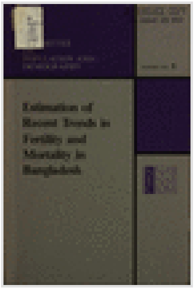

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POPULATION AND DEMOGRAPHY Report No. 5

Estimation of Recent Trends in Fertility and Mortality in Bangladesh

Panel on Bangladesh
Committee on Population and Demography
Assembly of Behavioral and Social Sciences
National Research Council

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This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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Preface

The Committee on Population and Demography was established in April 1977 by the National Research Council, in response to a request by the Agency for International Development (AID) of the U.S. Department of State. It was widely felt by those concerned that the time was ripe for a detailed review of levels and trends of fertility and mortality in the developing world. Although most people in the demographic community agree that mortality has declined in almost all developing countries during the last 30 years, there is uncertainty about more recent changes in mortality in some countries, about current levels of fertility, and about the existence and extent of recent changes in fertility.

In 1963, the Panel on Population Problems of the Committee on Science and Public Policy of the National Academy of Sciences published a report entitled The Growth of World Population. The appointment of that panel and the publication of its report were expressions of the concern then felt by scientists, as well as by other informed persons in many countries, about the implications of population trends. At that time, the most consequential trend was the pronounced and long-continued acceleration in the rate of increase of the population of the world, and especially of the population of the poorer countries. It was estimated in 1963 that the annual rate of increase of the global population had reached 2 percent, a rate that, if continued, would cause the total to double every 35 years. The disproportionate contribution of low-income areas to that acceleration was caused by rapid declines in mortality combined with high fertility that remained almost unchanged: the birth rate was nearly fixed or declined more modestly than the death rate.

Since the earlier report, however, the peak rate of growth in the world's population has apparently been passed. A dramatic decline in the birth rate in almost all the more developed countries has lowered their aggregate annual rate of increase to well below 1 percent, and the peak rate of increase has also apparently been passed in the less-developed parts of the world as a whole. A sharp decline in fertility in many low-income areas has more than offset the generally continued reduction in the death rate, although the rate of population increase remains high in almost all less-developed countries.

The causes of the reductions in fertility--whether they are the effect primarily of such general changes as lowered infant mortality, increasing education, urban rather than rural residence, and improving status of women or of such particular changes as spreading knowledge of and access to efficient methods of contraception or abortion--are strongly debated. There are also divergent views of the appropriate national and international policies on population in the face of these changing trends. The differences in opinion extend to different beliefs and assertions about what the population trends really are in many of the less-developed countries. Because births and deaths are recorded very incompletely in much of Africa, Asia, and Latin America, levels and trends of fertility and mortality must be estimated, and disagreement has arisen in some instances about reasonably reliable methods for estimating those levels and trends.

It was to examine these questions that the Committee on Population and Demography was established within the Assembly of Behavioral and Social Sciences of the National Research Council. It was funded for a period of three years by AID under Contract No. AID/pha-C-1161. The Committee has undertaken three major tasks:

1. To evaluate available evidence and prepare estimates of levels and trends of fertility and mortality in selected developing nations;

2. To improve the technologies for estimating fertility and mortality when only incomplete or inadequate data exist (including techniques of data collection);

3. To evaluate the factors determining the changes in birth rates in less-developed nations.

Given the magnitude of these tasks, the Committee decided to concentrate its initial efforts on the first two tasks; it initiated work on the third task in 1979.

The Committee approaches the first task through careful assessment, by internal and external comparison, and through analysis, by application of methods judged to be the most reliable methods, of all the data sources available. Each of the country studies therefore consists of the application of a range of methods to a number of data sets. Estimates of levels and recent trends are then developed on the grounds of their consistency and plausibility and the robustness of the individual methods from which they were derived.

The Committee's second task, refinement of methodology, is seen as a by-product of achieving the first. The application of particular methods to many different data sets from different countries and referring to different time periods will inevitably provide valuable information about the practical functioning of the methods themselves. Particular data sets might also require the development of new methodology or the refinement of existing techniques.

The Committee set three criteria for identifying countries to study in detail: that the country have a population large enough to be important in a world view; that there be some uncertainty about levels and recent trends of fertility or mortality; and that sufficient demographic data be available to warrant a detailed study. After a country has been selected for detailed study, the usual procedure is to set up a panel or working group of experts, both nationals of the country and others knowledgeable about the demography and demographic statistics of the country. The role of these panels and working groups, which generally include at least one Committee member, is to carry out the comparisons and analyses required. A small staff assists the Committee, panels, and working groups in their work.

As of early 1981, 162 population specialists, including 89 from developing countries, have been involved in the work of the Committee as members of panels or working groups. The Committee, the Assembly, and the National Research Council are grateful for the unpaid time and effort these experts have been willing to give.

Each country being studied has a different mix of data sources and different problems with data errors. Therefore, there is no standard pattern for all the reports. However, each report includes a summary of the main findings regarding estimates of fertility and mortality, a description of the data sources available, and a presentation of the analyses that were carried out, classified by type of data analyzed; detailed methodological descriptions are included where necessary in appendixes.

In some of the reports the estimates of fertility and mortality are presented as ranges. The use of a range is deliberate. It indicates that the panel and the Committee are confident that the range includes the true value, but have concluded that the evidence does not warrant selecting a single figure as best. The range conveys an important aspect (uncertainty) of the estimation. Ideally, in constructing an average for several populations in each of which estimation is presented as a range, an aggregate range would be calculated (as the population-weighted average of the constituents). The user who selects a single figure from the middle of the range does so at the risk of misleading simplification.

This report, on levels and recent trends of fertility and mortality in Bangladesh, is number 5 in a series of country reports to be issued by the Committee on Population and Demography. The Committee's thanks for this study are clearly due to the panel, whose members are listed above. Many panel members put considerable effort into the work of the panel, contributing to the organization of the panel's activities and to the data analysis reported here. Several outside organizations have also contributed to the study; special mention should be made of the Bangladesh Institute of Development Studies, which sponsored the panel workshop in Dacca in April 1979, and of the World Fertility Survey, which provided some special tabulations from the 1976 Bangladesh Fertility Survey. Special thanks are also due to the many individuals who contributed to the work of the panel. All the permanent staff of the Committee have contributed in some measure to this report; special thanks are due to the Committee's administrative

Summary

Estimation of fertility and mortality levels and trends in Bangladesh is particularly difficult because conventional data in the form of complete registration of vital events and accurate census counts are absent and because the censuses and sample demographic surveys are characterized by very extensive misreporting of age, understatement of parity (at least among older women), and possible overall misenumeration. The analysis is further complicated by two special problems: extensive but unrecorded international migration and fluctuations in fertility and mortality caused by recent natural disasters or political upheavals. Nevertheless, it has been possible to establish approximate limits for recent fertility and mortality rates and for their evolution during years not characterized by catastrophes.

No sustained trend (up or down) in fertility in Bangladesh is evident from the early 1960s to 1975. In most years the total fertility rate was within the range of 6.8 to 7.3 and the crude birth rate was between 47 and 51 per thousand. The absence of any obvious trend does not mean that fertility was constant. On the basis of apparently quite reliable birth registration data for one area of rural Bangladesh, fertility in the area was particularly low in 1975, after the 1974 famine, but recovered in 1976 and 1977. Sharp fluctuations in national fertility rates also doubtless occurred in some years in response to natural disasters or political

upheavals. It is therefore likely that average fertility over a period of several years may have been lower when the years in question encompass floods, small crops, and wartime disruptions; but there is no indication of tangibly lower fertility in recent "normal" years. The limited information on regional differentials suggests that there are no substantial differences in fertility by division.

Marriage historically has been early and universal for women. A recent tendency toward later marriage has had a relatively minor effect on overall fertility for two reasons: first, the mean age at first marriage has been so low that most of the decrease in the proportion currently married has been among teenage women; and second, there has been an offsetting tendency toward higher proportions married at the later childbearing years as a result of a lower incidence of widowhood.

Information on children ever born from the four sources available is reasonably consistent, although all the data sets show a tendency among older women to underreport their parity; average parities for younger women show almost no change from 1961-62, through 1968 and 1974, to 1975. Dual-record survey estimates of fertility for 1964-65, considered more reliable than those for the whole survey period 1962-65, are very consistent with adjusted retrospective estimates obtained from the 1974 survey data, the total fertility rates being 7.1 and 7.2, respectively.

The three surveys providing pregnancy histories--conducted in 1961-62, 1968, and 1975--all show pronounced declines in fertility during the decade prior to the survey date: the Demographic Survey of East Pakistan (DSEP) showed a decline in fertility of 22 percent between 1953-55 and 1957-60, the National Impact Survey (NIS) showed a decline of 20 percent between 1960-62 and 1966-68, and the Bangladesh Fertility Survey (BFS) showed a decline of 23 percent between 1966-71 and 1971-75. In each case, the fertility for the earlier period, from which the decline started, indicated a total fertility rate in excess of 8. In view of the similarities between the results of these surveys, and the obvious inconsistency of their results when combined, the information they provide on fertility trends has been discounted.

Estimates of child mortality are based largely on reports by mothers on the survival of their children--either in the aggregate form of survivors among all children ever born or in the more detailed form from pregnancy histories of date of birth and date of death, if dead, of each child. The mortality estimates derived from these two types of data are remarkably consistent and show little change in child mortality from the late 1950s to the mid-1970s, although the rates do fluctuate from year to year around the approximately constant level. Infant mortality, deaths under age 1 per thousand live births, seems to have averaged around 150 throughout the period; approximately 78 percent of children survived from birth to age 5. The only other national data on child mortality, provided by adjusted survey registration for the mid-1960s, are also consistent with the indirect estimates, showing an infant mortality rate of 154 and 76 percent of children surviving from birth to age 5. Though the information on mortality differentials by sex is not extensive, both direct and indirect data sources indicate lower female infant mortality, but higher female mortality between ages 1 and 5.

Two main types of data are available on which to base estimates of adult mortality, one being registered or reported deaths by age and sex as recorded by sample surveys and the other being information about the survival of close relatives, specifically parents and first spouses. Techniques exist to estimate the completeness of reporting of deaths and to convert the data on survival of relatives by age of respondent into traditional life table measures of mortality. After adjustment, the two available sets of the first type of data, on deaths by age, give rather similar estimates of adult mortality for 1964-65 and 1974, although the estimates of completeness are quite different for the two periods.

On the basis of these data, it appears that adult mortality is rather low in comparison to child mortality, that males have a marked advantage over females, and that for both sexes adult mortality fell somewhat between 1964-65 and 1974, increasing the expectation of life at birth by two to three years. The second type of data, on survival of relatives, gives higher estimates of adult mortality, but given that these estimates reflect average mortality over a considerable period of time before the survey, they are not inconsistent with the estimates obtained from adjusted deaths. Combining the estimates of child and adult mortality, the crude death rate is estimated to have been around 18 per thousand in the mid-1960s and around 17 per thousand in the mid-1970s.

The available estimates of fertility and mortality indicate that the population of Bangladesh has had a high rate of natural increase in the recent past, in the range of 2.9 to 3.4 percent per annum for most years during the period from the early 1960s to 1975 and has increased only slightly over the period. The population age distributions agree with these conclusions reasonably well, stable population analysis of the 1961 and 1974 age distributions indicating a birth rate in the range of 44 to 48 per thousand. However, the population total, as recorded by the censuses, has not been growing at anything like that rate, the increase in the enumerated population between 1961 and 1974 being only 2.6 percent.

Part of the discrepancy is accounted for by emigration, primarily of Hindus, throughout the period 1951 to 1974. However, even for the Muslim population, which is unlikely to have experienced net emigration, there is a discrepancy between the estimates of natural increase and the observed rates of intercensal population growth. Another possibility is that changes in enumeration completeness from census to census have affected the observed rate of population growth, although no conclusive evidence of such changes could be found. The inconsistency could also be explained if the rate of natural increase has been somewhat overestimated, either as a result of the birth rate being overestimated or--and perhaps more likely--as a result of the death rate being underestimated. It is also possible that migratory flows have not been fully accounted for. Although we are confident that the estimates of fertility and mortality presented in this report are the best that can be made given the data available, we have not been able to resolve rigorously the apparent inconsistency of these estimates with the rate of growth of the enumerated population of Bangladesh.

1 Introduction

Bangladesh was selected for detailed study by the Committee on Population and Demography mainly on the grounds of population size; the 71 million inhabitants recorded by the 1974 population census made it the eighth most populous nation on earth and by far the most densely populated country among the top 20. A lack of certain types of demographic information, particularly those derived from a vital registration system, has been compensated for to some extent by a number of sample surveys, but as a result of the shortcomings of the data there has been considerable uncertainty about recent levels and trends of fertility and mortality.

A panel for Bangladesh was established in mid-1978 to take responsibility for carrying out a study on behalf of the Committee. In April 1979, a three-day workshop was held in Dacca under the sponsorship of the Bangladesh Institute for Development Studies (BIDS). A number of working papers by panel members and others were presented and discussed at this workshop, the proceedings of which have recently been published (Khan, 1981). At the completion of the workshop, the panel discussed general conclusions and identified additional analyses that needed to be carried out in order to complete the demographic picture as well as possible, given the data available. A report was then drafted, discussed and amended at a final panel meeting, and submitted to the

Committee on Population and Demography and to the National Research Council for review.

This report summarizes the evidence reviewed by the panel in arriving at its conclusions. In some cases, the details of the analytical procedures used are lengthy and technical, and in order to keep this report within reasonable bounds, such details have been summarized and suitable references made to the source material. Similarly, raw data published elsewhere have not been reproduced. However, where the consistency, or lack of it, of the results of a particular analysis have a bearing on the validity, or otherwise, of the conclusions drawn, the results have been presented in sufficient detail to demonstrate that consistency.

The introductory chapter that follows provides a brief description of Bangladesh and its people and describes the major sources of demographic data and the information available from them. Chapter 2 presents estimates of fertility, classified by the type of evidence on which they are based. Chapter 3 is concerned with changes in age patterns of marriage and marital dissolution and their impact on fertility. Chapter 4 presents estimates of mortality classified by the type of evidence on which they are based. Chapter 5 reviews the evidence concerning regional variations in fertility and mortality. Finally, in Chapter 6, the fertility and mortality estimates obtained are combined in order to examine rates of natural increase and population growth.

BANGLADESH AND ITS PEOPLE*

Bangladesh is a deltaic land covering an area of 143,998 square kilometers. It lies between latitudes 20°30' and 26°45' North and longitudes 88°00' and 92°56' East. It is bounded by India to the east, north, and west and shares a short frontier with Burma on the southeast. To the south lies the Bay of Bengal, and to the northeast lies the broad mass of the Assam range on the Shillong plateau. The Himalayas lie not far from the boundary on the northwest.

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*This section is adapted from Section 1.4 of the first report on the Bangladesh Fertility Survey (Bangladesh, 1978).

More than 85 percent of Bangladesh is flat alluvial plain crisscrossed by the mighty rivers Padma, Meghna, and Jamuna and by their innumerable tributaries. These rivers play a significant role in the lives of the people and in the physical environment of Bangladesh: they provide a cheap means of transport, serve as drainage channels, ensure an abundant supply of fish, and above all, deposit on the land every year an enormous quantity of fertilizing silt. About 92 percent of the population is rural and 80 percent are engaged in agriculture.

Mean annual temperatures vary between 57° and 80°F. The annual rainfall varies from 50 inches in the west to 100 inches in the southeast and to 200 inches in the Assam hills in the north. This heavy rainfall is associated with tropical cyclones and floods which on numerous occasions have devastated the country and caused frequent suffering for millions of its people.

Muslims ruled the country from the early thirteenth century until the eighteenth century, when the British took over and administered the area until 1947. In 1947, the partition of India took place and the two independent states of India and Pakistan were created. Pakistan consisted of the Muslim areas of the northwest and northeast parts of the Indian subcontinent, known respectively as West Pakistan and East Pakistan (called Muslim East Bengal before 1947). The 1,500 miles of foreign territory separating the two wings, the differences in climate, topography, language, sociocultural characteristics, and above all an unequal economic development and political representation resulted in the de facto existence of two separate nations within Pakistan. Following a political debacle that culminated in the War of Liberation in 1971, Bangladesh emerged as a sovereign and independent state on December 16, 1971.

For administrative purposes, Bangladesh has four divisions: Dacca, Chittagong, Rajshahi, and Khulna. At the time of the 1974 census, these divisions were subdivided into 19 districts. Each district is divided into subdivisions, which in turn are subdivided into thanas, classified as rural, urban, or semi-urban. The 1974 census listed 422 thanas, which in turn were subdivided into 4,350 unions. A union is comprised of a group of villages; the 1974 census reported the existence of 68,385 villages.

Dacca is the capital city of Bangladesh. Chittagong, Khulna, and Narayanganj are the three other principal cities. The official language is Bengali, which is spoken and understood throughout the country.

More than 85 percent of the population is Muslim. Other religious groups are Hindus, who constitute 13 percent of the population, and Buddhists and Christians, who constitute less than 2 percent. The Hindu population can conveniently be further subdivided into Caste Hindus and Scheduled Caste Hindus, the latter formerly known as untouchables.

