterns are shown in table 31. The inclusion of father's occupation in the model using 1976 data shows lower child mortality in families with the father working in professional and clerical positions and higher mortality where the father is working in agriculture or is not working outside

the household. The effects of both the mother's and the father's education in reducing child mortality are substantially lessened in both magnitude and significance, with the reduction being somewhat larger for paternal education than for maternal education. The urban/rural differential is also slightly reduced. It appears likely that both education variables in the basic model are picking up effects associated with standard of living rather than education *per se*. The variable for source of income in 1981 behaves very differently. Although each category of source of income is significant and the coefficients have the expected signs, their inclusion has no major effect on the coefficients of the education categories. Their inclusion does, however, have an effect on the place of residence variable, with the mortality disadvantage associated with rural residence losing significance and falling almost to zero. It seems likely that the residence variable in the basic equation is largely a proxy for other, uncontrolled variables, rather than an important independent variable in its own right.

It is sometimes suggested in the literature that important interactions exist between place of residence and other variables included in child mortality models. In order to examine this issue in the case of Jordan, the basic model shown in table 30 has been applied (without a residence variable, of course) for urban and rural areas separately. For those applications, separate urban or rural estimates of child mortality, obtained from proportions dead of children ever born to currently married women classified by duration of marriage, were used to compute the dependent variable. If important interactions exist, one should expect to see substantial differences between urban and rural coefficients. The coefficients are shown in table 32. A number of points arise from the figures given in table 32. First, the 1976 rural model has a negative constant, indicating negative child mortality for the reference category. The number of women in this model with high education is probably so low that the regression fit has been distorted. Secondly, the effects of the mother's education show no clear pattern for both 1976 and 1981; in 1976, maternal education appears to be more protective of children in rural areas than in urban, but in 1981 the opposite is the case. Thirdly, for the father's education, there does appear to be a pattern; in urban areas, paternal education seems to be protective for nine or more years of schooling, whereas in rural areas there is little difference by level of schooling up to 12 or more years. Age at first marriage shows no consistent pattern, although the association of low child mortality with an age at marriage under age 20 appears in both urban and rural areas. Getting water from a public tap rather than from a private tap or from other sources appears to be associated with reduced child mortality risks in both surveys and for both places of residence, although the coefficients are significant only for rural areas. Access to electricity has no effect in either urban or rural areas. The effects of duration of marriage reverse from 1976 to 1981, such that in 1976, longer marital duration is associated with lower child mortality in urban areas and higher mortality in rural areas, whereas in 1981, the signs are all reversed. Overall, there appears to be no strong evidence for inferring major interactions between place of residence and any of the other variables, except perhaps in the case of paternal education.

One further interaction was examined, that between maternal and paternal education. The specific question considered was whether a large positive or negative difference in education between fathers and mothers reduced the overall effect of education on child mortality. Two dummy variables were specified, one that would be zero unless the mother had an educational level at least two categories higher than that of the father, and the second that would be zero unless the father had an educational level at least two categories higher than that of the mother. Those two variables were included with the other variables found to be consistent and often significant, namely, residence, mother's education and father's education. The results are shown in table 33. In 1981, large differentials in educational levels between spouses do appear to be associated with higher child mortality risks, especially when it is the male who has the higher level of education. Using the 1976 data set, on the other hand, large educational differentials between spouses are associated with lower child mortality risks. The picture is thus not consistent, and given the problems of multicollinearity involved, no conclusions can be drawn.

TABLE 32. SUMMARY RESULTS OF MULTIVARIATE REGRESSIONS, JORDAN, 1976 AND 1981

Variable	*1976 survey regression coefficient*		*1981 survey regression coefficient*	
	Urban	*Rural*	*Urban*	*Rural*
M	0.979	1.018	1.176	1.022
$_5q_0$	0.091	0.113	0.069	0.097
Mother's education (years)				
None	0.379[a]	0.897	0.557[a]	0.335[a]
1-5	0.377[a]	0.999	0.515[a]	0.343[a]
6-8	0.043	0.539	0.279[a]	0.086
9-11	0.087	0.181	0.122[a]	0.049
12 or more	[b]	[b]	[b]	[b]
Father's education (years)				
None	0.311[a]	0.378[a]	0.395[a]	0.398[a]
1-5	0.401[a]	0.333[a]	0.361[a]	0.381[a]
6-8	0.306[a]	0.277[a]	0.349[a]	0.223[a]
9-11	0.008	0.411[a]	0.155[a]	0.366[a]
12 or more	[b]	[b]	[b]	[b]
Mother's age at first marriage				
Under 16	-0.100	-0.211[a]	0.352[a]	-0.106
16 or 17	0.038	-0.345[a]	-0.114[a]	-0.110[a]
18 or 19	-0.132[a]	-0.391[a]	0.074[a]	-0.093
20 or over	[b]	[b]	[b]	[b]
Source of water				
Other	0.068	-0.090	0.009	0.086
Public tap	-0.060	-0.248[a]	-0.041	-0.227[a]
Private tap	[b]	[b]	[b]	[b]
Method of lighting				
Other	0.023	0.008	0.081	-0.027
Electricity	[b]	[b]	[b]	[b]
Duration of marriage (years)				
15-19	-0.272[a]	0.229	0.159[a]	-0.206[a]
10-14	-0.141	0.260[a]	0.036	-0.229[a]
5-9	-0.246[a]	0.125	0.007	-0.293[a]
0-4	[b]	[b]	[b]	[b]
Constant	0.727	-0.002	0.461	0.775
R^2	0.026	0.029	0.030	0.014
Number of cases (births)	7 355	2 416	23 277	9 877

[a] Significantly different from zero at the 5 per cent level.
[b] Reference category.

Trends over time in child mortality differentials

Comparisons between regression coefficients from the 1976 and 1981 data have been made above from the perspective of assessing the plausibility of the results obtained. The results given in table 30 could also, however, be looked at from the point of view of time trends; sharp changes in differentials over time should appear as large changes from 1976 to 1981 in the regression coefficients given in table 30 (although the potential for such changes is quite small, since both data sets cover all births to the sample women over a common 15-year period).

TABLE 33. REGRESSION COEFFICIENTS FOR MODELS, INCLUDING PLACE OF RESIDENCE, MOTHER'S AND FATHER'S EDUCATION AND SPOUSAL EDUCATIONAL DIFFERENTIAL, JORDAN, 1976 AND 1981

Variable	*Regression coefficients*	
	1976 survey	*1981 survey*
Place of residence		
Rural	0.132[a]	0.075[a]
Urban	[b]	[b]
Mother's education (years)		
None	0.532[a]	0.325[a]
1-5	0.478[a]	0.343[a]
6-8	0.123	0.131[a]
9-11	0.064	0.056
12 or more	[b]	[b]
Father's education (years)		
None	0.159	0.611[a]
1-5	0.174	0.555[a]
6-8	0.220[a]	0.377[a]
9-11	0.026	0.260[a]
12 or more	[b]	[b]
Mother with greater education		
Two or more categories	-0.319[a]	0.071
Other	[b]	[b]
Father with greater education		
Two or more categories	-0.205[a]	0.212[a]
Other	[b]	[b]
Constant	0.541	0.437
R^2	0.027	0.024

[a] Significantly different from zero at the 5 per cent level.
[b] Reference category.

It is not easy to compare the regression coefficients in table 30 directly, because the constant values change and because some of the variables included in the model change erratically, confusing the comparison. Therefore, only changes in mortality risks by place of residence, maternal education and paternal education were considered, and the regression coefficients were converted into estimates of the probability of dying by age 5, $_5q_0$. All the other coefficients shown in table 30 are multiplied by their population means. For the highest risk group, children of rural women who have no education and whose husbands have no education, the probability of dying by age 5 declines from about 121 per 1,000 in the 1976 data to about 98 per 1,000 in 1981, a decline of about 20 per cent in five years. For the lowest risk group, children living in urban areas and whose mothers and fathers both have 12 or more years of education, the estimated $_5q_0$ is 41 per 1,000 from the 1976 data versus 32 per 1,000 from the 1981 data, a decline of about 25 per cent. Thus, major declines in child mortality risks have occurred within risk groups, as defined here, and the overall change in child mortality in Jordan reflects real declines within groups rather than changes over time in the structure of the population by risk group. The ratio of highest to lowest mortality risk remains about three to one in both surveys.

Identification of child mortality risk groups

Regression models can be used to identify mortality risk groups for children according to the characteristics of their families. In identifying risk groups, the study has focused on two characteristics—place of residence and mother's education—in order to define risk cells with numbers of children in the samples of 100 or more. Table 34 shows risks expressed in terms of the probability of dying by age 5, $_5q_0$, obtained by converting the value of M estimated by the relevant regression model into a $_5q_0$ on the basis of the average value of $_5q_0$, the average value of M and the regression coefficients and constant[3]. The risk categories used are highest, more than 30 per cent above the national average; high, from 11 to 30 per cent above the national average; average, from 10 per cent below to 10 per cent above the national average; low, from 11 to 30 per cent below the national average; and lowest, more than 30 per cent below the national average.