Twenty-four percent of the population aged 5 and over is literate. The proportions of literate males and females are 33 percent and 15 percent, respectively.

Bangladesh enjoys fertile agricultural lands. Rice, jute, sugar cane, tea, tobacco, oil seeds, pulses, wheat, and potatoes are the principal crops. A sizeable quantity of tea is exported, though jute and jute manufactured goods account for more than 80 percent of exports.

Although Bangladesh is primarily an agricultural country, there are some large-scale industries based on local raw materials. Jute manufacturing, paper and newsprint, sugar, cement, chemical fertilizer, and textile industries are major industrial activities. Several natural gas fields with large reserves have recently been discovered.

DEMOGRAPHIC DATA SOURCES

The Indian subcontinent has a long history of census taking, stretching back to 1871-72. The tradition of decennial censuses was continued after partition, and censuses of Pakistan were held in 1951 and 1961. These two censuses were extensively tabulated for the east and west wings of Pakistan separately, making it possible to study the area that is now Bangladesh. The demographic content of these two censuses, however, was limited to questions about age, sex, birthplace, and marital status. No census was held in 1971, because of the turmoil of the War of Liberation. The first census of independent Bangladesh was carried out in 1974. In addition to information on age, sex, and marital status, this most recent census collected data on children ever born. It was followed that same year by a post-enumeration coverage check and by a special retrospective demographic survey, which is described below.

Although its census data are reasonably extensive, Bangladesh is not so favorably endowed with the other traditional source of demographic data, vital registration. A system of birth and death registration does exist, but the coverage is so incomplete that no attempt is made to tabulate the information collected, and no vital registration data are available for the period covered by this study.

Fortunately, the lack of vital registration data is compensated for to some extent by the availability of data from a number of demographic sample surveys. The first national survey during the period under consideration was the Population Growth Estimation (PGE) Experiment, a dual-record survey conducted from 1962 to 1965. In most sample areas demographic events were recorded both by a continuous (longitudinal) registration system (LR) and by a cross-sectional survey (CS) carried out in each sample area four times a year. Total events, adjusted for omission, were then estimated by matching the events recorded by the two collection systems and then applying the Chandrasekaran and Deming (1949) formula to matched and unmatched events. (This formula estimates the number of events missed by both systems from the number covered by both systems, the number covered by registration but not survey, and the number covered by survey but not registration.)

In East Pakistan, the PGE sample covered ten rural and two urban clusters, each with a population of approximately 5,000, although four of the rural areas were not covered by the dual-record system, two being covered only by the LR method, and two more being covered only by the CS method. One district, Chittagong Hill Tracts, accounting for about 1 percent of the population, was excluded from the sample frame.

During 1968 and 1969, the Pakistan Family Planning Council conducted the National Impact Survey (NIS) in a sample of about 120 rural villages and 50 urban electoral units in each wing of Pakistan. In East Pakistan, the sample covered about 3,000 households. A simple household questionnaire was used to select eligible men and women for more detailed questions, the criteria for eligibility being that a woman should be ever-married and under 55 and that a man should currently be married to an eligible woman. A detailed pregnancy history, together with information about the survival of each child, was collected from all eligible women. Unfortunately, more has been published about the planning and organization of the survey than about its results, and the only information tabulated is for currently married women under 50.

The next important national survey was the Bangladesh Retrospective Survey of Fertility and Mortality (BRSFM), conducted at the same time as the 1974 census post-enumeration check in a 0.5 percent sample of census blocks. A total of 482 such blocks and a population of about 364,000 were included in the sample. The survey collected information on age, sex, marital status, children ever born by sex of child, children surviving by sex of child, date of most recent birth and whether the child was still alive, survival of mother, survival of father, survival of first spouse, religion, education, and deaths in the household in the two years before the survey by age, sex, and approximate date.

The BRSFM was soon followed by the Bangladesh Fertility Survey (BFS), organized under the auspices of the World Fertility Survey (WFS) program, and carried out between December 1975 and March 1976. With a sample of about 6,000 households from 240 sampling units, the BFS followed the standard pattern of WFS surveys, starting with a household questionnaire to collect certain basic demographic information about each household member and using that information to identify ever-married women under the age of 50, who were then reinterviewed to obtain complete pregnancy histories and other fertility-related data. The BFS differed from some WFS surveys in that all eligible women from the household schedule were reinterviewed, not only one per household.

Despite the fact that they cannot be regarded as nationally representative, three other sources of data deserve mention. The first, a population surveillance scheme in Matlab thana, is valuable because of its remarkable continuity and the high quality of the data collected. In 1966, the Cholera Research Laboratory (now the International Centre for Diarrhoeal Disease Research, Bangladesh) established in Matlab thana of Comilla district a longitudinal demographic surveillance system that combined registration of vital events with periodic censuses. In 1968, the initial study population of over 100,000 was virtually doubled by the inclusion of additional villages, but since then the study area has remained unchanged. The apparently high quality of the Matlab data may be accounted for by the effort put into their collection and by the heavy concentration of staff used, there being one full-time field worker for every

200 households, each of which is visited every two or three days. The second subnational data source is an extension of the surveillance system of the Cholera Research Laboratory, in Teknaf thana of Chittagong district. A complete census of the thana population of 82,000 was carried out around the end of 1974, and 15,000 of the population were covered by the surveillance system until mid-1976, when the population covered was increased to 40,000 and recording of births, deaths, marriages, and migration was started. It is assumed that the data available from the Teknaf surveillance system are of high quality, by analogy with Matlab, though the results are too recent to have been exhaustively tested. The third subnational data source, the 1961-62 Demographic Survey of East Pakistan, collected maternity histories from a sample of areas of central Bangladesh and is useful primarily for its information on infant mortality. It is discussed in detail in the chapter on mortality.

Table 1 summarizes the data sources used in preparing this report and shows the types of demographic information they provide.

POPULATION CHARACTERISTICS AS RECORDED BY CENSUSES

Population Growth

The population censuses of 1951, 1961, and 1974 show relatively modest rates of population growth for the period, a rate of 1.9 percent between 1951 and 1961, increasing to 2.6 percent for the period 1961 to 1974. Underlying these rates, however, is considerable variation in population growth by religion. Table 2 shows the enumerated populations by sex and religion for the three censuses and the implied population growth rates for each religious group. The Muslim population grew much more rapidly than the population as a whole, the growth rate being 2.4 percent between 1951 and 1961, and 3.1 percent between 1961 and 1974. Comparable rates for Caste Hindus were 0.5 percent and 0.9 percent; growth rates for the Scheduled Caste were negative, -0.1 percent and -0.4 percent for the two periods.

The recorded rate of growth of the Muslim population is not inconsistent with expected levels of natural increase, but the recorded rates of growth of the other two important segments of the population, the Caste and Scheduled Caste Hindus, are well below what would be

TABLE 1 Data Sources by Type of Evidence: Bangladesh

	Data Source								
	Population Censuses			PGE	NIS[a]	BRSFM	BFS	DSEP	CRL[b]
Type of Evidence	1951	1961	1974	1962-65	1968-69	1974	1975-76	1961-62	1966-77
Age-sex distribution									
Five-year age groups	x	x	x	x		x	x	x	x
Single years			x	x		x	x		
Own children						x			
Births by age group of mother				x	x	x	x	x	x
Deaths by age group and sex				x		x			x
Children ever born by age of mother					x	x	x	x	

Children surviving by age of mother					x	x	x	x	
Survival of mother						x			
Survival of father						x			
Survival of first spouse						x			
Complete pregnancy history					x		x	x	
Survival of most recently born child						x	x		
Marital status	x	x	x	x		x	x		x[c]

[a]All data for currently married women only.
[b]Matlab thana for all years; Teknaf for 1976 and 1977 only.
[c]Matlab 1974 only.

TABLE 2 Enumerated Population by Sex and Religion in 1951, 1961, and 1974, and Intercensal Growth Rates: Bangladesh

Population Group	1951 Census (thousands)	Intercensal Rate of Growth (percent)	1961 Census (thousands)	Intercensal Rate of Growth (percent)	1974 Census (thousands)
All Religions					
Males	21,938	1.85	26,349	2.61	37,071
Females	19,995	2.04	24,491	2.60	34,407
Total	41,932	1.94	50,840	2.61	71,478
Muslims					
Males	16,897	2.31	21,248	3.05	31,667
Females	15,330	2.50	19,642	3.08	29,371
Total	32,227	2.40	40,890	3.06	61,038
Caste Hindus					
Males	2,182	0.29	2,246	1.02	2,567
Females	2,006	0.66	2,141	0.74	2,359
Total	4,187	0.47	4,387	0.89	4,926
Scheduled Caste Hindus					
Males	2,619	-0.21	2,565	-0.38	2,440
Females	2,433	-0.02	2,428	-0.39	2,306
Total	5,052	-0.12	4,993	-0.39	4,747

expected. Given that errors in declaration of religion are extremely unlikely in Bangladesh for cultural reasons, there are two possible explanations for the low growth rate of the non-Muslim population: that completeness of enumeration by religion changed from one census to the next or that Hindus have been leaving Bangladesh in fairly large numbers throughout the period.

A detailed study of migration to and from Bangladesh during the period 1901 to 1961 (Khan, 1974) estimates a net emigration of Hindus of around 1.1 million for the period 1951 to 1961, a number consistent with a somewhat more reasonable rate of natural increase for the Hindu population during the period of 1.5 percent. The same study suggests that there was little net migration of the Muslim population of Bangladesh during the period, though it estimates that between 1941 and 1951 there was a net immigration of 0.7 million Muslims and a net emigration of 2.5 million Hindus. Direct migration between Bangladesh and Pakistan seems to have been very limited (Khan, 1974).

Looking at the population as a whole, the post-enumeration check of the 1974 census indicated an underenumeration of 19.3 percent in the four major towns and 6.5 percent elsewhere, giving an adjusted population of 76,398,000 for March 1, 1974. However, not much confidence can be felt in these estimates, because households in the census and those in the post-enumeration check could be matched in only 59 of the 482 sampled census blocks (Bangladesh, 1977). A comparable correction cannot be made for 1951 because there was no post-enumeration check; in 1961, the post-enumeration check indicated a small overenumeration. Because questions of the relative accuracy of census enumeration remain unresolved, we have used unadjusted population figures for each census year throughout this report.

Age and Sex Distribution of the Population

Age reporting is rather poor in Bangladesh, revealing massive digital preference and systematic overrepresentation or underrepresentation of particular age ranges. Figure 1 and Table 3 show, by sex, the proportions in successive five-year age groups reported by the three population censuses. In addition, Table 3 shows the proportions as reported by each of the data

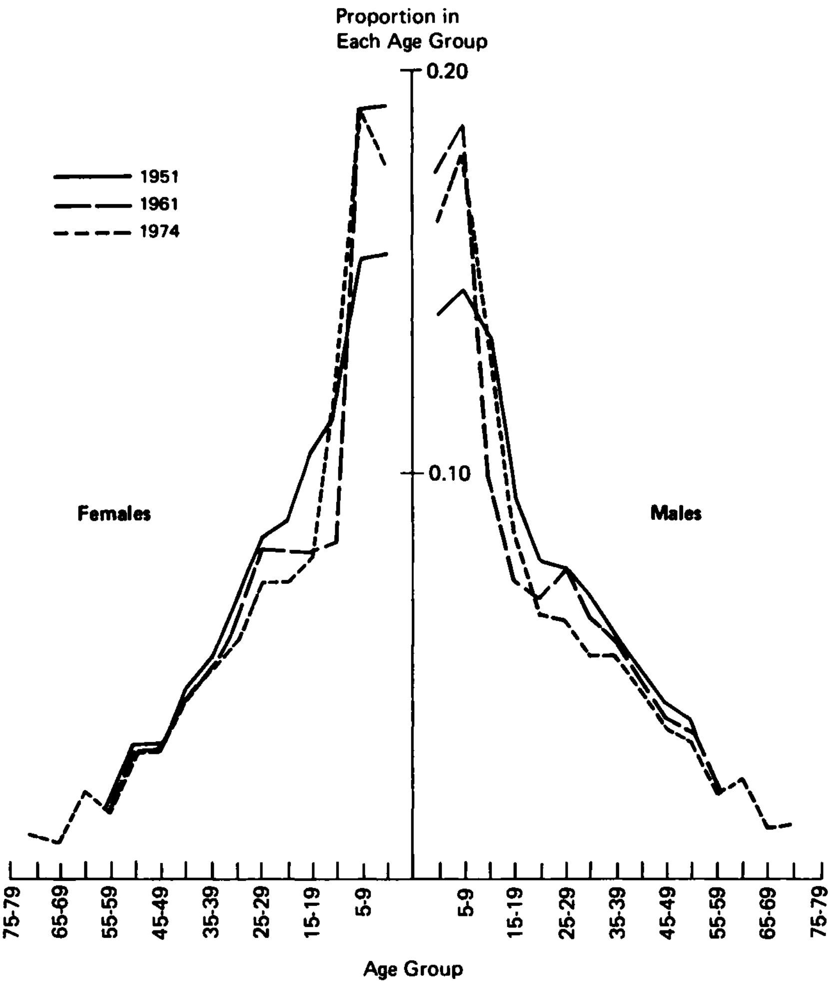


FIGURE 1 Age distributions of the census population by sex in 1951, 1961, and 1974: Bangladesh.

sources shown in Table 1 that provide a national age-sex distribution.

The irregularities of the census age distributions are clear to see; indeed, the 1951 age distribution in five-year groups was published only on a restricted basis because of doubts about its accuracy. Not only are the age distributions obviously affected by error--of age reporting or of completeness of enumeration--but the

TABLE 3 Distribution of the Population by Age and Sex, from Major Sources, 1951-75: Bangladesh

	Proportion of the Population Reported in Each Age Group					
	1951 Census	1961 Census	1964-65 PGE	1974 Census	1974 BRSFM	1975 BFS
Males						
0-4	.139	.174	.164	.162	.145	.144
5-9	.145	.185	.178	.178	.167	.172
10-14	.135	.099	.127	.135	.145	.151
15-19	.094	.073	.075	.085	.090	.093
20-24	.078	.069	.059	.065	.072	.080
25-29	.077	.076	.069	.063	.070	.065
30-34	.069	.064	.066	.055	.057	.051
35-39	.060	.059	.063	.055	.056	.050
40-44	.052	.048	.047	.047	.047	.038
45-49	.043	.039	.040	.037	.037	.034
50-54	.039	.036	.036	.035	.033	.029
55-59	.023	.023	.022	.021	.021	.023
60-64 } 65-59	.028 (60-64 and 65-59)	.056 (60-64 through 75+)	.025	.025	.024	.022
65-59			.011	.012	.012	.017
70-74 } 75+	.019 (70-74 and 75+)		.009	.013	.013	.012
75+			.009	.012	.012	.015
Females						
0-4	.154	.191	.177	.176	.160	.156
5-9	.153	.190	.189	.189	.180	.176
10-14	.117	.083	.105	.122	.136	.147
15-19	.106	.081	.078	.080	.088	.105
20-24	.088	.081	.079	.073	.077	.085
25-29	.084	.082	.079	.073	.076	.072
30-34	.068	.063	.064	.059	.059	.048
35-39	.055	.051	.051	.052	.052	.043
40-44	.047	.045	.047	.044	.043	.039
45-49	.032	.033	.034	.032	.033	.034
50-54	.035	.033	.038	.032	.031	.025
55-59	.020	.018	.018	.017	.018	.027
60-64 } 65-69	.027 (60-64 and 65-69)	.049 (60-64 through 75+)	.021	.022	.020	.016
65-69			.008	.009	.009	.011
70-74 } 75+	.015 (70-74 and 75+)		.006	.011	.010	.007
75+		.007	.010	.009	.007	
Sex Ratio of the Population (males/female)	1.097	1.076	1.066	1.077	1.075	1.052

patterns of error are not consistent from one census to the next. Thus, although there seems to be a general tendency for there to be too many children aged 5-9 relative to those aged 0-4, the 1961 census also has a sharp deficit of population aged 10-14 and a marked plateau between 15 and 34. One explanation offered for the sharp change in the recorded age distribution between 1951 and 1961 has been the change in the lower age limit of coverage for occupational questions--from 12 years old in 1951 to 10 years old in 1961 (Bean et al., 1966). It is suggested that enumerators in 1961, in order to avoid putting the extra questions, systematically transferred respondents to ages below the limit, thereby inflating the population under 10 in 1961. Such inconsistencies in the error patterns make it impossible to adjust the age distributions satisfactorily, in turn making it difficult to use them for the estimation of their underlying demographic parameters.

The age distributions of the sample surveys are not displayed in Figure 1, to avoid overburdening it with basically similar distributions. The 1964-65 PGE distribution is similar to the 1961 census distribution, except for some transfer from under 10 to the 10-14 age group. The BRSFM age distribution is very similar from age 30 onward to that of the 1974 census, of which it was a sample; under age 30, however, the BRSFM age distribution is substantially older than the census age distribution. The BFS age distribution is, broadly speaking, rather similar to the BRSFM age distribution.