Using this classification, there are no highest risk mothers or children. The high-risk group in 1976 consists of children born to mothers in rural areas with less than completed primary education, accounting for a total of 19 per cent both of children born and of women. In 1981, however, this category of high risk also includes the children of women in urban areas with no education, raising the size of the group to 64 per cent of children and 52 per cent of mothers. The intermediate risk group is made up of the children of the remaining women with less than completed primary education. The low-risk group consists of the children of rural

TABLE 34. CATEGORIES OF RELATIVE RISKS OF CHILD MORTALITY, BY RISK FACTOR, JORDAN, 1976 AND 1981

Place of residence	Mother's education (years)	1976 survey: Probability of dying before age $_5q_0$	1976 survey: Percentage of births	1976 survey: Total women	1981 survey: Probability of dying before age $_5q_0$	1981 survey: Percentage of births	1981 survey: Total women
		A. *High risk* (11-30 per cent above national average)					
Rural	None	0.116	18	17	0.095	23	20
Rural	1-5	0.115	1	2	0.089	3	3
Urban	None				0.089	38	29
		B. *Intermediate risk* (90-110 per cent of national average)					
Urban	None	0.102	50	40	..	..	..
Urban	1-5	0.101	11	11	0.084	13	12
		C. *Low risk* (11-30 per cent below national average)					
Rural	6-8	0.079	1	2	0.068	2	3
Rural	9-11	0.071	<1	<1	0.054	1	1
Urban	6-8	0.065	12	17	0.063	11	14
		C. *Lowest risk* (>30 per cent below national average)					
Rural	12+	0.062	<1	<1	0.041	<1	<1
Urban	9-11	0.057	3	5	0.048	5	8
Urban	12+	0.048	3	6	0.036	4	9

NOTE: The highest risk group is not shown in table 34 because there were none with more than 30 per cent over the national average.

women with less than completed secondary education and of urban women with from six to eight years of education, accounting for about 20 per cent of all women but only about 14 per cent of children. The lowest risk group is made up of the children of women with completed secondary education or tertiary education, plus those of urban women with 9-11 years of education; the children in this category comprise only some 6-9 per cent of all children.

The results given in table 34 show that there are large differentials in child mortality risks between different segments of the population of Jordan. Those differentials, however, are not as large as those found in some other developing countries. For example, in 1976, the risk of death by age 5 for children born to women in the most disadvantaged group, rural women with no education, was about 2.5 times that of the most advantaged group, women with 12 or more years of education who were living in urban areas. It should also be noted that the actual risk of dying by age 5 for children in the most disadvantaged group in 1981 was below 100 per 1,000 live births, a relatively low figure for a developing country. On the other hand, structural factors have resulted in a redistribution of children within risk groups, such that the high-risk group in 1981 comprised 64 per cent of all children born, an increase from only about 20 per cent in 1976.

D. CONCLUSION

This study has explored the factors associated with child mortality differentials in Jordan using data from two household surveys, respectively, held in 1976 and 1981. Those surveys and other data

sources show that child mortality has been declining rapidly in Jordan since the 1950s and reached quite low levels, by developing country standards, by the late 1970s, by which time the probability of dying by age 5 is estimated to have fallen below 90 per 1,000 live births.

The study of mortality differentials by characteristics of the household discloses strong relationships between child mortality risks and maternal and paternal education and urban/rural residence. The magnitude and direction of those relationships were consistent with expectations, both internally between groups and externally between surveys. Perhaps the most interesting feature of the education results is that a small amount of education, either of fathers or of mothers, has little effect on child mortality risks; not until primary school has been completed does education reduce risks appreciably. This finding may suggest that substitutes for formal education, such as adult literacy campaigns, may have little effect on child survival, although it may also indicate merely that a little education is not associated with much income increase since income is not controlled. A number of other characteristics were incorporated into the child mortality model, such as age at first marriage, duration of marriage, type of lighting and source of water. Results for those other variables were either not consistent with expectations (the role of source of water, for example), or were not consistent internally between groups (the role of duration of marriage, for example) or not consistent between surveys (the role of age at first marriage, for example). Perhaps the most surprising result is the apparent protective effect of getting water from a public tap rather than from a private tap; although the data suffer from definitional problems, this result may indicate possible contamination of household water-supplies. The child mortality models accounted for very little of the variance of the mortality indicator being used, but this result is to be expected given the characteristics of the mortality indicator.

The greatest weakness of the models used is the lack of measures of income. Proxies for household income based on information on occupation and work status proved to be significantly related to child mortality risks and indicated that at least part of the effect of paternal education on child mortality was probably an income effect rather than an education effect.

The results of the analysis show the existence of substantial child mortality differentials by place of residence and parental education. The child of a woman with no education living in a rural area, for example, is estimated to have between two and three times the risk of dying of the child of a woman with completed secondary education living in an urban area. The differentials in child mortality risks do not appear to have changed appreciably in the recent past; each risk group appears to have experienced approximately equal percentage declines in child mortality. Only a small part of the national decline in child mortality has been the result of changes in the proportions of children in the various risk categories; more important have been changes in risks within categories, although to what extent these changes are due to, for example, rising income levels within categories, cannot be determined. Although the differentials are not extreme by developing country standards, they do indicate a need to direct health services and health information to less educated women, particularly those living in rural areas.

NOTES

[1] In the present publication, the term "West Bank" refers to the occupied West Bank of the Hashemite Kingdom of Jordan and the term "Jordan" refers to the Hashemite Kingdom of Jordan excluding the occupied West Bank, whenever it is necessary to differentiate between these two areas.

[2] Of course, it is not strictly speaking the same women in the cohort. First, both data sets are from samples, the overlaps between which are probably few. The cohort increments provide a useful test of the broad comparability of the samples. Secondly, mortality removes a small proportion of women from each cohort, and international migration can add or remove women. The effects of mortality and migration are likely to be negligible.

[3] The mortality risks shown in table 34 were calculated from regression equations including only the two variables, maternal education and residence, shown in the table. The coefficients for the equations are as follows:

Variable	*Jordan Fertility Survey, 1976*	*Jordan Demographic Survey, 1981*
Constant	0.534	0.523
Residence	0.154	0.084
Education (years)		
1-5	0.101	0.187
6-8	0.190	0.398
9-11	0.582	0.708
12	0.601	0.792

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VIII. THAILAND

*Chintana Pejaranonda and Sureerat Santipaporn**

The transition from higher to lower mortality rates in Thailand began around 1950. Since then, infant and child mortality have declined substantially. Infant mortality declined from more than 100 deaths per 1,000 live births in the late 1950s to an estimated 35 per 1,000 in the early 1980s (Thailand, 1985; Chayovan, Kamnuansilpa and Knodel, 1988).

The purpose of the present study is to document trends in the differentials in early-age mortality. Such trends are described in relation to changes in overall child mortality levels and in the context of changes in socio-economic development and health policies.

Section A of this chapter presents the geographical and demographic characteristics of Thailand and some aspects of the socio-economic development of the country. In section B, recent trends in child mortality and its differentials by place of residence and by the mother's educational level are described. Section C presents the regression analysis of the differentials in child mortality, using data from the 1970 and 1980 censuses of Thailand. The last section consists of a brief discussion of the results obtained.

A. SOCIO-ECONOMIC AND DEMOGRAPHIC CONTEXT

Geography and population

Thailand is a tropical country with an enumerated population of 44 million, according to the 1980 census. The population is ethnically relatively homogeneous, the vast majority being made up of ethnic Thais, who speak some version of the Thai language and adhere to Buddhism. Thailand is predominantly rural, with 87 and 83 per cent of the population living in rural areas in 1970 and 1980, respectively. The country is economically and culturally dominated by Bangkok, the only major urban area, whose population represented 11 per cent of the national population in 1980.

Thailand is divided into four natural regions by rivers and mountains—the northern, north-eastern, central and southern regions. These areas display major socio-economic differences. In the central region, which includes Bangkok, 32 per cent of the population are settled in the central plain. This region is the heartland of rice cash-cropping, in a country where rice is the mainstay of the economy.

The north-east, a flat, dry limestone plateau bordered by the Lao People's Democratic Republic, has poor soil and insufficient irrigation. It is the poorest region of Thailand, and it has the lowest educational levels in the country. In 1980, the north-east contained 35 per cent of the total population. The northern region is the second poorest region. It consists of sparsely settled mountainous areas extending to Myanmar in the north and in the west. Rice farming is concentrated in densely settled narrow valleys. In 1980, the north contained approximately 20 per cent of the total population. Lastly, the south, or Peninsular Thailand, is the smallest region in terms both of land and of population; only 13 per cent of the Thai population lived in the south in 1980. Tin mining, rubber planting and coastal fishing are important contributors to the local economy.[1]

In spite of the relative cultural homogeneity of the population, there are some important minorities in Thailand. The population of Chinese ancestry probably constitutes the largest ethnic minority, even though it is difficult to distinguish between the Thai and Chinese populations due to the large extent of mixed ancestry. Probably fewer than 10 per cent of the population are of Chinese ancestry (Varakamin and others, 1983). Approximately 4 per cent of the population are Muslim; they are concentrated in the south and predominate in four of the 14 southern provinces. Various ethnic groups are located primarily in the hills of the north-western region.