It is doubtful whether methods for estimating demographic parameters from population age distributions should be applied in Bangladesh. The extensive migration that took place around the time of partition, and the possibility that there has been substantial migration since, raise questions as to whether the population can be regarded as stable or even quasi-stable, though migration of whole families has little effect on an age distribution. Serious problems with age reporting or completeness of coverage have distorted the age distribution under 15 so severely that it is extremely unlikely that applying reverse-survival or own-children techniques to the enumerated populations could yield satisfactory fertility estimates. However, the estimation techniques can be as useful in highlighting weaknesses in the data as they are in producing reliable estimates, so an attempt has been made to analyze the Bangladeshi age distributions.

Stable population analysis has been applied to the 1951, 1961, and 1974 age distributions of the Muslim population. This subpopulation was selected because it seems to have been less affected by migration over the period than the whole population and can therefore be expected to have a less distorted age distribution. Such analysis will be distorted only mildly by migration of complete families, so long as an estimate of child mortality rather than an observed growth rate is used to fit the stable population. There seemed no reason to prefer the age distribution of one sex to that of the other, so both have been analyzed separately.

In each case, the proportion of the population under a given age has been matched with the proportion under that age in the "North" family of stable population models (Coale and Demeny, 1966), fixing either the rate of population growth or the mortality level. Stable populations based on the "North" age pattern of mortality were used because the mortality patterns observed by the PGE and BRSFM surveys appeared to conform more closely to the "North" pattern than to any of the other three regional patterns (see chapter on mortality). When using an indicator of child mortality such as l(2) to fit a stable population, the choice of mortality family does not greatly affect the results (U.N., 1967). For 1961 and 1974, the growth rates used in the analysis were taken from the observed intercensal growth rates for the Muslim population during the period before the census (as shown in Table 2), rounded to the nearest figure for which stable populations are tabulated by Coale and Demeny; for 1951, two growth rates were used, covering the range suggested by extrapolating backward the observed rates after 1951 and extrapolating forward those for before 1951. Mortality level 11 was used for both 1961 and 1974 because the analysis of child survival data from the BRSFM indicates that level 11 is appropriate for the years prior to 1974 and the PGE survey gives similar estimates of child mortality for the early 1960s.

Table 4 shows the observed proportions under each age, the birth rate in the matching stable population, and the median birth rate for each age distribution and fitting parameter. Table 5 shows the birth rate for the population as a whole (both sexes) and the sex ratio at birth implied by the combination of the estimated birth rates from Table 4 and the enumerated populations by sex.

Three major points stand out from Tables 4 and 5. First, the proportion of the population under age 5 is

TABLE 4 Stable Population Estimates of the Male and Female Birth Rates of the Muslim Population in 1951, 1961, and 1974: Bangladesh

		Males			Females		
			Stable Population Birth Rate[a] (per thousand)			Stable Population Birth Rate[a] (per thousand)	
Census Year	Age a	Proportion of Population Under Age a	Fixed Parameter r = .015	r = .020	Proportion of Population Under Age a	Fixed Parameter r = .015	r = .020
1951	5	.1425	36.1	33.4	.1580	43.1	40.0
	10	.2900	45.6	40.9	.3147	55.0	49.5
	15	.4263	54.0	47.6	.4318	55.9	49.6
	20	.5196	50.9	44.9	.5387	58.1	51.3
	25	.5975	47.3	42.1	.6269	58.0	51.4
	30	.6745	47.1	42.3	.7106	61.1	54.3
	35	.7427	47.4	42.9	.7780	62.4	55.8
	40	.8024	48.0	43.8	.8325	62.9	56.6
	Median		47.3	42.6		58.0	51.4
			Fixed Parameter Level 11	r = .025		Fixed Parameter Level 11	r = .025
1961[b]	10	.3640	55.1	65.5	.3890	58.7	77.0
	20	.5344	45.4	43.6	.5522	47.0	49.6
	40	.8047	43.4	40.6	.8306	47.9	50.7
	60	.9465	42.3	40.7	.9550	47.3	48.2
	Median		44.4	42.2		47.6	50.1

			Fixed Parameter			Fixed Parameter	
			Level 11	r = .030		Level 11	r = .030
1974[c]	5	.1666	43.3	38.0	.1812	46.5	44.4
	10	.3470	51.8	51.3	.3732	55.5	61.9
	15	.4870	53.1	54.0	.4930	53.9	58.8
	20	.5642	49.7	46.6	.5732	50.0	50.2
	25	.6283	46.1	40.4	.6459	47.9	45.9
	35	.7468	43.1	36.8	.7775	47.5	45.3
	45	.8482	42.7	37.7	.8572	47.9	46.3
	Median		46.1	40.4		47.9	48.3

[a]Calculated by holding constant either the population growth rate or the mortality level: r = rate of growth, Level 11 = mortality level 11 in the Coale-Demeny "North" model life tables.
[b]For 1961, data by religion are published only by broad age groups.
[c]For age 25 and over, data by religion are published only by 10-year age groups.

TABLE 5 Population Birth Rates and Sex Ratios at Birth of the Muslim Population, Implied by Stable Population Analysis of the Age Distributions in 1951, 1961, and 1974: Bangladesh

		Males		Females		Implied Parameters for Total Population	
Year	Fixed Parameter[a]	Birth Rate (per thousand)	Population (thousands)	Birth Rate (per thousand)	Population (thousands)	Birth Rate (per thousand)	Sex Ratio at Birth (males/female)
1951	r = .015	47.3	16,897	58.0	15,330	52.4	0.899
	r = .020	42.6		51.4		46.8	0.914
1961	r = .025	42.2	21,248	50.1	19,642	46.0	0.911
	Level 11	44.4		47.6		45.9	1.009
1974	r = .030	40.4	31,667	48.3	29,371	44.2	0.902
	Level 11	46.1		47.9		47.0	1.038

[a]As in Table 4, r = rate of growth and Level 11 = mortality level 11 from Coale-Demeny "North" model life tables.

too low in 1951 and 1974 (and also in 1961 for the total population, as can be seen in Figure 1), whereas the proportion under age 10 is too high in 1961 and 1974 (particularly in 1961) and the proportion under age 15 is too high in 1974. In 1951, on the other hand, the proportions under 10 and under 15 are not implausibly high.

Second, the male and female birth rates estimated using a fixed rate of growth are very different, the female birth rate being almost 10 points higher than the male in each case, whereas the sex-specific birth rates derived using a constant mortality level are much more similar, the difference being only two or three points. This contrast is underlined in Table 5, which shows that the effect of the high female birth rate relative to the male birth rate (as estimated by using a fixed growth rate) outweighs the masculinity of the population and implies the implausible sex ratio at birth of only some 90 males per 100 females, whereas the less extreme differentials in birth rate by sex (obtained by using the fixed mortality level) imply sex ratios at birth of around 101 and 104 males per 100 females. The estimating procedure based on a fixed growth rate is more vulnerable to age reporting errors, and a tendency for males to exaggerate their ages relative to females may account for at least some of the discrepancy observed in the cases based on a fixed growth rate. It may also be that the actual growth rates of the population by sex are not the same, though the evidence in Table 2 fails to support such a contention.

The third point concerns the age detail of the birth rate estimates in Table 4. When stable population analysis is applied to a population that is experiencing declining mortality, the birth rate estimates obtained will tend to fall as the upper age boundary of the group being considered rises. There is no evidence of such a pattern for 1951, and the existence of such a pattern for 1961 cannot be determined because there is insufficient age detail. In 1974, however, there does seem to be a clear tendency for the birth rate estimates to fall as the age boundary rises, suggesting that mortality may have been declining some time before 1974.

Clearly, the estimates presented in Tables 4 and 5 are not consistent enough to support the drawing of firm conclusions. However, on the basis of the relatively more consistent estimate obtained by fixing the mortality level on the basis of an estimate of 1(2), it seems likely that the birth rate was in the high 40s in 1961 and in 1974.

The age distribution analysis described above shows that the misreporting of age under age 10 is particularly severe, with the 0-4 age group being too small, for reasons either of omission or of age misreporting, and the 5-9 age group being too large, presumably because of age misreporting. With such distorted data, it is very doubtful whether the reverse-survival techniques could be successfully used to estimate fertility in the years prior to each census. However, for one data set it has been possible to apply the own-children variant of the reverse-survival technique. A special hand tabulation of the results of the 1974 BRSFM linked mothers with their own children living in the same household, and the results have been analyzed by Rahman (1979) and Hobcraft (1976). Table 6 shows the estimates given by Rahman and by Hobcraft of total fertility rate by year and by type of adjustment applied to the data. The estimates based upon the unsmoothed age distribution of the children (adjustments III, IV, and V) are very erratic, being implausibly high for some years and low for others. To draw conclusions about trends from such obviously distorted data would be unwise, and even fertility level can be inferred only within a broad range; the average total fertility rates vary with type of adjustment from 6.4 to 7.1.

Completeness of Enumeration

Population growth rates obtained from a series of censuses are sensitive to changes in the completeness of enumeration of the censuses, and estimates of demographic parameters based on such growth rates in combination with population age structures are therefore suspect. The observed growth rates for the whole population of Bangladesh, shown in Table 2, are surprisingly low given independent evidence about the rate of natural increase. The report on the post-enumeration check of the 1974 census suggests that the enumerated population should be corrected upward by 19.3 percent in the four major cities and by 6.5 percent elsewhere, although there were reportedly some problems with the post-enumeration check itself (Bangladesh, 1977). The post-enumeration check for the 1961 census suggested an overcount of 1.5 percent, though estimates suggesting a net undercount,

TABLE 6 Own-Children Estimates of Total Fertility Rates, 1964-73, Under Alternative Adjustments: Bangladesh

Part A. Estimated Total Fertility Rates by Adjustment (births per thousand population)

Year	Adjustment I	Adjustment II	Adjustment III	Adjustment IV	Adjustment V
1973	6.77	7.36	4.14	3.86	4.38
1972	6.70	7.05	4.73	4.41	4.96
1971	6.84	7.19	5.85	5.47	5.94
1970	6.77	7.12	6.70	6.25	7.02
1969	6.95	7.31	7.27	6.79	7.21
1968	6.72	7.07	7.57	7.07	7.82
1967	6.52	6.86	8.03	7.50	8.06
1966	6.60	6.94	7.33	6.85	7.78
1965	6.60	6.95	10.73	10.01	9.78
1964	6.63	6.97	5.86	5.47	6.31

Part B. Explanation of Adjustments

Adjustment	Author	Adjustment for Misreporting		Adjustment for Underenumeration	
		Women	Children	Women	Children
I	Rahman	Smoothed	Smoothed	None	1.7%
II	Rahman	Smoothed	Smoothed	6.8%	14.2%
III	Rahman	Smoothed	Unsmoothed	6.8%	7.1%
IV	Rahman	Smoothed	Unsmoothed	6.8%	None
V	Hobcraft	Unsmoothed	Unsmoothed	None	None

Source: Rahman (1979).

such as one of 8.62 percent by Krotki (1965), have been made using demographic analysis.

Cohort survivorship probabilities estimated from the age distributions of successive censuses are often better indicators of variations in enumeration completeness or of net migration than of the level of mortality, except at advanced ages. Implausibly low estimates of survivorship indicate emigration, particular kinds of age reporting errors, or a relative underenumeration at the second census, whereas implausibly high survivorship estimates indicate immigration, different types of age reporting errors, or an increase in enumeration completeness at the second census relative to the first. An examination of cohort survivorship probabilities for the two intercensal periods has been made by Hill

(1981). Table 7 shows the observed survivorship probabilities for closed and open-ended cohorts, by sex, for the periods 1951-61 and 1961-74. (The term "open-ended cohort" is used to mean the whole population of a given age or older at some initial point.) In view of the marked differences in the observed population growth rates for the major religious groups in the population, survivorship probabilities for Muslims, Caste Hindus, and Scheduled Caste Hindus were examined separately.

Although certain features stand out from Table 7 (notably that the Muslim population experiences the highest survivorship probabilities, followed by the Caste Hindus, with the Scheduled Caste giving the lowest survivorship probabilities, and that some Muslim cohorts between 1961 and 1974 imply survivorship ratios in excess of 1.0), it is not easy to interpret such survivorship probabilities. To make the interpretation easier, they have been converted into equivalent mortality levels in the "North" family of Coale-Demeny model life tables. The results are shown in Table 8. In estimating equivalent mortality levels, allowance has been made for the age structure of a stable population having a growth rate of 2.0 percent between 1951 and 1961, and 2.5 percent between 1961 and 1974. The choice of growth rate is unimportant in the case of the closed cohorts, though the assumed age structure and growth rate are important for the open-ended cohorts, the effect being greatest for open-ended groups starting from age 10, 20, or 30 and for low-mortality cases. In extreme cases, a change of 5 per thousand in the growth rate can make a difference of two levels in the mortality estimates, an upward change in the growth rate leading to an estimate of heavier mortality.

The results for the period 1951-61 are reasonably consistent and suggest certain patterns of age reporting, notably an increasing tendency to exaggerate age as age increases (suggested by the systematic pattern whereby the mortality level of the open-ended survivorship ratios rises with age) and a relative underenumeration of 10- to 19-year-olds in 1961 relative to 0- to 9-year-olds in 1951 (suggested by the low mortality levels obtained for the 1951 cohort aged 0-9).

Other notable features of the 1951-61 results are the low survivorship ratios, indicated by low mortality levels in Table 8, for Caste Hindus and the even lower ratios for the Scheduled Caste. The estimated mortality

TABLE 7 Intercensal Cohort Survivorship Probabilities by Sex and Religion, 1951-61 and 1961-74: Bangladesh

Part A. 1951-61

Closed Cohorts			Open-Ended Cohorts		
Age Group in 1951	Males	Females	Age Boundary in 1951	Males	Females
Muslims					
0-9	.739	.664	0	.800	.783
10-29	.884	.901	10	.825	.837
30-49	.803	.802	30	.754	.750
			50	.650	.636
Caste Hindus					
0-9	.761	.674	0	.687	.696
10-29	.653	.700	10	.662	.705
30-49	.744	.762	30	.671	.711
			50	.545	.621
Scheduled Caste					
0-9	.621	.559	0	.648	.644
10-29	.710	.734	10	.657	.677
30-49	.657	.657	30	.602	.612
			50	.494	.526

Part B. 1961-74

Closed Cohorts			Open-Ended Cohorts		
Age Group in 1961	Males	Females	Age Boundary in 1961	Males	Females
Muslims					
0-9	.718	.660	0	.917	.830
10-19	1.053	1.232	10	1.031	.938
20-39	1.002	.919	20	1.023	.831
			40	1.051	.686
Caste Hindus					
0-9	.696	.583	0	.712	.665
10-19	.745	.829	10	.720	.708
20-39	.855	.794	20	.711	.664
			40	.557	.512
Scheduled Caste					
0-9	.518	.454	0	.580	.565
10-19	.690	.828	10	.611	.626
20-39	.682	.634	20	.585	.561
			40	.465	.459

TABLE 8 Model Life Table Mortality Levels Implied by Intercensal Cohort Survivorship Probabilities for 1951-61 and 1961-74: Bangladesh

Part A. 1951-61

Closed Cohorts			Open-Ended Cohorts[a]		
	Coale-Demeny "North" Mortality Level			Coale-Demeny "North" Mortality Level	
Age Group in 1951	Males	Females	Age Boundary in 1951	Males	Females
Muslims					
0-9	1.4	<1	0	4.4	2.3
10-29	5.9	6.6	10	7.5	7.4
30-49	6.0	3.8	30	9.9	7.3
			50	18.6	14.3
Caste Hindus					
0-9	2.3	<1	0	<1	<1
10-29	<1	<1	10	<1	<1
30-49	2.4	1.4	30	2.7	3.8
			50	8.5	12.5
Scheduled Caste					
0-9	<1	<1	0	<1	<1
10-29	<1	<1	10	<1	<1
30-49	<1	<1	30	<1	<1
			50	5.1	5.1

levels for both groups of Hindus are unacceptably low and can be explained only by selective underenumeration of Hindus in 1961 or substantial emigration of Hindus between 1951 and 1961. If the cohorts distorted by age misreporting are excluded, the survivorship ratios for the Muslim population suggest a mortality level of around 6 or 7. Such a mortality level is possible for the period and, because survivorship ratios are highly sensitive to changes in enumeration completeness, suggests that the completeness of enumeration in 1951 may have been similar to that in 1961. The deficit of Hindus can more plausibly be accounted for by net emigration, presumably to India, than by differential changes in completeness of enumeration by religion between 1951 and 1961.

TABLE 8 (continued)

Part B. 1961-74

Closed Cohorts			Open-Ended Cohorts[a]		
	Coale-Demeny "North" Mortality Level			Coale-Demeny "North" Mortality Level	
Age Group in 1961	Males	Females	Age Boundary in 1961	Males	Females
Muslims					
0-9	1.8	<1	0	22.6	8.8
10-19	*	*	10	*	>24
20-39	*	14.5	20	*	16.6
			40	*	15.4
Caste Hindus					
0-9	<1	<1	0	1.4	<1
10-19	<1	1.8	10	1.8	<1
20-39	9.6	3.7	20	5.3	<1
			40	6.7	1.5
Scheduled Caste					
0-9	<1	<1	0	<1	<1
10-19	<1	1.7	10	<1	<1
20-39	<1	<1	20	<1	<1
			40	1.5	<1

*Indicates a survivorship probability in excess of 1.0.

[a]Mortality estimates obtained from survivorship of open-ended cohorts are sensitive to the age structure of the population. The calculations given here were made assuming a stable population age structure with a growth rate of 2 percent between 1951 and 1961 and 2.5 percent between 1961 and 1974. The use of a higher growth rate produces higher mortality estimates (lower levels), an increase of 0.5 percent reducing the estimates by between one and two levels.

The results for the period 1961-74 are more puzzling. There is still a clear deficit of Hindus in 1974 relative to 1961, as is indicated by the very low survivorship ratios and implied mortality levels over the period, suggesting a continuation of the steady emigration apparently established for the period 1951-61. It is also clear that the cohort aged 0-9 in 1961 was either too large in 1961, perhaps because of age reporting errors associated with the occupation questions used in the 1961 census, or too small in 1974. For other cohorts, however, there are too many Muslims in 1974 compared to 1961, giving rise to survivorship ratios greater than 1.0 for several cohorts; the number of males is particularly excessive. The figures suggest that enumeration was more complete in 1974, particularly for males, or that there was some net immigration of Muslims between 1961 and 1974. Such a change in enumeration completeness would imply that the observed intercensal growth rate of the Muslim population was higher than the rate of natural increase.

It might be hoped that birthplace data from the censuses of the Indian subcontinent would help to quantify migration movements, but such data are in fact difficult to use because of the huge size of the population movements that took place at the time of partition, the subsequent independence of Bangladesh (not previously tabulated as a country of birth in Indian statistics), and the lack of information on date of migration contained in birthplace data. However, the data do offer some clues. For instance, the number of people born in India but enumerated in Bangladesh fell from 849,000 in 1951 to 628,000 in 1961, a slightly faster drop than would be expected on the basis of mortality alone, possibly suggesting a slight return migration over the period. Between 1961 and 1974, on the other hand, the Indian-born population in Bangladesh increased from 628,000 to 737,000, indicating an immigration, presumably of Muslims, of over 200,000 people.

Such migratory flows cannot, however, explain the survivorship ratios in Table 7. Over 2 million more Muslim males would be required in 1961 to make the 1961-74 male survivorship ratios plausible, and the addition of such a large number of people would reduce the intercensal growth rate from 3.05 to 2.4 percent. For the female Muslim population, on the other hand, no extra people are required in 1961 to make the survivorship ratios plausible, only a redistribution of females by age in 1974.

There does not seem to be any consistent explanation of the evolution of the Muslim population from 1961 to 1974, since age reporting errors--and particularly changes in the pattern of such errors--are obscuring what is actually going on. Only two things can be concluded with any confidence, the first being that the Hindu population, and in particular the Scheduled Caste, lost members at a faster rate than mortality can explain both between 1951 and 1961 and between 1961 and 1974, the most probable explanation being net emigration to India; and second, that there is no conclusive evidence of differences in enumeration completeness among the three censuses of 1951, 1961, and 1974, although there is evidence of strange changes in age reporting.

SUMMARY

The population growth rates for what is now Bangladesh--indicated by the censuses of 1951, 1961, and 1974--are lower than would be expected given available estimates of the rate of natural increase over the period. Some part of the low growth rate of the whole population is explained by a sustained emigration of Hindus throughout the period, and growth rates for the Muslim population alone are closer to the estimated rates of natural increase. Although age data are of poor quality, the census age distributions for Muslims show a young, rapidly growing population (nearly 50 percent under age 15 in 1974), and stable population analysis of the 1961 and 1974 age distributions suggest a birth rate probably in the range of 44 to 48 per thousand. Analysis of intercensal survival by religion and broad age groups confirms a probable emigration of Hindus, but gives apparently inconsistent results for Muslims, of whom there seems to be a deficit in 1961 relative to 1951 and a surplus in 1974 relative to 1961. The natural explanation of this finding, a relatively more serious underenumeration in 1961 than in 1951 or 1974, would increase the growth rate of the Muslim population for the period 1951-61 and reduce it for the period 1961-74, making the population growth rate for the second period less consistent with available estimates of natural increase; an explanation in terms of net migration suffers from the same problem. The interpretation of data on the size and age distribution of the population thus remains uncertain; complex changes in enumeration completeness, age misreporting, and net migration make it impossible to draw firm conclusions about the evolution of the total population.

2 Fertility

THE POPULATION GROWTH ESTIMATION (PGE) EXPERIMENT

The main features of the PGE, described in detail in the final report (PIDE, 1971), have already been outlined in the section on data sources. The experiment was conducted as a dual-record survey, with information on births being collected independently by registrars and periodic retrospective surveys, over the period 1962-65. Fertility measures can be computed from the longitudinal registration data (LR), from the retrospective survey data (CS), or from a combination of both. The measures based on a combination of data from both the LR and the CS sources, referred to here as CD estimates, are obtained by matching the events recorded by the two systems in order to identify the events recorded by both systems, those recorded only by the LR system, and those recorded only by the CS system. A final estimate of total events is then obtained by summing these three categories plus a fourth category of events recorded by neither system and estimated by the Chandrasekaran-Deming (1949) formula assuming that the probability of an event being missed by one system is independent of its probability of omission by the other system. The crude birth rate and age-specific fertility rates can also be computed for different segments of the time period covered by the survey. Table 9 shows the CD and LR estimates of crude birth rates and age-specific fertility rates for the period 1963-65.

TABLE 9 Fertility Estimates from the PGE 1963-65: Bangladesh

Age Group	Age-Specific Fertility Rates 1963-65[a] Registration Data (LR)	Adjusted Data (CD)	Adjusted (CD) Age-Specific Fertility Rates[b] 1964	1965
15-19	.230	.276	.277	.273
20-24	.303	.359	.356	.346
25-29	.313	.356	.345	.344
30-34	.221	.260	.221	.251
35-39	.129	.150	.160	.124
40-44	.048	.056	.061	.050
45-49	.013	.022	.014	.024
Total Fertility	6.29	7.40	7.17	7.05
Crude Birth Rate	44[c]	53[c]	50	49

[a]As reported in the final report (PIDE, 1971).
[b]As calculated from detailed tables published in the final report.
[c]For the complete survey period 1962-65.

Also shown in Table 9 are age-specific fertility rates calculated for 1964 and 1965 on the basis of adjusted (CD) births and de facto midyear population. The 1963-65 CD rates show very high fertility, a birth rate of 53 and total fertility rate of 7.4, whereas the rates for 1964 and 1965 are somewhat lower. In 1962, the first year of the PGE, no information on age of mother was collected; in 1963, such information was collected, but the level of non-response was high; it was only in 1964 and 1965 that age of mother was collected for a high proportion of all recorded births. It may be that the collection of the extra detail improved the quality of the data collected, although the proportion of all CD events recorded by the registration system fell in both 1964 and 1965; the proportion of all CD events covered by the retrospective survey rose in 1964 and fell sharply in 1965. The Indo-Pakistani war in 1965 may have had adverse effects on the results for that year, although its immediate impact in Bangladesh was small.

Dual-record surveys like the PGE are sensitive to the accuracy of the matching operation. A false match means that what are in fact two separate events are counted as only one, whereas a false non-match has the opposite effect: one event is inflated to count as two. Such errors will also have small additional effects since the size of the CD correction for unreported events is determined by the relative sizes of the categories of matched and unmatched events. Thus, overly strict matching criteria, exaggerating the number of non-matches, will lead to an overestimation of the true number of events, whereas overly lax matching, exaggerating the number of matches, will lead to underestimates. A number of empirical studies have shown the seriousness of this problem (Brass, 1971a; Alam and Yusuf, 1970). The PGE did not collect parity data for all women, so there is no internal yardstick with which to measure the results obtained, but it is generally thought that in East Pakistan the number of false non-matches exceeded that of false matches (Yusuf, 1968), in which case the CD birth rate of 53 should be regarded as a maximum.

Parity information was, however, collected for an area of central Bangladesh by the Demographic Survey of East Pakistan (DSEP) in 1961-62 (Muniruzzaman, 1965, 1966a, 1966b; Obaidullah, 1966). Parity data from the 1974 census indicate that the fertility of the sampled area was approximately representative of that of the country as a whole, so the PGE fertility rates can be compared with the lifetime fertility information available from the DSEP.

Given the data available on current and lifetime fertility, it is possible to apply the P/F ratio method (Brass, 1964) to examine the consistency of the two types of data. First, age-specific fertility rates (f) obtained from information on recent fertility--in this case from the PGE--are cumulated, in order to obtain measures equivalent to the lifetime fertility that would be experienced by women at the upper limits of the age groups to which cumulation has proceeded given the age-specific fertility rates being used. Lifetime fertility measures for age groups of women (F), equivalent to data on average parity by age group, are then obtained by interpolating between the values for exact ages. These parity equivalents obtained from the current fertility data can then be compared with reported parities (P)--in this case available from the DSEP.

The P/F method is often used not only as a consistency check but also as a correction procedure. In order to use the method for correction, it must be assumed that fertility has not been changing, that the errors characterizing data on children ever born do not seriously distort the average parities for women up to age 30 or 35 (because their childbearing is more recent, younger women may be expected to give more accurate accounts of children ever borne), and that the errors characterizing data on recent fertility do not seriously distort the age pattern of fertility. Under these assumptions, the age pattern of recent fertility can be scaled by the level of lifetime fertility for the younger women to estimate an improved age-specific fertility schedule.

The application of the method is shown in Table 10. Leaving aside the P/F ratio for the 15-19 age group, which is generally unreliable, the ratios start close to 1.0 and decline thereafter. For older age groups (40 and over) this decline probably indicates an increasing level of omission in women's reports of children ever borne. For the younger women, however, such an explanation is not very plausible, given that the average parities for

TABLE 10 Comparison of Current Fertility from the PGE (1963-65) with Retrospective Fertility from the DSEP (1961-62): Bangladesh

Age Group	CD Adjusted Age-Specific Fertility from PGE f	Reported Average Parity from DSEP[a] P	Cumulated Fertility Parity Equivalent F	P/F	Adjusted Age-Specific Fertility f[b]
15-19	.276	0.58	0.655	0.885	.263
20-24	.359	2.31	2.279	1.014	.342
25-29	.356	3.87	4.105	0.943	.339
30-34	.260	5.10	5.651	0.903	.248
35-39	.150	5.84	6.669	0.876	.143
40-44	.056	6.09	7.159	0.851	.053
45-49	.022	6.24	7.354	0.848	.021
Total Fertility	7.395				7.050

[a]From Schultz and DaVanzo (1970).
[b]Using a correction factor of 0.953, the average P/F ratio for women aged 20-34.

women under 35 are higher than those reported by any other source except the Bangladesh Fertility Survey. An alternative explanation of the level of the ratios for women aged 20 to 35 is that the CD fertility estimates for the period 1963-65 are somewhat too high. Adjusting the age-specific rates by the average of the P/F ratios for women in the age range 20 to 34, 0.953, gives an estimate of total fertility of 7.05, more in line with the levels obtained by the PGE for 1964 and 1965, the years for which the classification of births by mother's age was most complete.

Another criticism leveled at the PGE estimates is that while the CD adjustment process takes into consideration the omission of events used in the numerators of rates, no correction is made for the omission of population from the denominators (Shaw, 1970; Afzal, 1977). Such omission would tend to inflate the vital rates obtained from the survey, though no internal basis exists for estimating the likely magnitude of the error. One indication that the error may not be large is provided by the P/F ratio consistency check just described; such a check should allow for denominator error, since fertility rates are affected by underenumeration but average parities are not, or at least not to the same extent. The P/F ratio comparison does suggest that the CD fertility rates are slightly too high, but not by anything like the order of magnitude suggested by Afzal (1977).

THE NATIONAL IMPACT SURVEY (NIS)

The NIS was conducted in 1968-69 to investigate the impact of the national family-planning program. It is a frustrating data source for two reasons, the first being that detailed information was collected from ever-married women under age 55 only, without providing even an age distribution for the rest of the population, and the second being that the only published results are those for currently married women (Sirageldin et al., 1975). The estimates of marital fertility for three three-year periods prior to the survey show a marked fertility decline over the period, as shown in Table 11.

Table 11 also compares the average number of children ever born per currently married woman obtained from the NIS in 1968-69 and from the BFS in 1975-76. The agreement of the two distributions up to age 30 is

TABLE 11 Fertility Measures for Currently Married Women, from the National Impact Survey and BFS: Bangladesh

Age Group	Fertility Rates Based on NIS Data 1960-62	1963-65	1966-68	Average Number of Children Ever Born NIS	BFS
10-14	.112	.107	.113	n.a.	.08
15-19	.335	.312	.297	.94	.87
20-24	.347	.353	.314	2.53	2.49
25-29	.348	.324	.260	4.26	4.33
30-34	.288	.262	.208	5.60	5.86
35-39	.180	.159	.142	6.40	6.90
40-44	.116	.080	.046	6.57	7.58
45-49	n.a.	n.a.	.005	6.55	7.26
Total Marital Fertility	8.66[a]	8.01[a]	6.93		

Note: n.a. means not available.

[a]Calculated by assuming that the 1966-68 rate for women 45-49 applied in earlier periods.

Sources: Sirageldin et al. (1975) and Bangladesh (1978).

impressive, suggesting that the fertility of young women in the 10 to 15 years prior to 1975-76 was very similar to that for a similar period prior to 1968-69, a conclusion inconsistent with the marital fertility decline shown by the NIS data for the period 1960-68. For currently married women over age 30, the BFS shows systematically and substantially higher average numbers of children ever born than does the NIS, suggesting that the number of children ever born was underreported by older women interviewed in the NIS. Sirageldin et al. (1975) also note that such omission may have taken place, on the grounds that the infant mortality rates obtained from the NIS are lower than would be expected on the basis of other information. Although the tabulations available from the NIS do not permit a convincing demonstration, it must also be regarded as very probable that the sharp downward trend in marital fertility shown by the NIS data is largely the result of dating errors in the reporting of births in the pregnancy history. This type of error has been shown to be common in data collected by fertility history surveys (Potter, 1977; Brass and Rashad, 1981).

THE BANGLADESH RETROSPECTIVE SURVEY OF FERTILITY AND MORTALITY (BRSFM)

The BRSFM collected two complementary types of information on fertility: lifetime fertility (by sex of child) and recent fertility. Table 12 shows the number of women in each age group, the number of male and female children they report ever having borne, the implied sex ratios at birth, and the number of births reported as having occurred in the 12-month period before the survey. For women aged 15 to 34, the sex ratios of children ever born are reasonable, 105 or 106 males per 100 females. Above that age, the sex ratios increase somewhat, suggesting the possible omission of female children from reports of children ever born or, alternatively, a tendency to report female children as male. Up to age 35, however, the sex ratios give no indication of errors in the data.

The availability from the BRSFM of data on lifetime and recent fertility makes it possible to apply the P/F ratio comparison of recent and lifetime fertility. The results are shown in Table 13. The average parities used were calculated using an estimate of the true level of non-response among ever-married women obtained by

TABLE 12 Children Ever Born by Sex, and Births in Year Before Survey by Age Group of Woman, from BRSFM 1974: Bangladesh

Age Group	Number of Women (thousands)	Children Ever Born (thousands)		Sex Ratio of Children Ever Born (males/female)	Births in 12 Months Before Survey (thousands)
		Male	Female		
10-14	4,675	4	3	1.33	7
15-19	3,015	597	564	1.06	320
20-24	2,653	2,507	2,394	1.05	609
25-29	2,607	4,676	4,410	1.06	561
30-34	2,016	5,109	4,801	1.06	368
35-39	1,772	5,436	4,948	1.10	237
40-44	1,480	4,884	4,281	1.14	95
45-49	1,135	3,715	3,191	1.16	38

TABLE 13 Comparison of Current and Retrospective Fertility Information, from BRSFM 1974: Bangladesh

Age Group	Reported Age-Specific Fertility f^a	Reported Average Parity P^b	Cumulated Fertility Parity Equivalents F	P/F	Adjusted Age-Specific Fertility f^c
15-19	.109[d]	0.385	0.278	1.387	.229
20-24	.230	1.850	1.237	1.496	.337
25-29	.215	3.490	2.348	1.486	.310
30-34	.183	4.922	3.333	1.477	.256
35-39	.134	5.867	4.107	1.429	.178
40-44	.064	6.200	4.552	1.362	.086
45-49	.034	6.092	4.781	1.274	.041
Total Fertility Rate	4.84				7.19

[a] The reported rates refer to age groups half a year younger than shown, because they were calculated from births in a 12-month period by age of mother at the end of the period.
[b] Calculated after allowing for non-response as estimated by the El-Badry method.
[c] Adjusted by factor of 1.486, average P/F ratio for women aged 20-34; also adjusted to refer to true age groups.
[d] Includes some births reported by women under age 15.

applying El-Badry's correction (1961). This correction allows for the practice of misallocating women of zero parity to the category of not-stated parity. The true level of non-response was estimated as 0.1 percent of ever-married women.