* National Statistical Office, Population Survey Division, Bangkok, Thailand.

Economic and social development

In 1980, agriculture was the predominant industry in Thailand, providing employment for nearly three out of every four workers. Since the Second World War, however, the share of agriculture in the national labour force has been declining steadily, mainly because of the continuing expansion of employment in the manufacturing, construction and service sectors. Between 1970 and 1980, the proportion of the labour force engaged in agricultural activities declined from 79.3 to 72.5 per cent (table 35).

The change in the importance of various occupations and industries over time has been accompanied by changes in the sex composition of workers in those sectors. Female workers have begun to make significant inroads into some traditionally male-dominated occupations. In 1980, women constituted 44.4 per cent of the economically active population.

As indicated by the growth of its gross domestic product, the economy of Thailand has been relatively strong since the 1960s (table 35). In 1980, GDP per capita was about 49 per cent higher than its level in 1970, and its average annual rate of increase between 1965 and 1980 was as high as 7.2 per cent.

Between the two most recent censuses, educational levels increased, with females making the largest gains in literacy levels. In 1980, almost 90 per cent of the population aged 10 and over were literate (table 35). In the same period, material living conditions improved significantly, as shown by the large increases in the proportions of households with electric lighting, piped water and a latrine.

During the period 1970-1980, the health sector showed particular improvement. Improvements in health care were made possible by increases in medical personnel, number of hospitals and beds and expanded health-service availability in remote rural areas. A detailed description of the development of health and population policies can be found in Porapakkham (1986). A policy for public-health programmes was developed for the first time in the First Five-Year National Economic and Social Development Plan (1962-1966). The health policy could be divided in two stages: the first stage was directed to improving medical care by increases in staff, number of hospital beds and equipment; in the second stage, the objectives shifted towards prevention of disease and, in particular, towards the expansion of health services in remote rural areas and locations that lacked easy access to hospitals. In addition, the training of various categories of medical personnel was expanded (Porapakkham, 1986).

During the second plan (1967-1971) and the third plan (1972-1976), public health was recognized as an important part of the social sector together with education and social welfare. Emphasis was also placed on family planning and child care, development of environmental health, integrated health services and manpower development in the health sector. The public-health elements were retained for the fourth plan (1976-1981) and extended into the fifth plan (1982-1986). The budget allocations for health for the first four plans constituted 3.6, 3.4, 4.3 and 7.9 per cent, respectively, of the total national budget.

The fifth plan also included rural development and a commitment to attaining Health for All by the Year 2000. The plan included a national drug policy, a traditional-medicine policy and a self-reliance policy. The Government targeted districts of the poverty-stricken areas to introduce special programmes, such as primary health care, nutrition development, clean water-supply and community-hospital construction. The Ministry of Public Health added two more programmes to the development plan: one on immunization; and the other on maternal and child health.

B. LEVELS, TRENDS AND DIFFERENTIALS IN CHILD MORTALITY, 1960-1985

Sources of data

The levels and trends in child mortality in Thailand since the early 1960s can be estimated from two types of sources—censuses and surveys. The 1970 and 1980 population censuses of Thailand included questions relating to women in the reproductive ages on the total number of children ever born and the number surviving. Indirect methods can be applied to such data, classified by five-year age

TABLE 35. SOCIO-ECONOMIC INDICATORS, THAILAND, 1970 AND 1980

Indicators	*1970*	*1980*
Economic		
Gross domestic product per capita at 1972 prices (baht)	4 126.8	6 141.3
Average annual growth rate of GDP	7.2[a]	5.6[b]
Social		
Percentage of population in urban areas	13.2	17.0
Literacy level (percentage literate among population aged 10 and over)		
Both sexes	81.8	88.8
Male	88.9	92.5
Female	74.8	85.3
Percentage of population engaged in farming activities	79.3	72.5
Sanitation		
Percentage of private households with:		
Electric lighting	18.9	43.0
Piped water	12.4	18.1
Latrine	31.3	54.5
Health		
Life expectancy at birth:		
Male	57.7	61.0[c]
Female	61.5	65.0[c]
Population per physician	8 642.0[d]	7 055.0[e]
Population per hospital bed	864.0[d]	687.0[e]
Number of hospitals	209.0[d]	402.0[e]
Number of health centres	2 226.0[d]	4 728.0[e]

Sources: The sources for table 35 are given below by category:

Economic: for gross domestic product per capita, calculated from data of the National Economic and Social Development Board, Bangkok, Thailand; for average annual growth rate, World Bank, *World Development Report 1989* (New York, Oxford University Press for the World Bank, 1989).

Social and sanitation: Thailand, *1970 Population and Housing Census* (Bangkok, National Statistical Office, 1973); and *1980 Population and Housing Census* (Bangkok, National Statistical Office, 1983).

Health: Yawarat Proapakkham, *Mortality and Health Issues: Levels and Trends of Mortality in Thailand*, Asian Population Studies Series, No. 77 (Bangkok, Thailand, Economic and Social Commission for Asia and the Pacific, 1986).

[a] 1965-1980.
[b] 1980-1987.
[c] 1980-1985.
[d] 1971.
[e] 1981.

group of women, to estimate the levels of child mortality at various dates prior to the census. A number of demographic surveys have also been conducted since 1975: in 1974-1975, the Survey of Population Change (Thailand, 1977a); in 1975, the Survey of Fertility in Thailand (SOFT), which was part of the World Fertility Survey project (Thailand, 1977b); in 1981, the Contraceptive Prevalence Survey (Kamnuansilpa and Chamratrithirong, 1982); in 1984, the Contraceptive Prevalence Survey (Thailand, 1986); and in 1987, the Thai Demographic and Health Survey (TDHS) (Chayovan, Kamnuansilpa and Knodel, 1988). All those surveys included questions on the total number of children a woman had had and the number who survived, hence providing the data needed to estimate child mortality indirectly. The Survey of Fertility in Thailand and the Thai Demographic and Health Survey also included maternity histories; those data permitted the

calculation of direct life-table estimates of child mortality. Figure VI summarizes the information available from those seven sources in the form of estimates of the probability of dying by age 5 obtained from each source by indirect methods. In all cases, the model life-table used is the West family of the Coale-Demeny models (Coale and Demeny, 1966). The selection of the appropriate model life-table was based on the relationship between infant mortality ${}_1q_0$, and the probability of dying between exact ages 1 and 5, ${}_4q_1$. The relationship between the direct estimates of ${}_1q_0$ and ${}_4q_1$ derived from the SOFT survey data appear to be similar to the corresponding relationship in the West family of model life-tables.

Levels and trends in the probability of dying by age 5

Figure VI shows that the probability of dying by age 5, ${}_5q_0$, has declined considerably in Thailand since the early 1960s. While in 1960, ${}_5q_0$ was of the order of 160 deaths per 1,000 live births, by the early 1980s the estimated ${}_5q_0$ had declined to about 50 per 1,000.

Figure VI also shows the discrepancy in the ${}_5q_0$ estimates obtained from the two types of sources: estimates derived from survey data are consistently higher than estimates derived from census data, even though some irregularities can be seen in the survey estimates. The irregularities in the survey estimates are likely to be due to small sample sizes and to variation by age of women in the quality of the reporting of live births and child deaths, coupled with age-misreporting. The inconsistency between estimates derived from survey and from census data indicates systematic underreporting of child deaths in the two censuses.

Differentials by place of residence and by mother's education

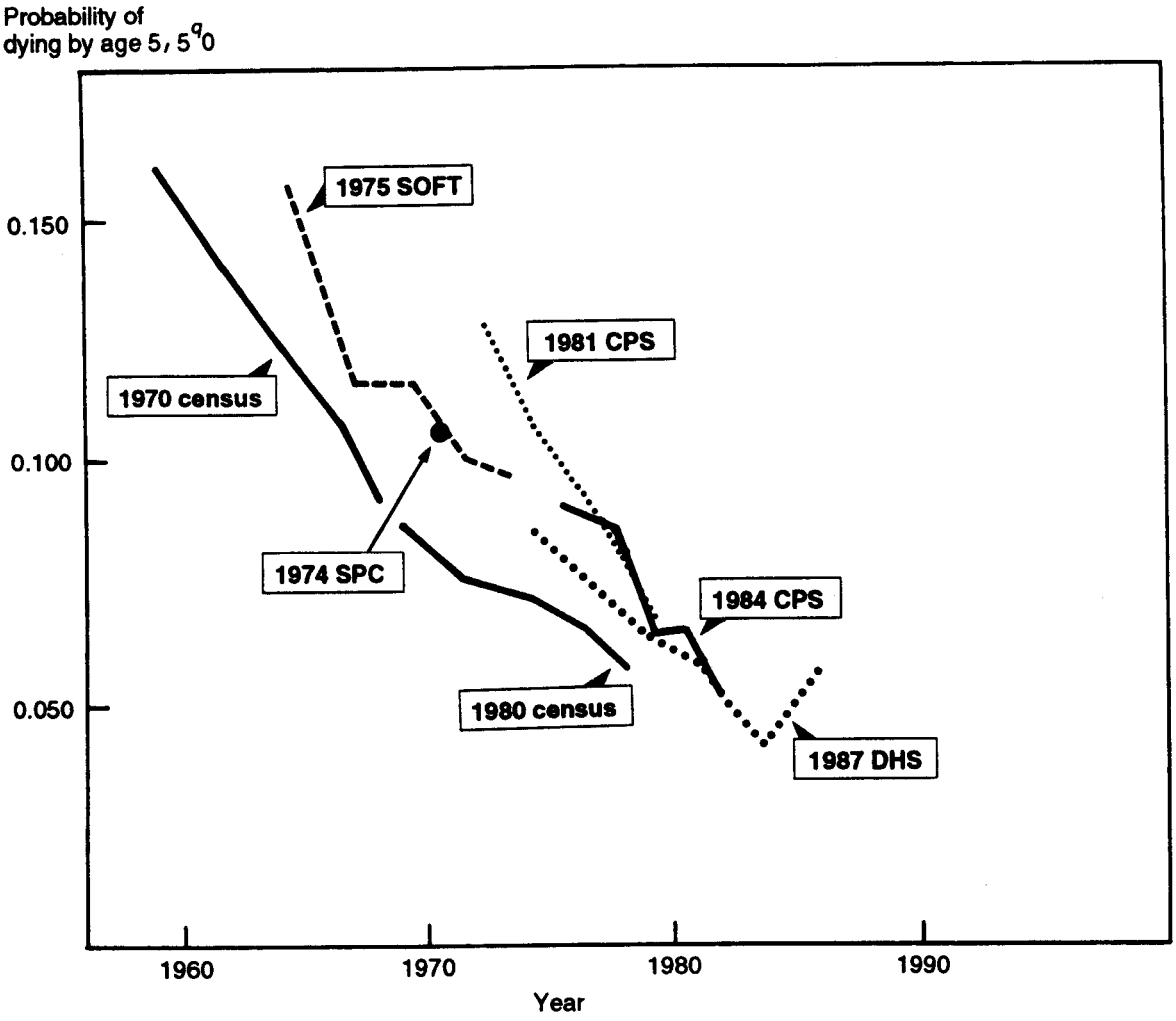
The levels and trends in infant mortality in Thailand were studied by Porapakkham (1986), using data from the 1970 and 1980 censuses. She reported large differences in the levels of infant mortality between the urban and rural areas of Thailand, the rural levels being considerably higher than the urban levels. Socio-economic differentials in infant mortality were also found. In both censuses, infant mortality is strongly related to the mother's education. The higher the educational level of the mother, the lower was the probability of dying in infancy.

Similar differentials exist in the probability of dying by age 5. The trends in those differentials can be seen from the comparison of estimates derived from the various data sources. Figure VII presents estimates of ${}_5q_0$ obtained separately for urban (municipal) and rural (non-municipal) places of residence.[2] The child mortality levels are significantly higher in the rural than in the urban areas of Thailand, a finding that holds true throughout the period under consideration. It is clear that the probability of dying by age 5 declined in both urban and rural areas between the late 1960s and early 1980s, but the decline was considerably sharper in the rural areas. As a result, the ${}_5q_0$ estimates by place of residence converge over the period considered. Although in the early 1980s, the probability of dying by age 5 in rural areas was estimated to be 52 per 1,000 (a level similar to that in urban areas during the late 1960s), it was estimated to be 35 per 1,000 in urban areas.

Figure VII also indicates that the 1980 census underestimates child mortality considerably in rural areas, whereas for urban areas the 1980 census estimates are relatively consistent with the levels estimated from other sources. Consequently, the differentials in child mortality by place of residence are underestimated by the 1980 census. The estimates for rural areas corresponding to the older age groups of women appear to be affected by larger underreporting than those corresponding to the younger age groups.

Table 36 presents ${}_5q_0$ estimates by educational level of the mother, as obtained from three sources, the censuses of 1970 and 1980 and TDHS in 1987. The differentials by educational level of the mother are quite large: around 1970, the probability of dying by age 5 was more than four times higher for children whose mothers had no schooling than for children whose mothers had secondary or higher education. Between the late 1960s and the late 1980s, child mortality declined in all categories of maternal education. The decline was stronger for children whose mothers either had no formal

Figure VI. Trends in the probability of dying by age 5, Thailand, 1960-1985



Sources: The sources for figure VI are given below in chronological order:

1970 census: Griffith Feeney, "Estimation of mortality trends from child survivorship data", unpublished paper of the East-West Population Institute; Honolulu, Hawaii, East-West Center, 1977.

1974 Survey of Population Change: John Knodel and Apichat Chamratrithirong, *Infant and Child Mortality in Thailand: Levels, Trends and Differentials Derived Through Indirect Estimation Techniques*, Papers of the East-West Population Institute, No. 57 (Honolulu, Hawaii, East-West Center, 1978).

1975 Survey of Fertility in Thailand: based on World Fertility Survey standard recode tapes.

1980 census: official country data sent to the United Nations Statistical Office.

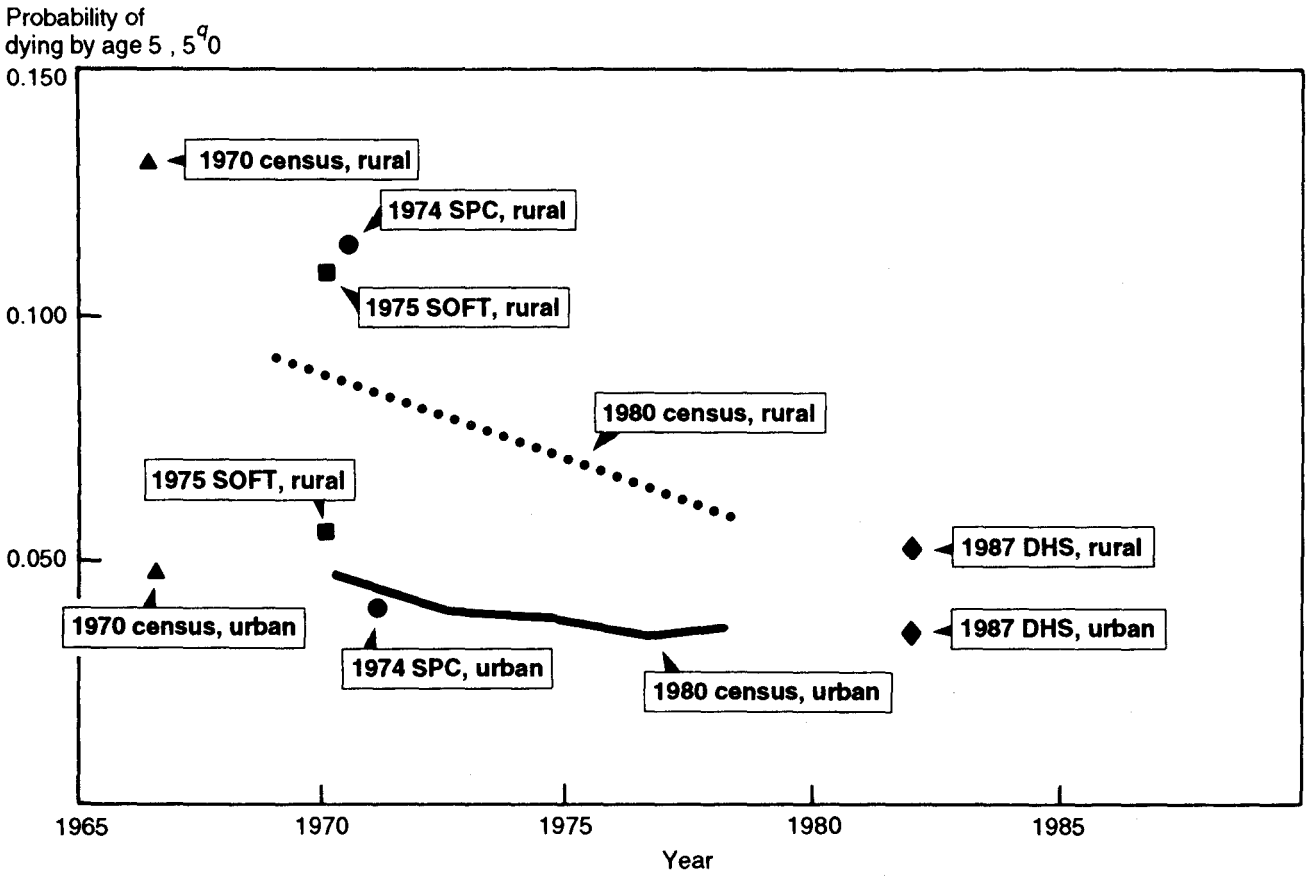
1981 Contraceptive Prevalence Survey: Peerasit Kamnuasilpa and Apichat Chamratrithirong, *A New Decade of Fertility and Family Planning in Thailand: 1981 Contraceptive Prevalence Survey* (Bangkok, Ministry of Public Health; and Columbia, Maryland, Westinghouse Applied Systems, 1982).