The P/F ratios in Table 13 are all substantially higher than 1.0, indicating that current fertility, as reported, is lower than lifetime fertility, as reported. The ratio for the age group 15-19 is often unreliable, because the interpolation procedure used to convert cumulated fertility into parity equivalents is too simplified to allow for the rapid increase in fertility among this group of women, and conclusions should not be drawn from it. The ratios for women between 20 and 35 are very consistent, averaging 1.486. This average ratio is substantially higher than those normally encountered in applications of this method. For women 35 and older the ratios decline steadily with age group.

The high values of the ratios for women aged 20 to 34 could be explained if fertility in the year before the survey were lower than the average level of fertility experienced during the women's lifetimes or if the number of births reported as having occurred in the year before the survey were lower than the actual number. There are three possible reasons why fertility in the year before the survey might actually have been lower than lifetime fertility: marital fertility might have been declining; age at marriage might have been rising; or a cataclysmic event, such as a war or a famine, might have lowered fertility that year.

If fertility in the year before the survey was lower than lifetime fertility because of a general trend of declining fertility within marriage, the P/F ratios would be expected to rise with age, since the decline would have had a greater proportional impact on the lifetime fertility of the younger women than on that of the older women. If age at marriage were rising, but fertility within marriage was remaining unchanged, the ratios would decline with age, though such a decline would be smallest in age groups in which almost all the women were already ever married, that is, above age 25. The fact that the observed ratios show neither of these patterns suggests that the level of the ratios cannot be accounted for by a continuing fertility decline. The level of the ratios could still be accounted for if fertility had been one third lower than normal in the year before the survey; however, 1973 was not a period of exceptional disaster, so there seems no reason why fertility would have been a third below normal in that year.

The most likely explanation for the observed ratios therefore seems to be that births in the year before the survey were underreported. A detailed analysis of the data suggests that several factors contributed to this underrecording, including failure to answer the question on date of most recent birth and a tendency to report births as having occurred longer ago than was actually the case.

The tendency for the ratios to fall off after age 35 suggests that the reporting of parity became progressively less complete for older women. In the circumstances, it seems reasonable to use an average of the P/F ratios for women aged 20 to 34 as a correction factor for the current fertility distribution, giving the adjusted age-specific fertility rates shown in the last column of Table 13. These adjusted rates imply a total fertility rate of 7.19 and a crude birth rate of 47.1 per thousand.

An alternative procedure for adjusting age-specific fertility rates was used in a report on the BRSFM (Blacker, 1977). A Coale-Trussell (1974) fertility model was fitted to the reported age-specific fertility distribution for women under age 35, and the model was then scaled by cumulation and comparison with the reported average parities for younger women. The fitted and scaled model was then accepted as the age-specific fertility distribution. In effect, the procedure smoothes out irregularities in the fertility distribution but makes little difference to estimates of aggregate fertility; for reasons of simplicity, we have preferred to use and adjust the reported fertility distribution.

The BRSFM also tabulated the number of women by age group and parity, as well as the number of women who reported a birth in the year before the survey by age group and parity, making it possible to compare cumulated current first-birth fertility rates with lifetime proportions of women with at least one child. In effect, such a comparison is the calculation of P/F ratios for first births only and provides an additional insight into the consistency or inconsistency of the data being used. Table 14 shows the application of the method. The proportion of women with at least one child (P_1) was calculated after excluding the number of women estimated by the El-Badry technique as having provided no information about their parity.

All the P_1/F_1 ratios in Table 14 except that for the 15-19 group (which is even more unreliable in the case of first births than in the case of all births) are substantially greater than one, indicating that the number of first births recorded in the year before the survey was lower than would be expected on the basis of the reported proportions of women in each age group with at least one child, thus qualitatively confirming the earlier analysis in Table 13 of all births. Quantitatively, however, the agreement is not so good. All the first-birth ratios are lower than the corresponding all-birth ratios, in some cases by more than 10 percent, and although they are almost constant above age 30, they are anything but consistent before that age.

Another data problem is revealed by the fact that when the P_1/F_1 ratio for the 20-24 age group is applied to the final proportion of women who become mothers as

TABLE 14 Comparison of Current and Retrospective Information on First Births, from BRSFM 1974: Bangladesh

Age Group	Reported Age-Specific First-Birth Rates f_1	Reported Proportion of Women with At Least One Child[a] P_1	Cumulated and Interpolated First-Birth Rates F_1	P_1/F_1	Adjusted Proportion of Women Becoming Mothers by Age 50[b]
15-19	.0756	.117	.234	0.501	0.380
20-24	.0577	.789	.568	1.388	1.052
25-29	.0142	.927	.713	1.300	0.985
30-34	.0030	.956	.747	1.279	0.969
35-39	.0011	.969	.756	1.281	0.971
40-44	--	.963	.758	1.270	0.963
45-49	--	.962	.758	1.269	0.962

[a] Calculated after allowing for non-response as estimated by the El-Badry method (El-Badry, 1961).
[b] Each adjusted by the P_1/F_1 ratio for the age group.

implied by the current first-birth rates, the adjusted final proportion becomes greater than one, as shown in the last column of Table 14. Clearly, age-specific first-birth rates implying that more than 100 percent of women will ultimately become mothers cannot long be sustained, and the use of the P_1/F_1 ratio from age group 20-24 as a correction factor is unacceptable. A high P_1/F_1 ratio for the 20-24 age group is consistent with a recent shift toward later age at marriage; indeed, the first-birth ratios above age 20 do exhibit the pattern to be expected from such a shift, even though the all-birth ratios do not. The average of the ratios for women aged 30-49, 1.27, implies that 96 percent of women would ultimately become mothers, but if such an adjustment were applied to the all-birth fertility rates, the implied total fertility rate would be only 6.15, lower than the average parity reported by women aged 40-44. An analysis of all births in the year before the survey by birth order suggests that first births were overrecorded relative to higher order births, implying that the comparison of first-birth rates with proportions of mothers should not be used to provide an adjustment factor for all births.

THE BANGLADESH FERTILITY SURVEY (BFS)

The Bangladesh Fertility Survey, conducted in 1975 under the auspices of the World Fertility Survey, collected detailed pregnancy histories from a small but carefully designed sample of ever-married women; a household schedule also collected data on age, sex, and marital status from the entire population of the sample areas. Age-specific fertility rates for 1975 computed from the births recorded by the pregnancy histories are shown in Table 15, which also shows the average parities for ever-married women by age group derived from the BFS and other sources.

The age-specific fertility rates computed for 1975 are substantially lower than the adjusted rates obtained from the BRSFM for 1973-74, giving a total fertility rate of 5.4 as opposed to 7.2. As Ahmad (1980) has shown, however, the BFS estimates of fertility in 1975 depend on the method of allocation to calendar month and year of those births recorded in terms of "years ago." Depending on the method of allocation used, the number of births occurring in the year before the survey can range from 1,008 to 1,535. The total fertility rate of 5.4 for 1975 is based on the assumption that for those births reported in terms of years ago, what was reported was not completed years ago, but rather the nearest number of completed years ago, the actual period ago thus being rounded to the nearest number of complete years.

The age patterns of fertility obtained by the BFS and the BRSFM are also different, that from the BFS having a younger pattern than that coming from the BRSFM; the respective mean ages of childbearing being 26.8 years from the BFS as opposed to 28.3 years from the BRSFM. The average parities from the BFS are higher at every age than those obtained by other surveys, suggesting more complete reporting of children ever born, though Zaba and Blacker (1980) have suggested that the change may have resulted from better age reporting in the BFS. The sex ratios of children ever born are very consistent age group by age group and very close to the generally expected value of 105 males per 100 females. It seems, therefore, that reporting of children ever born was of high quality, except perhaps among women aged 45-49, whose average parity is lower than that of women aged 40-44.

A detailed pregnancy history survey should in theory provide the basis for studying fertility trends in the 10

TABLE 15 Recent Fertility Estimates from BFS, and Average Parities by Age of Mother from BFS and Other Sources: Bangladesh

Age Group	Age-Specific Fertility Rates 1975[a]	Children Ever Born Per Ever-Married Women					Sex Ratio of Children Ever Born BFS (males/female)
		BFS 1975	DSEP 1961-62	Census 1961	Census 1974	BRSFM 1974[b]	
10-14	.006						
15-19	.171	0.85	0.63	0.77	0.67	0.57	0.913
20-24	.282	2.45	2.34	2.24	1.91	1.94	1.051
25-29	.254	4.24	3.89	3.51	3.29	3.53	1.063
30-34	.187	5.71	5.12	4.64	4.59	4.95	1.046
35-39	.113	6.71	5.85	5.24	5.52	5.88	1.064
40-44	.056	7.10	6.10	5.49	5.78	6.22	1.036
45-49	.006	6.73	6.25	5.74	5.95	6.12	1.063
Total Fertility Rate	5.38						

[a]From Brass and Rashad (1981) based on BFS data; rates are for women by age group at the end of 1975.
[b]Not adjusted for possible non-response.

or 15 years before the survey. However, the interpretation of the fertility history data from the BFS is made difficult by two features of the data. The first problem has already been mentioned and concerns the reporting of dates of births in the pregnancy histories. Dates were supposed to be reported in terms of month and year of occurrence, but when month and year were not known, the answer was to be recorded in terms of "time ago"--that is, the length of time before the survey that the birth occurred, in units of completed years. Of births occurring in the period 1971-75, the date was recorded for 2,239 and the time ago was reported for 3,670. It has been suggested that time ago may have been rounded to the nearest year, instead of being reported in completed-year form, or may have been systematically rounded up to the next higher number of years (Ahmad, 1980). If it is assumed that the recording was in the form of completed years, the fertility rates for the years before the survey show a very rapid decline taking place, the birth rate declining from around 53 per thousand 5 to 9 years before the survey to around 38 per thousand 0 to 4 years before the survey. If, on the other hand, it is assumed that time ago was always rounded up--an assumption that cannot be fully accepted because some births were recorded as having occurred zero years before the survey--the birth rate falls less drastically, from 54 per thousand 5 to 9 years before the survey to 46 per thousand 0 to 4 years before the survey.

The second problem also concerns the dating of births. It has been suggested (Potter, 1977; Brass, 1977) that in many cases the dates of births recorded by pregnancy histories are distorted in systematic ways that give rise to biases in the estimates of fertility levels and the trends derived from them. Given the way fertility histories have traditionally been collected, a common form of the bias seems to be the pushing back of recent events into the past, causing a deficit of recent births and a surplus of births in the period 5 to 15 years before the survey. It is difficult to pin down this sort of error by the application of internal consistency checks, because the fertility histories themselves will be internally consistent or will have been edited into consistency. Any assessment of consistency, therefore, has to be made in terms either of internal plausibility or of consistency with estimates from other sources.

Brass and Rashad (1981) have used repeated applications of the P/F ratio comparison of period and lifetime fertility for different periods to show the implausibility of the BFS fertility information as recorded. They show that whereas current fertility in the period 1971-75 was substantially below the levels of lifetime fertility, current fertility in the period 1966-70 was substantially above such levels. The age-specific fertility rates and P/F ratios obtained for the two periods are shown in Table 16. It is possible that fertility rose sharply to the extremely high levels indicated for the late 1960s, and then fell even more sharply, but such a conclusion would be inconsistent with other available estimates. The misplacing of births in time apparently indicated by Brass and Rashad's analysis could result largely from the mislocation of births for

TABLE 16 Age-Specific Fertility Rates for 1966-70 and 1971-75, and P/F Ratios for All and First Births, from BFS: Bangladesh

Age Group at End of Period	Age-Specific Fertility Rates[a] 1966-70	Age-Specific Fertility Rates[a] 1971-75	Comparison of Period and Lifetime Fertility (P/F) 1966-70 First Births	1966-70 All Births	1971-75 First Births[b]	1971-75 All Births
10-14	.0080	.0016				
15-19	.1689	.1090	0.78	1.02	1.07	1.06
20-24	.3601	.2886	0.97	1.01	1.21	1.17
25-29	.3601	.2911	1.02	0.99	1.27	1.21
30-34	.3317	.2502	1.03	0.93	1.28	1.21
35-39	.2408	.1848	1.02	0.90	1.27	1.18
40-44	.1462	.1074	0.98	0.78	1.23	1.16
45-49	(.0347)[c]	.0347	--	--	1.11	1.02
Total Fertility Rate	8.25	6.34				

[a]Calculated assuming that births for which no date of occurrence was recorded were reported in terms of nearest number of years ago.
[b]Numerator is the proportion of women with at least one child at the end of 1975.
[c]Survey provides no information about this cell, so the 1971-75 value was adopted as a conservative estimate.

Source: Brass and Rashad (1981).

which month and year of occurrence were not recorded, and more consistent sequences of numbers of births by year could be constructed by assuming that births reported in terms of time ago were rounded up to the next higher number of years.

If the P/F ratios for the period 1971-75 in Table 16 were taken to imply a correction factor of around 1.2, the adjusted total fertility rate would be 7.6, an unacceptably high figure. A possible explanation for the ratios being too high is that rising age at marriage has reduced current fertility in the age group 15-19. P/F ratios calculated by duration of marriage are little distorted by changing age at marriage; Goldman and Chidambaram (1980) have calculated such ratios, the average adjustment being around 1.1, implying total fertility around 7.0. Such ratios by duration of marriage are sensitive to errors in reporting date of marriage, however.

Brass and Rashad (1981) also attempt to adjust the reported fertility for cohorts by the use of the relational Gompertz fertility model. Their conclusion is that fertility may have declined marginally, by some 5 percent, but that such a decline occurred among young women, possibly as a result of a rising age at marriage. However, even this conclusion is tentative, since the use of the model is least satisfactory for the youngest age groups, in which women have completed a relatively small proportion of their lifetime fertility, and since the age pattern of the average parities may be distorted both by age misreporting and, for dates before the survey, by dating errors. Thus, whether for reason of doubts about the time allocation of births reported as occurring a given number of years ago, or for reason of suspicion that accordion-like distortions have affected the time scale on which births are reported, the information on fertility trends available from the BFS seems to be of uncertain validity.

An alternative to looking at internal consistency is to compare the fertility estimates obtained from the BFS with those available from other sources. The PGE estimated total fertility in 1964 and 1965 to be around 7.1, showing no evidence of the very high fertility (8.25) reported by the BFS for the period 1966-70. The NIS estimated total fertility for the period 1966-68 at 6.0, an estimate that must itself be regarded as highly dubious. The BRSFM gives an estimate of total fertility, after adjustment, of 7.2 for 1973-74. The external evidence concerning fertility levels can be seen to be inconsistent, but gives no indication whatever of the very high fertility levels computed from the BFS data for the period 1966-70 or of the very rapid decline indicated for 1970 onward.

The fertility trends apparently indicated by the BFS need to be interpreted with caution, since there is strong evidence that the trends are largely figments of errors in the dating of births. The overall fertility level indicated by the data also needs to be critically examined. At face value the BFS data imply a very high level of fertility; women aged 40-44 report an average of 7.1 children each, suggesting an average of 7.4 or more children by the end of childbearing. When reporting of births nears completeness, there is a need to consider the factors that might lead to an excessive average number of children being reported per woman. The four most likely factors are a systematic tendency to overreport the number of children ever borne, a tendency for childless women to conceal the fact by inventing children, a tendency to select women with large numbers of children for interview, and a tendency for women with above-average numbers of children to survive to the time of the survey while their less fertile peers do not.

The first factor, overreporting, is always a possibility, though in the case of the BFS the internal consistency of the parity data, in terms of sex ratio and proportions surviving, suggests that it was not important. The second factor, "invention" of nonexistent children to conceal childlessness, probably did affect the BFS results, since only 2.7 percent of ever-married women aged 45-49 reported themselves as childless, an implausibly low percentage. However, the effect of this error on total fertility might not be large; if the true incidence of childlessness were 5 percent and the women who incorrectly reported children reported an average of two each, the effect on total fertility would be less than 0.05. The third factor, selection of high-parity women, should not have affected the BFS, since all ever-married women in each household were to be questioned, leaving the interviewer no selection to make. In the case of the fourth factor, selective mortality, even the direction of the effect is not well established, so it seems unlikely that the absolute effect would be large. There are thus some reasons for supposing that fertility was overreported by the BFS, though the overall impact was probably minor.

THE CHOLERA RESEARCH LABORATORY (CRL)

In 1963, the Cholera Research Laboratory (CRL) started a research project in Matlab thana of Comilla district, a rural area of southern Bangladesh. In 1966, a study area was defined, its population was enumerated, and the registration of demographic events--births, deaths, marriages, and migrational movements--was begun. In 1968, the study area was almost doubled to include over 200,000 people, and the Demographic Surveillance System (DSS) has continued in the expanded area since then, with periodic censuses and the continuous registration of demographic events. The CRL has not only placed great emphasis on the complete registration of all events, making the DSS a source of high-quality demographic data, but has also provided health services to the area's population. The DSS and its results are well described in the series of scientific reports published by the CRL (1978). In 1976, registration of vital events was started for a population of 40,000 in another study area, the Teknaf thana of Chittagong district.

Matlab thana is fairly typical of rural southern Bangladesh in most respects, but no one area can be taken as being representative of a whole country; nevertheless, any pronounced national trends may be expected to be observed in the DSS data. Chowdhury and Sheikh (1980) have calculated fertility measures from the DSS data for the period 1966-77; crude birth rates and total fertility rates are shown in Table 17.

All the birth rates, with one exception, fall between 41.8 and 47.1, and the total fertility rates are all, again with one exception, between 5.5 and 6.7. The exception in both cases is 1975, which appears to have been a year of very low fertility in Matlab; 1974 was a year of famine, which may explain the low fertility in 1975. In general, the level of fertility in Matlab appears to be rather low relative to the national estimates already presented; the Matlab birth rate averages around 45, the total fertility rate around 6.2. Information on regional variations in fertility (see Chapter 5) show Comilla district to have lower fertility than average, though not as much lower as would be expected on the basis of the difference between estimates for Matlab and those for Bangladesh as a whole. In terms of age-standardized average parity as recorded by the 1974 census, Comilla district had lower fertility than the national average, ranking sixteenth out of the 19

TABLE 17 Crude Birth Rates and Total Fertility Rates, 1966-77: Matlab Thana, Bangladesh

Year	Crude Birth Rate	Total Fertility Rate
1966-67	47.1	6.7
1967-68	45.4	6.3
1968-69	46.6	6.3
1969-70	45.3	6.1
1970-71	43.5	5.9
1971-72	44.5	6.0
1972-73	41.8	5.5
1973-74	45.6	not available
1974	42.9	6.5
1975	29.4	4.3
1976	43.3	6.2
1977	46.4	6.7

Source: Chowdhury and Sheikh (1980).

districts of Bangladesh, with an average parity of 3.72 as compared with the national average of 3.89 (Khan and Blacker, 1981).

Another feature of the fertility estimates for Matlab is that although they fluctuate there is no significant trend. Fertility was clearly very low in 1975, and it seems possible that fertility was relatively low in the years 1970-73, a period that includes the War of Liberation. The DSS data seem to suggest, therefore, that although fertility fluctuates substantially from year to year, no systematic decline in fertility had started by 1977.

Fertility estimates are available for the Teknaf DSS for 1976 and 1977 (Rahman et al., 1980). The birth rates obtained are 47.9 and 49.6 for 1976 and 1977, respectively, the total fertility rate for both years combined being 7.1. It thus appears that Teknaf has rather higher fertility than Matlab, the Teknaf levels being comparable with most national estimates.

SUMMARY

Fertility estimates for Bangladesh vary widely with the method of data collection and analysis used to obtain them. The PGE, a dual-record survey, gave an unadjusted estimate of total fertility based on registration of births of 6.3 for the period 1963-65; after adjustment for missed events, the estimate was 7.4. The births reported in the year before the 1974 BRSFM indicated a level of total fertility of 4.8; after adjustment for consistency with reported lifetime fertility, the estimated total fertility was 7.2, more consistent with the PGE results. Both pregnancy history surveys, the NIS and the BFS, indicated sharp declines in fertility over the 10 years before the survey, and both showed high levels of lifetime fertility, measured in terms of average parity. A third pregnancy history survey, the DSEP, carried out in the early 1960s in central Bangladesh, gave similar results. Data from the CRL's carefully controlled vital registration system in a small area of central southern Bangladesh give lower estimates of fertility, with total fertility averaging around 6.0 over the period 1966 to 1975, and indicate rather sharp annual fluctuations in the level of fertility.

There are obviously good reasons for doubting the validity of the sharp fertility declines indicated by the fertility history surveys, since the trends they show are mutually inconsistent. The lifetime fertility levels reported, however, suggest average levels of total fertility in the range of 7.0 to 7.5, though these levels may be somewhat higher than the true level as a result of overstatement of lifetime fertility. The adjusted fertility estimates from the PGE are obtained after the application of a rather substantial correction factor, which is sensitive to the accuracy of the matching operation; the CD estimates obtained from the PGE should therefore be regarded as upper limits of the true level of fertility. The adjusted fertility estimates from the BRSFM are obtained by the application of an even larger correction factor to the recorded age-specific fertility rates; so, although the final estimate of total fertility falls neatly within the broad range of values indicated by other surveys, the sensitivity of the final estimate to the exact value of the correction factor needs to be borne in mind when interpreting the results. The one data source that indicates substantially lower fertility, the Demographic Surveillance System in a part of Matlab thana, covers a relatively small area and cannot be taken as representative of the country as a whole. It is possible that all the methods based on children-ever-born data (the fertility history surveys and the BRSFM) may overestimate fertility slightly, if numbers of children ever born are distorted by the inclusion of stillbirths or the concealment of childlessness.

Our conclusion, therefore, is that because of data weaknesses it is impossible to be sure of the exact level of fertility in Bangladesh, although total fertility has probably averaged somewhere in the range of 6.8 to 7.3 over the 15 years or so prior to 1975. There is no firm evidence of any significant trend in fertility up to 1975, although rising age at marriage may be having some downward effect on fertility.

3 Marital Status

In the recent past, marriage has occurred early and has been virtually universal for females in Bangladesh; for males, marriage is also almost universal, but occurs on average somewhat later in life. Table 18 shows proportions ever married by age group and sex, together with the implied singulate mean age at first marriage (SMAM) for the censuses of 1951, 1961, and 1974. The SMAM, as calculated from proportions of those single in each age group recorded by a census, is neither a period nor a cohort measure and should be interpreted with caution.

For males, the figures show a rising age at first marriage throughout the period, with the SMAM increasing by half a year between 1951 and 1961 and by a year between 1961 and 1974. For females, age at marriage appears to have fallen between 1951 and 1961, the SMAM falling by half a year and the proportion of girls ever married in the 10-14 age group increasing from 0.26 to 0.33 in the same period. Between 1961 and 1974, however, female age at marriage rose sharply, the SMAM increasing by two whole years. It seems likely that female age at first marriage has been rising since 1951, but that some definitional or data-collection problem affected the information for 1961; deficiencies in age reporting in the 1961 census have already been noted in Chapter 1 in the section on population characteristics.

TABLE 18 Proportions Ever Married by Sex and Age Group in 1951, 1961, and 1974: Bangladesh

Age Group	Males			Females		
	1951	1961	1974	1951	1961	1974
10-14	.0207	.0223	.0068	.2631	.3261	.0952
15-19	.1611	.1224	.0766	.8870	.9171	.7552
20-24	.5373	.5029	.3994	.9698	.9866	.9676
25-29	.8491	.8270	.7752	.9885	.9948	.9913
30-34	.9448	.9472	.9432	.9953	.9958	.9944
35-39	.9738	.9739	.9783	.9976	.9976	.9957
40-44	.9805	.9895	.9850	.9976	.9985	.9955
45-49	.9872	.9918	.9890	.9979	.9989	.9967
Singulate Mean Age at Marriage	22.4	22.9	23.9	14.4	13.9	15.9

Changes in age at first marriage may be expected to have some impact on fertility, especially in a country like Bangladesh, in which extramarital fertility is virtually nonexistent. However, the distribution of currently married women, on which overall fertility would depend, is affected not only by age at first marriage but also by marital dissolution. Table 19 shows the proportions of women currently married by age group from the censuses of 1951, 1961, and 1974. Although the 1961 figures confuse the picture somewhat, from 1951 to 1974 the rise in age at first marriage has led to a decline in the proportion currently married under age 20. At the same time the proportions currently married above age 25 have increased substantially, as a result of a marked reduction in proportions widowed. For instance, in 1951, 20 percent of women aged 35 to 39 were widows, compared with 14 percent in 1961 and 9 percent in 1974. The decline in proportions widowed is so rapid that it gives rise to doubts about the data, though it may indicate some increase in the probability of remarriage.

In order to examine the effects on fertility of these changes in current marital status, a marital fertility schedule was calculated from the BRSFM data, by dividing the number of births in the year before the survey by the number of currently married women in each age group and then applied to each distribution of women by current marital status. The marital fertility schedule, shown in the last column of Table 19, was corrected for a half-year displacement, but was not adjusted for level, because only the distribution of fertility by age is important, or for denominator problems, which would tend to result in underestimates of marital fertility under age 20, where many first marriages are likely to have occurred in the six months before the survey.

The estimates of total fertility, calculated by applying the marital fertility schedule to the age distribution of women currently married, are also shown in Table 19. The lowest overall fertility is obtained for 1951, and the highest for 1961, with the 1974 value falling more or less between the two. The high 1961 value, however, is influenced by the high proportions currently married under age 25; if the more plausible 1951 proportions currently married under age 25 were used instead of the observed 1961 proportions, 1961 total fertility would be only 0.7 percent higher than that for 1974. Thus the two major trends in current marital status from 1951 to 1974--a rising age at marriage and a reduction in the incidence of widowhood--have had opposite effects on the total fertility. From 1951 to 1961, reduced proportions widowed were an upward influence on total fertility, whereas any impact of

TABLE 19 Proportions of the Female Population Currently Married by Age Group in 1951, 1961, and 1971, with Fertility Implications: Bangladesh

Age Group	Proportions of Women Currently Married: 1951 Census	1961 Census	1971 Census	Marital Fertility Schedule (from BRSFM)
10-14	.2542	.3175	.0884	.0433
15-19	.8612	.8948	.7176	.1747
20-24	.9338	.9560	.9298	.2499
25-29	.9212	.9475	.9520	.2249
30-34	.8602	.9077	.9335	.1919
35-39	.7932	.8466	.8985	.1431
40-44	.6601	.7155	.8138	.0758
45-49	.6046	.6131	.7512	.0415
Implied Total Fertility	4.73	4.99	4.88	--

rising age at first marriage would have been small. From 1961 to 1974, changes in current marital status were probably a downward influence on fertility. Rising age at marriage reduced the proportions of women married in the younger age groups, but this decrease was to some extent counterbalanced by the continuing increase in proportions currently married in the older groups, itself a result of the continuing reduction in the incidence of widowhood.

From 1974 onward, a continued trend toward later marriage is likely to have more impact on fertility, since the mean age at first marriage will be moving into an age range in which marital fertility is high. At the same time, the effects of a continued reduction in the incidence of widowhood will have less and less impact on total fertility, since the potential for further increases in the proportions currently married is now small for those age groups in which marital fertility is high.

4 Mortality

Mortality information for Bangladesh is in general either indirect in its nature--consisting of measures of indicators that reflect mortality without being pure mortality parameters--or derived from sample surveys, with their associated risk of substantial sampling errors for individual age- and sex-specific mortality rates. For the conversion of indirect indicators into conventional mortality measures and for the smoothing and graduation of distorted mortality rates, it is useful to identify some general age pattern of mortality that broadly represents the true pattern. A convenient and flexible system proposed by Brass (1971b) is based on the observation that any two survivorship functions are approximately linearly related on a suitably transformed scale, from which it follows that the survivorship function of any particular life table will be linearly related, on a suitable scale, to some standard function. In practice, the relationship is only approximate, and the functioning of a model system based on the logit transformation (the logit of a proportion p is defined as $0.5 \log_e(1 - p)/p$) is improved the more closely the standard function matches that of the given life table. The four "regional" age patterns of mortality embodied in the Coale-Demeny (1966) model life tables provide a convenient range of standards on which to base a logit system.

In this study of mortality in Bangladesh, the "North" regional age pattern of mortality has been used to provide standards for the logit system. The "North" family was chosen for several reasons. Information on child mortality by age from the BFS shows rather low infant mortality relative to mortality between ages 1 and 5, a typical feature of the "North" pattern. In addition, transformed adult survivorship probabilities calculated from adjusted deaths by age from the PGE and BRSFM fall on a line with a slope nearer to 1.0 when plotted against a standard taken from the "North" family than when plotted against a standard from one of the other families, suggesting that the "North" mortality pattern best represents the relationship between child and adult mortality in Bangladesh. The relatively low old-age mortality indicated by the PGE and BRSFM data are also most closely approximated by the "North" pattern. The choice is not perfect, however. A comparison of age-specific mortality rates from the PGE and BRSFM with rates from life tables of similar mortality level from each of the regional families indicates little difference in performance overall, and the "North" family's rather high young-adult mortality does not seem to be a feature of Bangladeshi mortality. However, the choice of standard is not crucial to summary mortality measures, such as the expectation of life at birth or the crude death rate, so even if the age pattern of mortality cannot be well represented by the logit system using a "North" standard, the general conclusions of this section would not be greatly altered.

THE POPULATION GROWTH ESTIMATION (PGE) EXPERIMENT

The final report on the PGE (PIDE, 1971) does not give complete life tables based on the survey results, but it does give certain mortality measures based on deaths recorded by the longitudinal registration system and on deaths adjusted for omission by the Chandrasekaran and Deming method for the full survey period 1962-65. Table 20 shows the results.

Infant and Child Mortality

For females, the child mortality estimates based on adjusted deaths--an infant mortality rate of 131 per

TABLE 20 Mortality Measures by Age and Sex, from PGE 1962-65: Bangladesh

	Age-Specific Mortality Rates (per thousand)			
	Males		Females	
Age Group	LR	CD	LR	CD
Under 1	197	245	146	185
1-4	20	25	24	30
5-14	4	4	4	5
15-44	4	4	6	8
45+	31	36	31	36
All Ages	17	20	16	20
Infant Mortality Rate in 1964-65[a] (per thousand)	156	176	119	131

[a]Calculated as reported deaths under age 1 divided by reported births during period.

thousand live births and a death rate of 30 per thousand for ages 1-4--are similar to the child mortality parameters of the "North" female level 11 life table, which was used in Table 4 to analyze the 1961 age distribution; the model life table has an infant mortality rate of 129 per thousand and a death rate of 30 per thousand for the 1-4 age group. For males, the agreement with the model is not so close; the recorded mortality rates for infant mortality and mortality 1-4 are 176 and 25 per thousand, respectively, as compared with rates of 152 and 31 per thousand in the "North" model life table of level 11. It is difficult to compare the recorded mortality rates with those of models for older age groups, because the age distribution within the broad age groups used has an important effect on the death rates.

Apart from the 1961 census, which has an age distribution that is clearly unsatisfactory, there is no national data source against which the PGE estimates can be compared; in the case of child mortality, there is no internal consistency check that can be applied either. However, there is one sub-national source of data for a comparable period, namely the 1961-62 Demographic Survey of East Pakistan (DSEP), which collected a complete maternity history from a sample of some 4,000 ever-married women in central Bangladesh (Muniruzzaman, 1965, 1966a, 1966b; Obaidullah, 1966). Infant mortality rates have been calculated directly from the DSEP maternity histories for the period 1952-60 and are shown in Table 21.

The DSEP data also permit the application of an indirect mortality estimation method that uses information on the proportion dead of the children ever borne by women classified by standard age groups. Brass (1964) first proposed a method that made it possible to estimate probabilities of dying between birth and exact ages from such information; using fairly simple models of fertility and mortality, the Brass procedure made it possible to allow for the effects of the age pattern of childbearing on the proportions of children dead. Since that time, several authors have suggested refinements of the original Brass technique, among them Sullivan (1972), Trussell (1975), Brass (1975), Preston and Palloni (1978), and Feeney (1980). The method used here is Trussell's (Hill et al., 1981) and permits the selection of a suitable mortality pattern (one of the four regional mortality patterns embodied in the Coale-Demeny model

TABLE 21 Estimates of Infant and Child Mortality by Calendar Year, 1952-60, Calculated Directly from the DSEP Fertility Histories: Central Bangladesh

Year of Birth	Infant Mortality Rate[a] (per thousand)	Death Rate For Ages 1-4[a] (per thousand)
1952	173	33
1953	172	27
1954	167	20
1955	156	34
1956	156	23
1957	158	n.a.
1958	150	n.a.
1959	155	n.a.
1960	156	n.a.

[a]Weighted average of separate estimates for urban and rural areas.

Source: Schultz and DaVanzo (1970).

life tables) and the calculation of the time period to which the estimates of child mortality refer. Trussell used regression analysis on a large number of simulated cases of proportions dead among children borne by women classified by age to examine the relationship between the proportions of children dead [D(i)] and probabilities of dying between birth and exact ages x of childhood [q(x)] for a wide range of fertility and mortality patterns. Specifically, ratios of q(x) to D(i) were related to the parity ratios P(1)/P(2) and P(2)/P(3), used as indicators of the age pattern of childbearing. The regression coefficients obtained can then be used with observed parity ratios in order to estimate a factor to convert observed proportions dead [D(i)] into mortality measures [q(x)]. The application of the method to the child survival data from the DSEP is shown in Table 22.