1984 Contraceptive Prevalence Survey: Thailand, *Contraceptive Use and Fertility in Thailand: Results from the 1984 Contraceptive Prevalence Survey* (Bangkok, National Institute of Development Administration, Research Centre; Mahidol University, Institute for Population and Social Research; and Ministry of Public Health, National Family Planning Programme, 1986).

1987 Demographic and Health Survey: Napaporn Chayovan, Peerasit Kamnuansilpa and John Knodel, *Thailand, Demographic and Health Survey, 1987* (Bangkok, Chulalongkorn University, Institute of Population Studies; and Columbia, Maryland, Institute for Resource Development/Westinghouse, 1988).

NOTE: CPS = Contraceptive Prevalence Survey; DHS = Demographic and Health Survey; SOFT = Survey of Fertility in Thailand; SPC = Survey of Population Change.

Figure VII. Probability of dying by age 5, by place of residence, Thailand, 1965-1987



Sources: The sources for figure VII are given below in chronological order:

1970 census and 1974 Survey of Population Change: John Knodel and Apichat Chamratrithirong, *Infant and Child Mortality in Thailand: Levels, Trends and Differentials Derived Through Indirect Estimation Techniques*, Papers of the East-West Population Institute, No. 57 (Honolulu, Hawaii, East-West Center, 1978).

1975 Survey of Fertility in Thailand: Shea O. Rutstein, "Regional infant and child mortality levels: preliminary tables for 38 countries", unpublished manuscript, World Fertility Survey; Voorburg, Netherlands, International Statistical Institute, 1984.

1980 census: official country data sent to the United Nations Statistical Office.

1981 Contraceptive Prevalence Survey: Peerasit Kamnuasilpa and Apichat Chamratrithirong, *A New Decade of Fertility and Family Planning in Thailand: 1981 Contraceptive Prevalence Survey* (Bangkok, Ministry of Public Health; and Columbia, Maryland, Westinghouse Applied Systems, 1982).

1987 Demographic and Health Survey: Napaporn Chayovan, Peerasit Kamnuansilpa and John Knodel, *Thai Demographic and Health Survey, 1987* (Bangkok, Chulalongkorn University, Institute of Population Studies; and Columbia, Maryland, Institute for Resource Development/Westinghouse, 1988).

NOTE: DHS = Demographic and Health Survey; SOFT = Survey of Fertility in Thailand; SPC = Survey of Population Change.

TABLE 36. PROBABILITY OF DYING BY AGE 5, BY MOTHER'S EDUCATION, THAILAND, 1970, 1980 AND 1987

Mother's education	*Probability of dying by age 5, $_5q_0$ (per thousand)*		
	1970 census[a]	*1980 census*[a]	*1987 TDHS*[b]
None	142	96	74
Primary education	118	60	49
Secondary education	29	24	21

Sources: **1970**: John Knodel and Apichat Chamratrithirong. *Infant and Child Mortality in Thailand: Levels, Trends and Differentials Derived Through Indirect Estimation Techniques*, Papers of the East-West Population Institute, No. 57 (Honolulu, Hawaii, East-West Center, 1978); **1980**: Harald Hansluwka and others, eds., *New Developments in the Analysis of Mortality and Causes of Death*, Geneva, World Health Organization, Global Epidemiological Surveillance and Health Assessment; and Bangkok, Mahidol University, Faculty of Public Health, Institute for Population and Social Research, 1986); **1987**: Napaporn Chayovan, Peerasit Kamnuansilpa and John Knodel, *Thai Demographic and Health Survey, 1987* (Bangkok, Chulalongkorn University, Institute of Population Studies; and Columbia, Maryland, Institute for Resource Development/Westinghouse, 1988).

NOTE: For 1980, estimates of $_5q_0$ were inferred from estimates of $_1q_0$ using the North family of the Coale and Demeny model life-tables.

[a] Indirect estimates.
[b] Direct estimates, reference period is from zero to nine years prior to the survey.

education or had reached only the primary level, thus reducing the differentials over time. In the late 1980s, $_5q_0$ for children whose mothers had at least a secondary education was estimated to be 21 per 1,000. For children whose mothers had primary education or no schooling at all, the probabilities of dying by age 5 were more than twice or three times as high, respectively.

To the extent that most of the women with secondary or higher educational level live in urban areas and those with lower educational levels live in rural areas, it is likely that, whereas the estimates derived from the former areas are reasonably correct, those for the latter may underestimate child mortality.

C. MULTIVARIATE ANALYSIS

Data and methods

Data sources and quality

The data used in this study were obtained from a 1.5 per cent sample of the census carried out on 1 April 1970 and a 1 per cent sample of that conducted on 1 April 1980. The data from both samples had to be appropriately weighted to derive national estimates.

The analysis in this study focuses on women aged 15-34 who were married to the head of the household, lived in private households and stated that they had given birth to at least one child. The head of the household was assumed to be the father of the woman's children; it is likely that this assumption was true in the vast majority of the cases. From the samples, it was estimated that approximately 1,785,000 women who met those criteria were enumerated in the 1970 census; those women had had approximately 6,130,000 live births. For 1980, the corresponding figures were 3,144,000 women and 8,103,000 live births.

The census information used in the following analysis is the data on the total number of children ever born to a woman and the numbers of children dead and of those who survived. Such data are classified by five-year age group of the women to serve as the basis for the indirect estimation of mortality and to calculate the mortality indicator used in this study.

It was shown in the previous section that the indirect estimates of child mortality derived from the two censuses underestimated the true levels. Moreover, the underreporting of child deaths appears to have occurred differentially by type of

place of residence: although the 1980 estimates for urban places are consistent with the other sources of data available for Thailand, the estimates for rural places are too low. Those problems in the quality of the reporting of child deaths in the censuses have several implications for the analysis presented in this study.

First, the child mortality levels estimated from the 1970 and 1980 censuses will be underestimated and the trends they imply will not be representative of true trends. Secondly, and more importantly, when there are more omissions of child deaths in the groups with the higher mortality levels, the differentials will be underestimated. Figure VII shows that this is the case for differentials by place of residence. In addition, because of the high degree of association between socio-economic indicators and place of residence, the underestimation of differentials is likely to affect other variables under study. Lastly, the interpretation of any apparent trends in child mortality differentials based on the census data will be difficult. Because the 1980 data appear to underestimate child mortality more than the 1970 data in high-mortality groups, any apparent reduction over time in the differentials could be due to differential data quality and not to a true reduction. In contrast, increases in the differentials would be more likely to reflect true increases.

Estimation procedure

Indirect estimates of child mortality were obtained from the data on the total number of children ever born to a woman and the number of those children who had died, tabulated by five-year age group of women, for each of the census samples. The level of the standard schedule of mortality for the overall population was determined by taking the weighted average of the levels identified for each of the five-year age groups used in this analysis—15-19, 20-24, 25-29 and 30-34—the weights being the number of children ever born to the women in each age group. The probabilities of dying by age 5 corresponding to the standard mortality schedules are 96 per 1,000 for the 1970 census sample and 55 per 1,000 for the 1980 census sample. Those estimates correspond to periods approximately centred on 1965 and 1975, respectively.

The expected proportions of children dead, by age group of the women, were calculated by applying in reverse the multipliers designed to estimate the probabilities of dying from the proportions of children who had died. For each woman currently married to the head of the household, a mortality indicator, M, was calculated as the ratio of her observed proportion of her children dead among the children ever born to her expected proportion of children dead, given her age group. After weighting each observation by the total number of children ever born to the woman, the overall value of M for the 1970 sample was 1.005, while the overall value of M for the 1980 sample was 0.984.

Independent variables

The number of indicators available for analysing child mortality differentials from the Thai census data are relatively limited. They are, however, comparable across censuses and provide information on the entire national population. The covariates of child mortality that are examined in this study are the mother's and the father's education, maternal and paternal occupation, place of residence (urban or rural), region of residence and mother's religious affiliation. Table 37 presents the distributions of the sample populations in 1970 and 1980, by socio-economic characteristics.

In the censuses of Thailand, data on educational level were collected by asking the respondent the highest level or grade or the total number of years of schooling that he or she had completed. In this study, four categories are used for paternal and maternal education: no schooling; some primary education or primary education completed; some secondary education or secondary education completed; and university level. The vast majority of live births in the samples under study occurred to mothers and fathers who reported some or complete primary education (more than 75 per cent).