The infant mortality rates shown in Table 21 are remarkably consistent over time, indicating an overall rate between 150 and 160 per thousand for the births occurring between 1955 and 1960. The indirectly obtained estimates shown in Table 22 confirm the general level of child mortality for a similar period, though it should be pointed out that the equivalent infant mortality rates given in Table 22 depend on the age pattern of mortality in the "North" model life tables. Another limitation of the DSEP data is that they were collected only in central Bangladesh, the sample universe covering only 27 percent of the total population of the country, so its results cannot be considered nationally representative. However, the regional variation in child mortality seems, on the basis of the BRSFM data for 1974, to be rather modest.

The results of the DSEP therefore seem to show a level of child mortality for the late 1950s that is very similar to the child mortality estimates derived from the PGE for the early 1960s. The time periods do not coincide exactly, of course, but the two surveys appear to confirm each other's estimates and to indicate that infant mortality remained rather constant from the mid-1950s to the mid-1960s.

The one national survey that might have provided child mortality estimates that could be compared with those from the PGE is the National Impact Survey (NIS). Unfortunately, however, the only data from the survey that have been tabulated are for women married at the time of the survey, and it might be suspected that the children of such women would have experienced below-average mortality risks. It is also suspected that

TABLE 22 Derivation of Child Mortality Estimates from Data on Children Ever Born and Surviving, DSEP 1961-62: Central Bangladesh

Age Group of Women	Average Number of Children: Ever Born	Average Number of Children: Surviving	Age x	Probability of Dying by Age x q(x)	Time Reference of Estimate (years before survey) t*	Mortality Level Implied[a]	Equivalent Infant Mortality Rate[a] (per thousand)
20-24	2.294	1.794	2	.1990	2.7	10.0	155
25-29	3.852	2.960	3	.2062	4.8	11.0	141
30-34	5.050	3.663	5	.2579	7.3	10.2	152

[a]From Coale-Demeny "North" model life tables.

child deaths were underreported by the NIS (Sirageldin et al., 1975); the estimated infant mortality rates are 139 for the period 1960-62, 116 for 1963-65, and 113 for 1966-68.

In conclusion, the confirmation available for the child mortality estimates from the PGE is not overwhelming, either because of differences in the populations exposed to risk or because of doubts about data reliability, but the agreement with other estimates is pleasingly close.

Adult Mortality

With regard to adult mortality, several techniques derived from stable population theory have been proposed for using the age structure of reported deaths, in conjunction with either the age structure of the population or an estimate of the rate of natural increase, to assess the completeness of death recording. Basically, these methods assume that the population is stable and that the proportion of deaths recorded is constant by age, at least after childhood.

The first method, proposed by Brass (1975), uses information on the age distribution of the population and of recorded deaths; from these, it estimates the completeness of death recording and the rate of natural increase of the population. A stable population has an age distribution that remains constant over time, so all age segments of such a population grow at the same rate. It thus follows that for all age segments the balance between new entrants to the segment and departures from it will be a constant proportion of the average membership of the segment, the proportion being the stable growth rate. If a series of population segments are defined as being of age a and over, the new entrants in a year to each segment are those that have an a-th birthday during the year, whereas the departures are the deaths in a year to those aged a and over. Dividing the new entrants by the average population produces a measure akin to a birth rate for the segment (described henceforth as the partial birth rate a+), and dividing the departures by the average population produces a partial death rate a+. A plot of partial birth rates against partial death rates for a series of values of a should yield a straight line with an intercept equal to the growth rate and a slope equal to unity. However, if the recording of deaths is incorrect by a constant factor, all the death rates will be too small or too large by that factor. The birth and death rates, therefore, will still fall on a straight line, which will still have an intercept equal to the growth rate but will have a slope equal to the reciprocal of the completeness of death reporting. For example, if the number of deaths is only 80 percent complete, the slope of the line would be 1.25.

An alternative way of using similar information has recently been proposed (Preston et al., 1980). In a stationary, or life table, population, the number of people aged a is equal to the number of deaths that occur after age a. In a stable population, the number aged a is equal to the sum of deaths at each age over a inflated by exponential factors $e^{r(b - a)}$, where r is the stable growth rate and b is the age at death, to allow for the effects of population growth on the age distribution of deaths. The completeness of death reporting can then be estimated by comparing the reported population aged a to that estimated from reported deaths. Although an estimate of r is apparently required for the application of the method, in practice the pattern of the completeness estimates for different initial ages a provides information about the true underlying growth rate.

In this study, the Brass method has been preferred, since it does not require heavy weighting of deaths at old ages. The age pattern of deaths from the PGE suggests that age at death was exaggerated for the elderly, and such an exaggeration will always affect the results of the method just outlined. The Brass method, however, is not affected as long as only points below the age at which exaggeration starts to be an important feature are considered. Thus, the death rate over age a, and over all ages younger than a, will not be affected by a tendency to exaggerate the age at death of someone aged a + 10, only by a tendency to exaggerate the age at death of someone under age a. The second method could be applied satisfactorily if the age distribution of deaths at old ages were initially adjusted, but the adjustment would be dependent upon models and remove some of the value of the technique.

Information on deaths and population by sex and five-year age groups is available from the PGE final report for 1964 and 1965; the numbers of deaths are available from both data sources--longitudinal registration (LR) and cross-sectional survey (CS)--as well as after adjustment by the Chandrasekaran-Deming formula to compensate for omissions (CD). The Brass method just described has been applied by sex to the numbers of adjusted deaths (CD) for the two years together. The partial birth rates and death rates are shown in Table 23 and are plotted against each other in Figure 2.

For both males and females, the points for young ages lie on a reasonably straight line, but the later points show a distinct sawtooth pattern and also droop down to the right of the trend line of the earlier points. The sawtooth pattern can be explained by age heaping of the population, and the tendency for the line to bend down to the right could be explained by the exaggeration of reported age at death. Points for younger ages should not be affected by either of these errors, so an attempt has been made to fit a straight line to these points, in the hope that they are more reliable. A subjective inspection suggested that the seventh to thirteenth points, covering the age categories 35+ to 65+, seemed to be only modestly affected by error, in both the male and female cases, so in each case a straight line was fitted to these points using a simple group-average fitting procedure. The lines are shown in Figure 2.

Another feature that stands out from Figure 2 is that the slopes of the two fitted lines are less than 1.0, indicating that the number of deaths after adjustment by the Chandrasekaran-Deming formula was too high. (It should be mentioned in passing that the method of fitting employed is not crucial to this result; it would be difficult to draw a plausible-looking line through the points that would have a slope equal to or greater than 1.0, and the inclusion of points above 13 would lead to a line with a much lower slope.) Table 24 shows the slope, an estimate of the reciprocal of completeness of death reporting, and the intercept, an estimate of the rate of natural increase, for males and females. The two growth rates--2.92 percent and 3.06 percent for males and females, respectively--are fairly similar to one another and not implausible for Bangladesh in the early 1960s. The completeness of death recording for male deaths is 1.25, indicating greater overreporting of male deaths than of female deaths, for which the estimated completeness is 1.14. When deaths at all ages above 5 are considered, the application of the Chandrasekaran-Deming correction increased the number of male deaths by

TABLE 23 Population and Deaths by Sex and Age, and Partial Birth and Death Rates, from PGE 1964-65: Bangladesh

Age Group (a, a + 4)	Males: Population (hundreds)	Males: CD Adjusted Deaths (hundreds)	Males: Age a+ Partial Birth Rate	Males: Age a+ Partial Death Rate	Females: Population (hundreds)	Females: CD Adjusted Deaths (hundreds)	Females: Age a+ Partial Birth Rate	Females: Age a+ Partial Death Rate
0-4	95,070	6,707			96,000	5,953		
5-9	103,230	649	.0410	.0109	102,510	679	.0444	.0112
10-14	73,270	201	.0464	.0122	57,010	134	.0464	.0125
15-19	43,550	149	.0380	.0145	42,270	362	.0346	.0145
20-24	33,890	137	.0294	.0163	43,040	288	.0348	.0156
25-29	39,690	105	.0320	.0181	43,020	345	.0426	.0175
30-34	38,020	302	.0409	.0213	34,740	254	.0490	.0200
35-39	36,440	201	.0490	.0246	27,510	257	.0502	.0236
40-44	27,180	195	.0550	.0307	25,270	120	.0547	.0277
45-49	23,300	291	.0571	.0379	18,180	162	.0609	.0358
50-54	21,000	365	.0681	.0470	20,640	306	.0731	.0450
55-59	12,820	270	.0767	.0611	9,800	221	.0937	.0642
60-64	14,290	578	.0867	.0775	11,450	485	.0937	.0821
65-69	6,340	342	.1215	.1087	4,110	139	.1386	.1227
70-74	5,420	516	.1105	.1414	3,240	385	.1032	.1740
75-79	1,990	252	.1420	.1893	1,480	186	.1216	.2201
80-84	1,930	322	.1214	.2279	1,480	379	.1233	.2783
85-89	470	104	.1846	.3185	360	96	.2000	.3141
90-94	480	166	.1145	.3735	280	67	.1143	.3446
95+	350	144	.2371	.4114	280	126	.2000	.4500

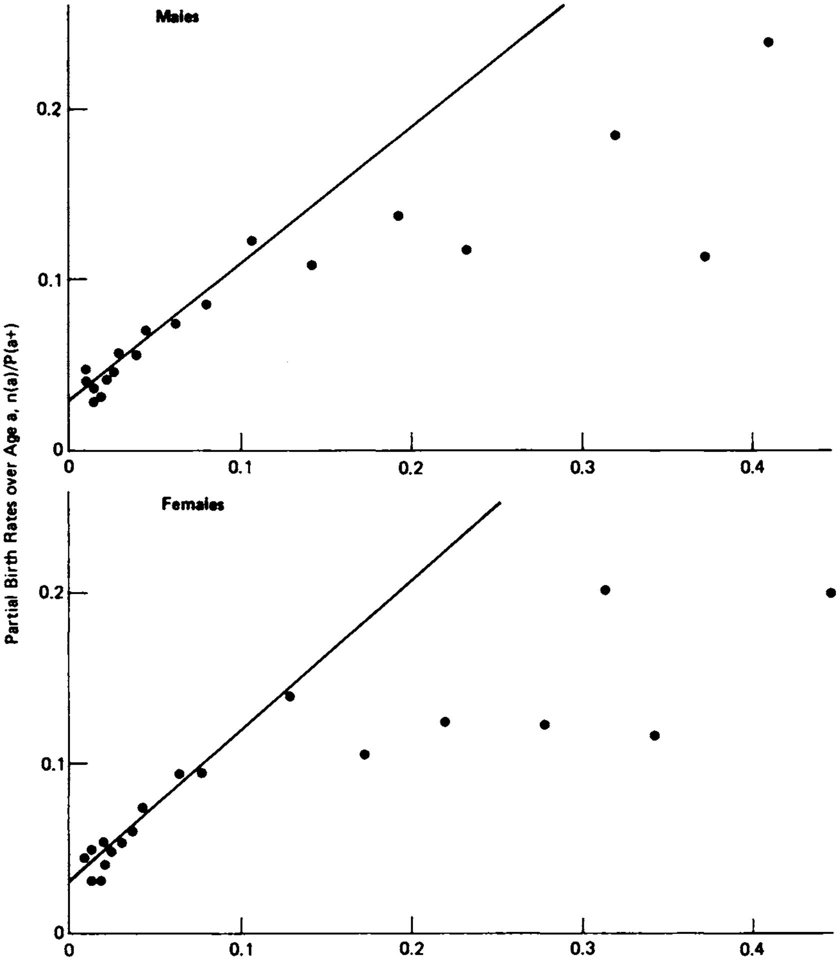


FIGURE 2 Partial birth and death rates over successive ages by sex, from PGE 1964-65: Bangladesh.

a factor of 1.20, and the number of female deaths by a factor of 1.17, over the number of registered deaths. It is tempting to draw the conclusion that the longitudinal registration of deaths over age 5 in Bangladesh by the PGE was approximately complete, relative to enumeration completeness, and that the matching with cross-sectional data and inflation by the CD formula actually worsened the results.

TABLE 24 Estimates of the Completeness of Death Recording and Rate of Natural Increase, from PGE 1964-65: Bangladesh

Sex	Completeness of Death Recording	Rate of Natural Increase (Percent)
Male	1.245	2.92
Female	1.136	3.06

Smoothing Estimates for a Composite Life Table

The adjusted deaths still show some fluctuations by age, so in order to construct a life table a smoothing procedure was applied. Recorded deaths adjusted for the overreporting estimated in Table 24 were combined with the recorded populations and used to calculate a life table for ages 5 to 65. Data for groups older than 65 were not included because exaggeration of age at death appears to become important in those groups. Following the principle of the Brass (1971b) logit life table system, the probabilities of surviving from age 5 to age a [l(a)/l(5)] were transformed into their logits and compared with similarly transformed survivorship probabilities from a standard life table--in this case a "North" level 10 life table of the appropriate sex from the Coale-Demeny (1966) regional families. A straight line was then fitted to each set of points, using a simple group-average procedure, and its slope and intercept were calculated. Broadly speaking, in the logit system, the slope of such a line is an indication of the age pattern of mortality in the observed life table relative to that of the standard, and its intercept is an indication of their relative levels. The straight line for males has a slope of 1.00 and an intercept of -0.465, indicating that the pattern of mortality matches that of the standard but at a lower level of mortality. For females, the slope was 1.03, also indicating a similar age pattern of mortality, and the intercept was -0.202, indicating lower mortality but not so much lower as in the case of males. Table 25 summarizes the calculations, and Figure 3 shows the points and fitted straight lines.

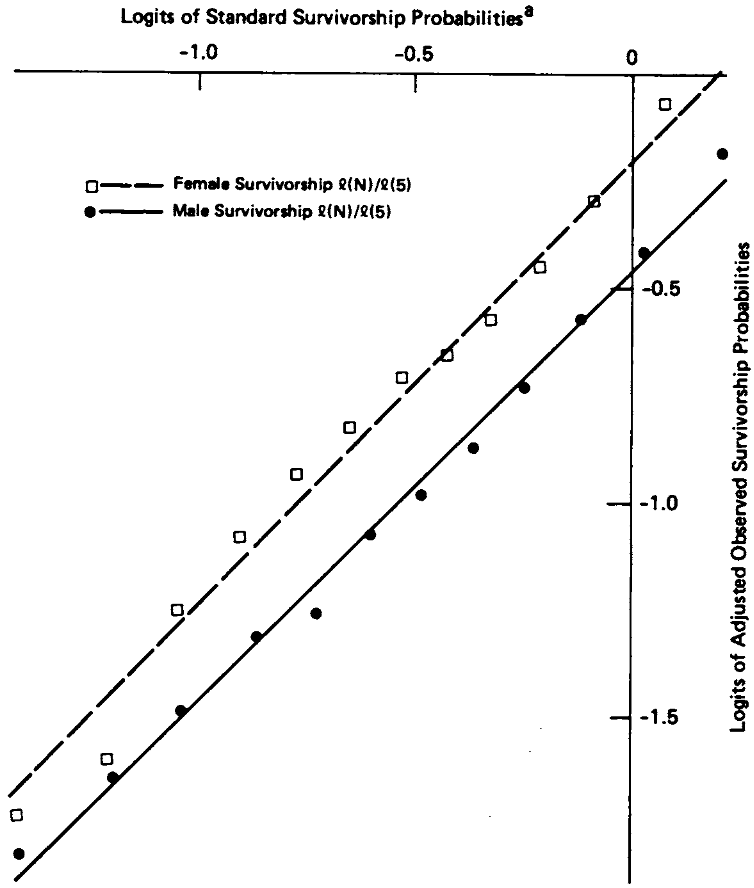
A smoothed life table for ages 5 and over can now be calculated from the standards, using the observed intercepts and slopes and extrapolating to ages over 65.

TABLE 25 Smoothing the Adjusted Age-Specific Mortality Rates from the PGE (1964-65), Using the Logit Transformation: Bangladesh

	Males					Females				
Age x	Adjusted Death Rate $_5m_x$	$_5q_x$	l_x	Logit l_x	Standard ls_x	Adjusted Death Rate $_5m_x$	$_5q_x$	l_x	Logit l_x	Standard ls_x
5	.00505	.0249	1.0000	--	--	.00583	.0287	1.0000	--	--
10	.00220	.0110	.9751	-1.8331	-1.4300	.00207	.0103	.9713	-1.7602	-1.4403
15	.00275	.0136	.9644	-1.6493	-1.2157	.00754	.0370	.9613	-1.6058	-1.2205
20	.00325	.0161	.9512	-1.4852	-1.0452	.00589	.0290	.9257	-1.2613	-1.0565
25	.00212	.0106	.9359	-1.3406	-0.8672	.00706	.0347	.8988	-1.0922	-0.9119
30	.00638	.0314	.9260	-1.2635	-0.7242	.00644	.0317	.8677	-0.9402	-0.7795
35	.00443	.0219	.8969	-1.0818	-0.6011	.00822	.0403	.8402	-0.8298	-0.6548
40	.00576	.0284	.8773	-0.9835	-0.4845	.00418	.0207	.8063	-0.7132	-0.5366
45	.01003	.0489	.8524	-0.8766	-0.3659	.00784	.0385	.7897	-0.6614	-0.4267
50	.01396	.0674	.8107	-0.7272	-0.2440	.01305	.0632	.7593	-0.5744	-0.3234
55	.01692	.0811	.7560	-0.5654	-0.1126	.01985	.0946	.7113	-0.4508	-0.2121
60	.03249	.1502	.6946	-0.4109	0.0346	.03729	.1705	.6440	-0.2965	-0.0813
65	--	--	.5903	-0.1825	0.2105	--	--	.5342	-0.0685	0.0826
70					0.4300					0.2940
75					0.7235					0.5722
80					1.1187					0.9367

Fitted Line for males: $\alpha = -0.465$, $\beta = 1.00$. See Figure 3.