Paternal and maternal occupations are classified into five categories. First, agricultural workers include workers engaged in agricultural activities, animal husbandry and forest exploitation. This category also includes fishermen and hunters. This

TABLE 37. DISTRIBUTION OF THE POPULATION AT RISK, BY SOCIO-ECONOMIC CHARACTERISTICS, THAILAND, 1970 AND 1980

Socio-economic characteristic	*Distribution of the population at risk*	
	1970	*1980*
Mother's education		
None	0.208	0.092
Primary	0.774	0.860
Secondary	0.016	0.036
University	0.002	0.012
Father's education		
None	0.161	0.061
Primary	0.790	0.827
Secondary	0.043	0.089
University	0.060	0.023
Mother's occupation		
Agricultural worker	0.929	0.825
Manual worker	0.005	0.017
Craftswoman	0.032	0.060
Sales worker	0.023	0.068
Professional, administrative or clerical worker	0.011	0.030
Father's occupation		
Agricultural worker	0.794	0.706
Manual worker	0.046	0.078
Craftsman	0.085	0.107
Sales worker	0.034	0.049
Professsional, administrative or clerical worker	0.041	0.060
Residence		
Rural	0.904	0.866
Urban	0.096	0.134
Region		
North	0.219	0.200
Central[a]	0.292	0.268
North-east	0.353	0.400
South	0.136	0.132
Religion		
Muslim	0.055	0.054
Buddhist	0.945	0.946

[a] Including Bangkok metropolis.

occupational category encompasses the vast majority of fathers and mothers in the 1970 and 1980 samples (the parents of over 70 per cent of the children under study were in this category). The second occupational category includes some types of manual workers (miners, quarrymen, well drillers, transport equipment operators, related workers and service workers). The third category includes craftsmen, production workers and labourers. The fourth category refers to sales workers. Lastly, the fifth category includes professional, technical, administrative, executive and managerial workers; government officials, clerical and related workers.

For place of residence, two categories are distinguished: municipal areas; and non-municipal areas. In this study, all places designated as "municipal" are referred to as "urban", while the places designated as "non-municipal" are referred to as "rural". In the 1970 sample, 90.4 per cent of the children were born to mothers residing in rural places at the time of the census. This proportion was still as high as 86.6 per cent in 1980.

The four natural regions constitute the four categories of another independent variable considered in this study. The Bangkok metropolis is included in the central region. Because of the specific characteristics of the samples under study, the distribution of the sample population across regions is slightly different from the distribution of the population as a whole (table 37).

Lastly, religion is analysed as a covariate of child mortality. The great majority of the population are Buddhists (approximately 95 per cent of the live births in this study occurred to Buddhist families), with the remainder being mostly Muslim. The Christian, Hindu and Confucian groups were omitted from the following analyses.

For all variables selected for multivariate analysis except region, the reference category is the category having the lowest mortality risk (occupational groups of professional, administrative and clerical workers, educational groups of university-educated mother or father, groups residing in urban areas and of Buddhist religion). The south region was selected as reference category.

Differentials observed in bivariate analysis

The probabilities of dying by age 5, ${}_5q_0$, were calculated for each category of each independent variable, on the basis of the average value of M for that category. Table 38 presents the values of ${}_5q_0$ for each group, as well as the risk of being in a

TABLE 38. PROBABILITY OF DYING BY AGE 5 AND RELATIVE RISKS OF CHILD MORTALITY, BY SOCIO-ECONOMIC CHARACTERISTICS, THAILAND, 1970 AND 1980 CENSUSES

Socio-economic characteristic	Probability of dying by age 5 $_5q_0$		Relative risk	
	1965	1975	1965	1975
Total country	0.096	0.053	-	-
Mother's education				
None	0.122	0.084	4.69	4.94
Primary	0.093	0.053	3.58	3.12
Secondary	0.029	0.024	1.12	1.41
University	0.026	0.017	1.00	1.00
Father's education				
None	0.115	0.086	3.59	3.44
Primary	0.097	0.055	3.03	2.20
Secondary	0.041	0.031	1.28	1.24
University	0.032	0.025	1.00	1.00
Mother's occupation				
Agricultural worker	0.106	0.061	4.08	2.65
Manual worker	0.065	0.051	2.50	2.22
Craftswoman	0.078	0.047	3.00	2.04
Sales worker	0.076	0.041	2.92	1.78
Professional, administrative or clerical worker	0.026	0.023	1.00	1.00
Father's occupation				
Agricultural worker	0.106	0.062	2.36	2.14
Manual worker	0.065	0.044	1.44	1.52
Craftsman	0.075	0.039	1.67	1.35
Sales worker	0.059	0.034	1.31	1.17
Professional, administrative or clerical worker	0.045	0.029	1.00	1.00
Residence				
Rural	0.103	0.058	2.71	1.81
Urban	0.038	0.032	1.00	1.00
Region				
North-east	0.115	0.062	1.49	1.41
North	0.113	0.068	1.47	1.55
South	0.077	0.044	1.00	1.00
Central[a]	0.073	0.037	.95	0.84
Religion				
Muslim	0.105	0.061	1.08	1.13
Buddhist	0.097	0.054	1.00	1.00

[a] Including Bangkok metropolis.

given category in relation to the reference category for the same variable.

The greatest differentials in $_5q_0$ among the various categories of one variable are seen for mother's education. The risk of dying by age 5 decreased sharply as maternal education rose: whereas the $_5q_0$ of children whose mothers had some university education were estimated to be 26 and 17 per 1,000 around 1965 and 1975, respectively, the

estimated ${}_5q_0$ of children whose mothers had no education were as high as 122 and 84 per 1,000, respectively. According to both census data, children whose mother had had no education had a risk of dying more than four times higher than that of children whose mother had had a university education; the differential persisted despite the decline in ${}_5q_0$ over time for both categories. Children whose mothers had had some primary education remained three times more likely to die by age 5 than were children of university-educated mothers, despite the general decline in child mortality. For children whose mothers had had some secondary education, the increased risk was small in relation to the reference group.

In the case of father's education, an inverse relationship is also observed between the risk of dying by age 5 and the educational level reported. The relative risks are somewhat smaller than those observed for mother's education. When the father had no formal education, the probability of dying by age 5 was more than three times as high as it was when the father had some university education, both around 1965 and around 1975. Between 1965 and 1975, with the reduction in child mortality, the increased risk associated with primary educational level of the father declined from three times to twice the risk associated with university education.

Among the mother's occupational groups, the lowest mortality risks were found for children of professional, administrative and clerical workers: 26 and 23 per 1,000 in 1965 and 1975, respectively. Children of agricultural workers had much higher mortality levels: about four times as high in 1965 and more than twice as high in 1975. Other non-professional occupations showed a risk of dying by age 5 up to three times as high as that observed for the reference category. During this decade of rapid expansion of female participation in the labour force and decline in child mortality, differentials in ${}_5q_0$ by the mother's occupational group declined.

Occupational categories of fathers were classified in the same manner as those of mothers. Children whose fathers were agricultural workers had a risk of dying by age 5 more than twice as high as children whose fathers had a professional, administrative or clerical position. It is interesting to note that socio-economic characteristics, such as education and occupation of the mother, have a larger effect on child mortality than the same characteristics in the father. Educational differentials, for both mother and father, are larger than occupational differentials.

Throughout the developing region, generally more favourable conditions in urban areas result in lower levels of child mortality than are found in rural areas. This is also the case in Thailand, since the risk of dying by age 5 was lower in urban than in rural areas in both 1965 and 1975. In 1965, ${}_5q_0$ for children living in rural areas was 2.7 times as high as ${}_5q_0$ for children living in urban areas. By 1975, however, a reduction was observed in this differential and ${}_5q_0$ for rural children was estimated to be only 1.8 times higher than ${}_5q_0$ for urban children. Of course, such a reduction could be due in part to differential quality of the 1970 and 1980 census data, as explained above.

Consideration of the relationship between child mortality and region of residence indicates regional differentials, perhaps due to diversity in ecology, climate and level of available health services and economic development. The lowest mortality is observed in the region in which the capital is located, the central region. Regions that are isolated and are known to have an unhealthy climate (north and north-east) have high mortality.

Compared with the differentials observed for the other variables, the differentials in ${}_5q_0$ according to religious group are very small. The Muslim population has slightly higher child mortality than the Buddhist population.

Multivariate regression

The use of multivariate regression analysis makes it possible to study the mortality risks associated with each variable independently of the influence of all other variables. The regression coefficients reflect the excess mortality of a given category in relation to the reference category of a variable, once the effects of all other variables are controlled. Table 39 presents the regression coefficients obtained by multivariate regression analysis of the 1970 and 1980 census samples. All seven variables

TABLE 39. MULTIVARIATE COEFFICIENTS OF CHILD MORTALITY BY SOCIO-ECONOMIC CHARACTERISTICS, THAILAND, 1970 AND 1980 CENSUSES

Socio-economic characteristic	*Regression coefficients*	
	1970 census	*1980 census*
Mother's education		
None	0.312[a]	0.651[a]
Primary	0.015[a]	0.222[a]
Secondary	-0.264[a]	0.073[a]
University	0.000	0.000
Father's education		
None	0.162[a]	0.403[a]
Primary	0.073[a]	0.080[a]
Secondary	-0.167[a]	-0.069[a]
University	0.000	0.000
Mother's occupation		
Agricultural worker	-0.015[a]	-0.072[a]
Manual worker	0.019[a]	0.216[a]
Craftswoman	0.060[a]	0.143[a]
Sales worker	0.034[a]	0.070[a]
Professional, administrative or clerical worker	0.000	0.000
Father's occupation		
Agricultural worker	0.096[a]	0.294[a]
Manual worker	0.002	0.111[a]
Craftsman	0.001	-0.016[a]
Sales worker	-0.136[a]	-0.098[a]
Professional, administrative or clerical worker	0.000	0.000
Residence		
Rural	0.369[a]	0.084[a]
Urban	0.000	0.000
Region		
North	0.455[a]	0.501[a]
Central[b]	0.187[a]	0.111[a]
North-east	0.531[a]	0.468[a]
South	0.000	0.000
Religion		
Muslim	0.231[a]	0.234[a]
Buddhist	0.000	0.000

[a] Statistically significant at the 5 per cent level.
[b] Including Bangkok metropolis.

under consideration are simultaneously included in the analysis.

The results of this analysis show that important mortality differentials persist even under multivariate control. With respect to the educational level of the parents, although educational attainment improved significantly over the period under study, the relative disadvantage of children with an illiterate mother or father grew

considerably between 1965 and 1975. Children whose mother had only some primary education had a higher disadvantage with regard to their mortality risk in 1975 than in 1965, while the relative advantage of children whose mother had some secondary education was greatly reduced.

Once the effects of all other variables are controlled, the effects of maternal and paternal occupation appear to be more differentiated than in the bivariate analysis. For children whose mother was an agricultural worker, child mortality was actually lower than it was for children whose mother had a professional position. In contrast, children whose father was an agricultural worker had increased risks of child mortality. Children whose father was a sales worker and craftsman tended to be protected, in relation to the children of professionals, while children whose mother was a sales worker or craftswoman tended to have increased risks.

A major decline seems to have occurred in the effect of rural residence on the mortality risks of children: in 1975 the disadvantage of living in a rural area, albeit statistically significant, was considerably smaller than it was in 1965. This finding, of course, could be due, at least in part, to differential quality of the census data in 1970 and 1980. Regional differentials scarcely varied between 1965 and 1975, and remained quite large in comparison with the differentials observed for other variables. Once the effects of other factors were controlled, the south region had the lowest mortality and the north and north-east regions had the highest mortality.

Religious differentials appear to have been greater than is suggested by the bivariate analysis, with the Buddhist majority having lower child mortality than the Muslim group. This differential does not seem to have changed over time.

Risk groups

In order to assist in targeting public-health policy, the socio-economic groups with the highest and lowest child mortality risks were identified on the basis of four characteristics. The characteristics of interest are: place of residence; mother's occupation; mother's education; and father's education. The probabilities of dying by age 5 were estimated from the two census samples for each combination of the four characteristics by converting the average values of M observed for each combination category, as was explained in chapter II.

The risk groups were determined on the basis of the average value of M for each combination category in the following manner: (*a*) highest risk, > 1.5; (*b*) high risk, 1.2-1.5; (*c*) intermediate risk, 0.8-1.2; (*d*) low risk, 0.5-0.8; and (*e*) lowest risk, < 0.5. For 1970, four risk groups emerged, while for 1980, five risk groups were determined.

Table 40 presents the results pertaining to the 1970 data and table 41 presents those pertaining to 1980. For each risk group, both tables present the range of probabilities estimated for the combination categories making up the risk group. In addition, for each combination category, the tables show the percentage of women in that category among all women (those aged 15-34 and married to the head of the household who reported at least one live birth) found in the census samples, the proportion of children ever born to women in the given category among the children born to all women selected for this analysis, the proportion of women in that category among all women of the same risk group and the proportion of children ever born among all children ever born in that risk group.

The residual groups shown in tables 40 and 41 consist of the categories containing fewer than 15 cases in the 1970 census sample and fewer than 10 cases in the 1980 census sample, as well as the observations for which one or more variables were missing or not stated, or the observations were excluded from the multivariate regression analysis.

The profile of the high-risk group identified from the 1970 census data consists of a rural population of mothers and fathers who had received no education or only some primary education and in which women were primarily employed as agricultural workers. Approximately 13 per cent of the women in the sample constituted this category. The intermediate-risk group consisted mainly of rural women employed in agriculture who had some primary education and whose husbands also had

some primary education. The intermediate-risk group was by far the largest group, with approximately 56 per cent of the observations. The low-risk and lowest risk groups were very small: each included fewer than 2 per cent of the observations. The lowest risk group was essentially made up of urban mothers, most of whom had at least some primary education.

By 1980, the disparities between the risk groups had increased, but the sizes of the higher risk groups had decreased. A highest risk group was distinguished from the high-risk group: these two groups, consisting essentially of rural women who had no education or only primary education and whose husbands also were in those educational catgories, made up close to 8 per cent of the women and approximately 9 per cent of the children ever born. As in 1970, the intermediate-risk group was primarily rural, but with higher educational levels for both parents than those in the highest risk and high-risk groups. Again, the intermediate-risk group was the largest, with more than 60 per cent of the births. The low-risk and lowest risk groups were mainly urban. Women in the low-risk group had at least some primary education, regardless of the educational level of their husbands, and made up approximately 9 per cent of the population. The majority of women with secondary or university education and professional occupation were in the lowest risk group, which included approximately 3 per cent of the women and 2 per cent of the children.

D. SUMMARY AND DISCUSSION

The purpose of this study was to examine the changes over time in levels and socio-economic differentials of child mortality in Thailand since the 1960s. Several sources of data document that child mortality declined considerably and steadily between the early 1960s and the early 1980s, and that the decline was mainly concentrated in rural areas. For the analysis of mortality differentials, the 1970 and the 1980 population censuses of Thailand were used. Child mortality appears to have been underestimated by both censuses, more so probably for the socio-economic groups with high mortality in the 1980 census. As a result, the mortality differentials estimated from the 1980 census data may be underestimated.

The analysis of differentials was carried out in three steps. First, bivariate relationships were explored between mortality and each of seven socio-economic factors selected for this study. Secondly, multivariate regression analysis was carried out, simultaneously including all socio-economic factors under study. Lastly, higher and lower mortality risk groups were identified on the basis of four important socio-economic characteristics.

As is usually the case, the bivariate analysis showed inverse relationships between the parents' educational levels and the mortality risks of their children. Bivariate results also showed that professional, administrative and clerical occupations of the parents were associated with lower child mortality than were agricultural or manual occupations. Child mortality was lower in urban areas than in rural areas. Regional differentials were also observed in children's risks of dying; the groups at lower risk were those who were living in the central region. The children of Buddhist parents had lower child mortality than the children of Muslim parents.

Among the findings of this study, a few important points deserve to be underlined. The comparison of the results of the bivariate and the multivariate analyses of the socio-economic differentials in child mortality showed that regional and religious differentials, which were moderate in the bivariate analysis, apparently became relatively large once multivariate control was used. In other words, ecological factors linked to region and cultural factors linked to religion may play a large role in determining child mortality in Thailand. Such a role is, however, obscured by the counteracting influence of other variables.

It also appeared from the multivariate analysis that the same occupation does not necessarily have the same association with child mortality risks when it is the mother's occupation and when it is the father's. Agricultural occupations of the mother seem to be associated with lower risks, but when the father is in those occupations, they are associated with higher risks. To have a father employed in sales and crafts was protective for the child, but to have a mother employed in those occupations was not. Such results are probably due

TABLE 40. CHILD MORTALITY RISK GROUPS, BY PLACE OF RESIDENCE, MOTHER'S OCCUPATION, AND FATHER'S AND MOTHER'S EDUCATION, THAILAND, 1970 CENSUS

Risk group level	Characteristics of the group				Percentage in 1970 census		Percentage in risk group	
	Place of residence	Mother's occupation	Father's education	Mother's education	Women aged 15-34	Children ever born	Women aged 15-34	Children ever born
High risk								
($_5q_0$ = 124-155)	-	-	-	-	12.8	14.4	100.0	100.0
	Rural	Craftswoman	None	Primary	0.1	0.2	0.9	0.9
	Rural	Agricultural worker	None	None	5.7	6.3	44.5	44.0
	Rural	Agricultural worker	Primary	None	7.0	7.9	54.6	55.1
Intermediate risk								
($_5q_0$ = 82-123)	-	-	-	-	56.4	56.5	100.0	100.0
	Rural	Agricultural worker	None	Primary	5.2	5.1	9.1	9.0
	Rural	Sales worker	None	None	0.1	0.1	0.2	0.3
	Rural	Agricultural worker	Primary	Primary	49.1	49.1	87.0	86.8
	Rural	Craftswoman	Primary	Primary	1.1	1.2	2.0	2.0
	Rural	Sales worker	Primary	Primary	0.6	0.7	1.1	1.2
	Rural	Manual worker	Primary	Primary	0.1	0.1	0.2	0.3
	Rural	Craftswoman	Primary	None	0.2	0.2	0.4	0.4
Low risk								
($_5q_0$ = 52-81)	-	-	-	-	1.8	1.5	100.0	100.0
	Urban	Craftswoman	Primary	None	0.1	0.1	3.3	5.5
	Rural	Agricultural worker	Secondary	None	0.1	[a]	3.3	3.3
	Rural	Craftswoman	Secondary	Primary	0.1	0.1	6.7	4.4
	Urban	Sales worker	Primary	None	0.1	0.1	3.3	5.5
	Urban	Agricultural worker	Primary	Primary	0.2	0.2	13.3	13.2
	Rural	Agricultural worker	Secondary	Primary	1.0	0.9	60.0	59.3
	Rural	Professional worker	Primary	Secondary	0.1	0.1	6.7	5.5
	Rural	Agricultural worker	Secondary	Secondary	0.1	[a]	3.3	3.3
Lowest risk								
($_5q_0$ < 52)	-	-	-	-	1.8	1.5	100.0	100.0
	Urban	Manual worker	Primary	Primary	0.1	0.1	3.1	5.5
	Rural	Sales worker	Secondary	Primary	0.1	0.1	6.3	6.6
	Urban	Sales worker	Primary	Primary	0.3	0.4	18.8	26.4
	Urban	Craftswoman	Primary	Primary	0.4	0.4	21.9	25.2
	Urban	Craftswoman	None	None	0.1	0.1	3.1	5.5
	Urban	Craftswoman	Secondary	Primary	0.1	0.1	6.3	4.4
	Rural	Agricultural worker	Primary	Secondary	0.1	0.1	6.3	5.5
	Urban	Professional worker	Secondary	Secondary	0.3	0.2	15.6	11.0
	Urban	Professional worker	University	Secondary	0.1	[a]	6.2	3.3
	Urban	Professional worker	Primary	Secondary	0.1	[a]	6.2	3.3
	Urban	Professional worker	University	University	0.1	[a]	6.2	3.3
Residual	-	-	-	-	27.2	26.1	100.0	100.0

NOTE: The highest risk group is not shown in table 40 because no group had M greater than 1.5.

[a] Less than 0.1.

to the fact that occupation of the father and occupation of the mother are differently related to risk factors of mortality for the child. The mother's occupation is likely to influence child-care practices and her ability to respond to the daily needs of her child. In contrast, the father's occupation is more

TABLE 41. CHILD MORTALITY RISK GROUPS, BY PLACE OF RESIDENCE, MOTHER'S OCCUPATION, AND FATHER'S AND MOTHER'S EDUCATION, THAILAND, 1980 CENSUS

Risk group level	Characteristics of the group				Percentage in 1970 census		Percentage in risk group	
	Place of residence	Mother's occupation	Father's education	Mother's education	Women aged 15-34	Children ever born	Women aged 15-34	Children ever born
Highest risk ($_5q_0 > 85$)	-	-	-	-	5.9	7.2	100.0	100.0
	Urban	Agricultural worker	Primary	None	*	*	0.5	0.3
	Rural	Manual worker	Primary	None	*	*	0.5	0.7
	Rural	Craftswoman	None	Primary	0.1	0.1	1.1	0.9
	Rural	Sales worker	None	Primary	0.1	0.1	1.1	1.0
	Rural	Agricultural worker	None	None	2.3	3.0	38.7	40.8
	Rural	Professional worker	Primary	Primary	0.1	*	1.1	0.7
	Rural	Craftswoman	None	None	*	*	0.5	0.7
	Rural	Agricultural worker	Primary	None	3.3	4.0	56.5	54.9
High risk ($_5q_0 = 68$-85)	-	-	-	-	1.6	1.9	100.0	100.0
	Rural	Agricultural worker	None	Primary	1.5	1.9	96.1	97.4
	Rural	Sales	Primary	Secondary	0.1	*	3.9	2.6
Intermediate risk ($_5q_0 = 46$-67)	-	-	-	-	60.6	61.7	100.0	100.0
	Rural	Craftswoman	Primary	None	0.2	0.2	0.3	0.4
	Urban	Agricultural worker	Secondary	Primary	0.1	0.1	0.1	0.1
	Urban	Manual worker	Secondary	Primary	0.1	0.1	0.2	0.2
	Rural	Professional worker	Primary	University	0.1	*	0.1	0.1
	Rural	Manual worker	Primary	Primary	0.5	0.5	0.8	0.8
	Rural	Sales worker	Primary	None	0.1	0.2	0.2	0.2
	Rural	Agricultural worker	Primary	Primary	55.8	57.1	92.1	92.6
	Rural	Craftswoman	Primary	Primary	2.9	2.7	4.8	4.4
	Rural	Craftswoman	Secondary	Secondary	*	*	0.1	*
	Rural	Agricultural worker	Primary	Secondary	0.2	0.2	0.4	0.3
	Rural	Sales worker	Secondary	Primary	0.5	0.5	0.8	0.8
	Urban	Craftswoman	Primary	None	0.1	0.1	0.1	0.1
Total	-	-	-	-	100.0	100.0	-	-
Low risk ($_5q_0 = 29$-45)	-	-	-	-	9.3	9.2	100.0	100.0
	Rural	Sales worker	Primary	Primary	2.4	2.5	25.9	27.4
	Urban	Sales worker	None	Primary	0.1	0.1	0.7	0.8
	Urban	Professional worker	Secondary	Secondary	0.6	0.5	6.1	4.9
	Urban	Agricultural worker	Primary	Primary	0.5	0.5	5.1	5.1
	Rural	Agricultural worker	Secondary	Primary	1.8	1.8	19.8	19.7
	Urban	Sales worker	Secondary	Primary	0.4	0.4	3.8	3.8
	Urban	Sales worker	Primary	Primary	1.1	1.2	11.6	13.2
	Urban	Sales worker	University	Primary	*	*	0.3	0.4
	Rural	Agricultural worker	University	Primary	0.2	0.2	2.1	2.0
	Urban	Manual worker	Primary	Primary	0.5	0.5	5.5	5.1
	Urban	Professional worker	Primary	Primary	0.1	*	0.7	0.6
	Urban	Professional worker	Secondary	Primary	*	*	0.3	0.6
	Urban	Craftswoman	Primary	Primary	1.2	1.1	13.0	12.0
	Urban	Craftswoman	None	Primary	*	*	0.3	0.6
	Rural	Craftswoman	Secondary	Primary	0.3	0.3	3.4	2.8
	Rural	Agricultural worker	Secondary	Secondary	0.1	0.1	1.4	1.0

(Table 41 continued)

TABLE 41 (*continued*)

Risk group level	Characteristics of the group				Percentage in 1970 census		Percentage in risk group	
	Place of residence	Mother's occupation	Father's education	Mother's education	Women aged 15-34	Children ever born	Women aged 15-34	Children ever born
Lowest risk ($_5q_0$ < 29)	-	-	-	-	3.2	2.2	100.0	100.0
	Urban	Sales worker	Primary	None	0.1	*	2.0	2.2
	Rural	Sales worker	University	Primary	0.1	0.1	4.1	6.1
	Urban	Professional worker	University	Secondary	0.2	0.2	8.2	7.2
	Urban	Sales worker	Primary	Secondary	0.1	*	2.0	2.2
	Rural	Professional worker	University	Secondary	0.2	0.1	6.1	6.7
	Urban	Professional worker	University	University	0.6	0.4	17.3	15.5
	Urban	Professional worker	Primary	Secondary	0.1	0.1	3.1	2.8
	Rural	Professional worker	Primary	Secondary	0.1	0.1	3.1	3.3
	Rural	Professional worker	Secondary	Secondary	0.5	0.3	14.3	14.9
	Urban	Professional worker	Secondary	University	0.2	0.1	5.1	4.4
	Rural	Professional worker	Secondary	University	0.2	0.2	8.2	8.8
	Urban	Craftswoman	Secondary	Primary	0.2	0.2	8.2	8.8
	Rural	Professional worker	University	University	0.6	0.4	18.3	17.1
Residual	-	-	-	-	19.4	17.8	100.0	100.0

* Less than 0.1.

likely to be a measure of economic standing and of the ability of the family to maintain a healthy lifestyle and to obtain health services. Consequently, to have a mother employed in agriculture may mean better child care and lower mortality risks, while to have a father employed in agriculture may imply lower economic standing and higher mortality risks.

The change over time in the socio-economic differentials of mortality revealed that while the educational and occupational distributions of the population were changing favourably for child survival, the relative mortality risks for some children were actually deteriorating. These were mainly children of illiterate parents, children whose mother had only some primary education, children whose father was an agricultural worker and children with either parent employed in a manual occupation.

Mortality differentials by place of residence declined between the two censuses, perhaps in part as a result of the expansion of health services to remote rural areas during the 1970s. Expansion of services and increased ease of access to health services make the decision to use, and the ability to purchase such services, more determinant of child mortality. It is thus probable that the decline in the rural/urban disparity in child mortality risks progressively made individual characteristics, such as education or occupation of the parents, more determinant. This factor, in turn, may have contributed to the widening differentials between the least and the most educated and between the various occupational categories. Thus, the decline in child mortality throughout Thailand since the 1960s, which was due in part to increased educational levels and in response to public policy, was accompanied by the marginalization of certain economic groups, those least likely to have had the adequate levels of knowledge and resources to benefit fully from socio-economic improvement.

NOTES

[1] For more information on regional characteristics and indicators, see Economic and Social Commission for Asia and the Pacific (1976) and Varakamin and others (1983).

[2] The territory of Thailand is divided into municipal and non-municipal areas. Municipal areas were established under the

Municipal Act of 1953, using criteria of population size and density, as well as source and amount of revenue and performance of specified functions. The analysis presented here treats the municipal areas as urban and the non-municipal areas as rural.

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