Fitted line for females: $\alpha = -0.202$, $\beta = 1.03$. See Figure 3.



[a]From Coale-Demeny "North" family, mortality level 10.

FIGURE 3 Plots of logit transformations of adjusted and standard survivorship functions from age 5 by sex, from PGE 1964-65: Bangladesh.

The life table can be completed for ages 0-4 by using the child mortality estimates derived from the PGE for the period 1964-65, since these estimates seem to be reliable. Table 26 shows the composite life tables and the expectations of life at birth (e_0) and at age 10 (e_{10}). The female mortality advantage in infancy is reversed thereafter, with young adult females having a

TABLE 26 Composite Life Tables by Sex, from PGE 1964-65: Bangladesh

	Males		Females	
Age x	l(x)	q(x)	l(x)	q(x)
0	1.000	.1760	1.000	.1310
1	.824	.0942	.869	.1118
5	.746	.0214	.772	.0337
10	.730	.0123	.746	.0174
15	.721	.0125	.733	.0205
20	.712	.0197	.718	.0237
25	.698	.0215	.701	.0285
30	.683	.0234	.681	.0338
35	.667	.0270	.658	.0380
40	.649	.0339	.633	.0442
45	.627	.0415	.605	.0496
50	.601	.0549	.575	.0609
55	.568	.0757	.540	.0870
60	.525	.1124	.493	.1258
65	.466	.1717	.431	.1949
70	.386	.2772	.347	.2997
75	.279	.4301	.243	.4362
80	.159	--	.137	--
Life Expectancy at Birth (e_0)	48.6		47.6	
Life Expectancy at Age 10 (e_{10})	56.0		53.1	

particularly marked disadvantage. Males have a one-year advantage in life expectancy at birth; at age 10, however, the male advantage in life expectancy is close to three years.

THE BANGLADESH RETROSPECTIVE SURVEY OF FERTILTY AND MORTALITY (BRSFM)

The 1974 BRSFM collected a substantial amount of mortality-related information. With regard to child mortality, data were collected on children dead among those ever borne by each woman, by sex of child, and on the survival of the most recently born child. For adult mortality, data were collected on the survival of the

TABLE 27 Child Mortality Estimates, from BRSFM 1974: Bangladesh

Age Group of Mothers	Proportion of Children Dead	Age x	Probability of Dying by Age x q(x)	Time Reference of Estimate (years before survey) t*	Mortality Level Implied[a]	Equivalent Infant Mortality Rate (per thousand)[a]
Male Children						
20-24	.2114	2	.2010	2.6	10.6	158
25-29	.2239	3	.2072	4.5	11.5	145
30-34	.2359	5	.2288	6.7	11.9	139
Female Children						
20-24	.1955	2	.1858	2.6	10.0	142
25-29	.2020	3	.1863	4.5	11.4	124
30-34	.2202	5	.2126	6.7	11.6	122

Note: Average parity ratios used in applying the child mortality estimation procedure: for male children, P(1)/P(2) = .2095 and P(2)/P(3) = .5268; for female children, P(1)/P(2) = .2072 and P(2)/P(3) = .5334.

[a]From Coale-Demeny "North" model life tables.

mother and father of each respondent, on whether or not the respondent was the eldest surviving child of the mother or the father, on the survival of each ever-married respondent's first spouse, and on the deaths occurring in the household during the preceding two years by sex, age at death, and date of death. The data therefore permit the application of most of the indirect mortality estimation procedures that have been devised.

Child Mortality

Child mortality estimates by sex have been obtained from the proportions dead among children ever borne by women in standard five-year age groups using the Trussell procedure (Hill et al., 1981) described earlier. The estimates of q(x) and the implied mortality levels in the "North" family of model life tables are shown in Table 27. The results are not very consistent, age by age, but on average they imply a level of child mortality of 11.0 for females and 11.3 for males, suggesting that although female child mortality is somewhat lower than that of males, the differential is smaller than that embodied in the "North" model life tables. The plausibility and consistency of the sex ratios of children ever born as reported by women in the age range 20-34, shown in Table 14, indicate that the female advantage in child mortality has not arisen entirely because of differential omission by sex of dead children. For comparison purposes, the values of l(5) in the life tables from the PGE (Table 26) imply levels of 10.8 for males and 10.9 for females in the "North" model life tables.

Alternative child mortality estimates can be derived from the data on survival of each woman's most recent live birth. The proportion surviving of births in the year before the survey should approximate the life table function ${}_1L_0$, person-years-lived between birth and first birthday; the proportion surviving of births in the year before that, 1 to 2 years before the survey, should approximate ${}_1L_1$. Table 28 shows the proportions surviving by age group of mother and the mortality level in the "North" model life tables that each implies.

The proportions surviving among the births in the year before the BRSFM show a plausible pattern by age, with heavy child mortality at the extremes of the childbearing span and relatively low mortality risks for the children of women aged 25 to 34. The level of the proportions

TABLE 28 Estimates of Survivorship Probabilities Derived from Data on Survival of Most Recent Child, BRSFM 1974: Bangladesh

Age Group of Women	Proportion Surviving of Births in Year Before Survey	Implied Mortality Level[a]	Proportion Surviving of Births 1 to 2 Years Before Survey	Implied Mortality Level[a]
10-19	.8750	7.8	.9127	16.4
20-24	.9067	11.0	.9434	19.2
25-29	.9146	11.9	.9392	18.8
30-34	.9106	11.4	.9384	18.7
35-39	.9016	10.4	.9283	17.8
40-44	.9067	11.0	.9151	16.6
45-49	.8719	7.6	.8773	13.6
All	.9030	10.6	.9325	18.1

[a]From the Coale-Demeny "North" model life tables.

indicates slightly heavier child mortality than does the analysis of proportions dead among children ever born (from Table 27), the mortality level implied by the survivorship of all births in the last year being 10.6, compared with a level of 11.2 for both sexes combined obtained from proportions dead among children ever born.

The information on survival of children born in the year before the survey thus appears to be quite good, being internally consistent and supporting the general level of the child mortality estimates derived independently from data on children ever born and children surviving. The slight discrepancy could be due to real differences if, for example, child mortality actually was slightly higher in the year before the survey than on average over the longer reference period of the other estimates or if the true age pattern of mortality under age 5 was not adequately represented by the "North" family of models (if, for instance, true infant mortality were higher relative to child mortality than in the models).

Unlike the data on survival of births in the year before the survey, the data on survival of births in the period one to two years before the survey are clearly inadequate. Although the age pattern is still plausible, with lower rates of mortality for the children of women aged 20 to 34, the overall level of mortality is unacceptably low and clearly inconsistent with the proportions surviving of births in the year before the survey, since the proportions surviving for the longer period are higher for every age group of mother than those for the shorter period.

Adult Mortality

The BRSFM data on deaths by age and sex occurring in the household during the 12 months before the survey make possible the application of the same methods of analysis described above in the section on the PGE. The BRSFM deaths, tabulated for five-year age groups only up to age 75, show no tendency toward systematic exaggeration of age at death, and all three possible methods of analysis--those proposed by Brass (1975), Preston (Preston and Hill, 1980), and Coale (Hill et al., 1981)--give results that are essentially the same. For the sake of consistency, and since the choice is not important to the results, the Brass method has again been used, and straight lines have been fitted to points for the same age range, that is, for categories 35+ to 65+. Table 29 shows the basic data and the partial birth and death rates, Figure 4 displays the points and fitted straight lines, and Table 30 summarizes the estimates derived for completeness of recording and rate of natural increase by sex. The rates of natural increase by sex are not as consistent as in the case of the PGE application (Table 24), the male rate being considerably lower than the female rate. The result of this discrepancy might be a slight exaggeration of the mortality advantage of males over females.

Smoothing Estimates for a Composite Life Table

The smoothing procedure applied to the adjusted mortality rates from the PGE can also be applied to those from the BRSFM: constructing a life table from age 5, transforming into logits the proportions surviving to each age, and comparing the logits with those of a standard life table. The calculations are summarized in Table 31, and Figure 5 plots the logits of the life tables calculated from the adjusted reported deaths against those of the standards, Coale-Demeny "North" tables of level 10. Once again, the overall fit is reasonably good, the slope of the lines being 0.98 for

TABLE 29 Population and Deaths by Sex and Age, and Partial Birth and Death Rates, from BRSFM 1974: Bangladesh

	Males				Females			
Age Group (a, a + 4)	Population (hundreds)	Reported Deaths (hundreds)	Age a+ Partial Birth Rate	Age a+ Partial Death Rate	Population (hundreds)	Reported Deaths (hundreds)	Age a+ Partial Birth Rate	Age a+ Partial Birth Rate
0-4	53,520	2,202			54,900	1,785		
5-9	61,850	115	.0365	.0040	62,000	158	.0405	.0038
10-14	53,480	70	.0454	.0045	46,750	73	.0480	.0042
15-19	33,230	53	.0432	.0053	30,150	84	.0427	.0049
20-24	26,480	35	.0357	.0061	26,530	53	.0378	.0053
25-29	25,760	41	.0371	.0070	26,070	52	.0427	.0060
30-34	21,010	31	.0406	.0082	20,160	63	.0475	.0071
35-39	20,730	39	.0443	.0097	17,720	41	.0491	.0081
40-44	17,240	47	.0517	.0119	14,800	36	.0548	.0099
45-49	13,680	58	.0550	.0147	11,350	33	.0587	.0123
50-54	12,160	73	.0608	.0180	10,490	57	.0657	.0156
55-59	7,940	83	.0663	.0228	6,070	64	.0728	.0202
60-64	8,770	127	.0746	.0272	6,970	94	.0783	.0237
65-69	4,390	77	.0965	.0354	3,250	36	.1054	.0311
70-74	4,680	131	.0982	.0439	3,290	87	.1016	.0411
75+	4,560	274	.2029	.0602	3,150	178	.2045	.0565

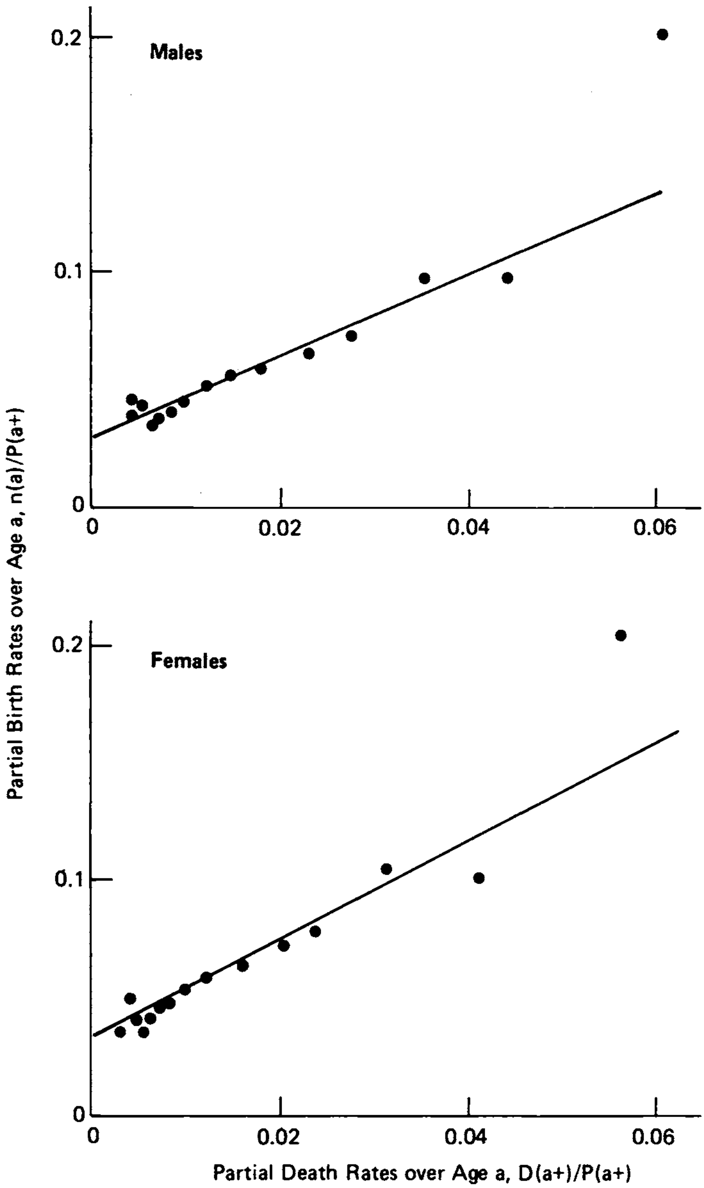


FIGURE 4 Partial birth and death rates over successive ages by sex, from BRSFM 1974: Bangladesh.

TABLE 30 Estimates of the Completeness of Death Recording and Rate of Natural Increase, from BRSFM 1974: Bangladesh

Sex	Completeness of Death Recording	Rate of Natural Increase (percent)
Male	0.570	2.92
Female	0.475	3.29

males and 0.97 for females, very similar to the values from the PGE. The intercepts are different, however, suggesting an overall decline in mortality between the ages of 5 and 65 during the period.

It can also be noted that the deviations of the observed points from the fitted lines are very similar, by sex, in Figures 3 and 5. For females, survival to age 10 or 15 is higher than in the model; then there is a period of excess mortality in the age range 15 to 30, followed by a period of lower-than-expected mortality between 40 and 50 or 55, after which mortality appears to increase more rapidly than in the model. For males, there seems to be a period of lower-than-expected mortality between 25 and 45, after which mortality again appears to increase more rapidly than is suggested by the model. It may be that these similarities between the patterns estimated from the PGE and BRSFM arise from similarities in errors, but it is suggestive of the possibility that the age pattern of mortality in Bangladesh may really differ from that of the model, that the period of excess female mortality coincides with the age range in which fertility is highest, during which maternal mortality would also be most important. The "North" model life table should therefore be regarded as only an approximation to the true age pattern of mortality.

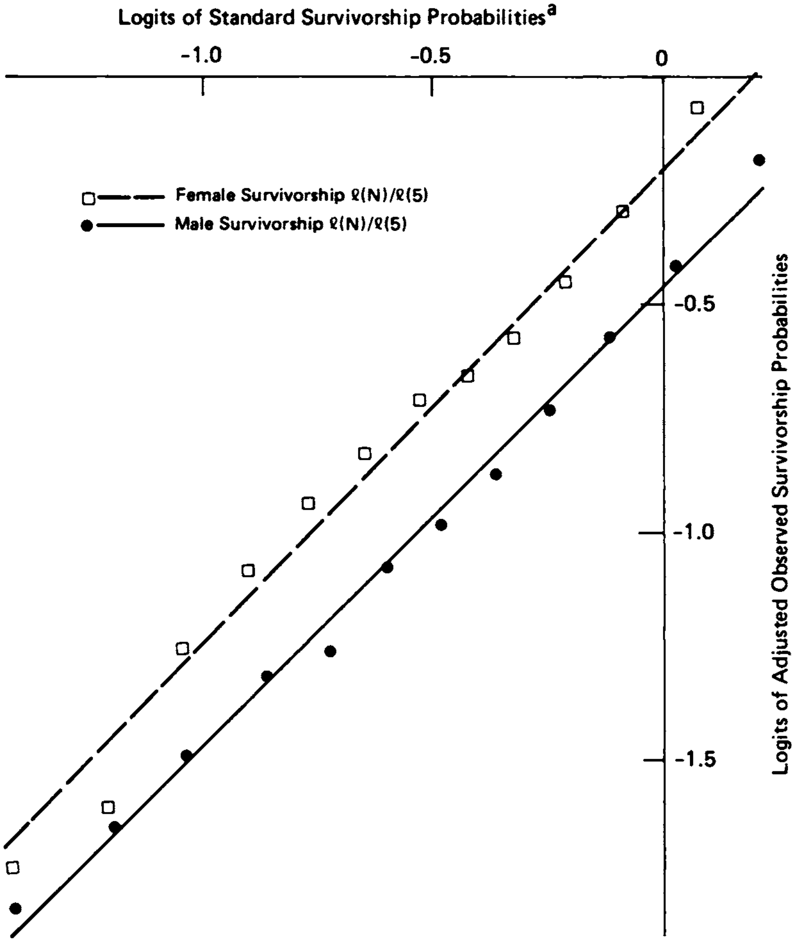
Once again, the life tables over age 5 can be completed by adding a section for birth to age 5, in this case derived from the child mortality estimates presented in Table 27. Since there is no evidence that child mortality was changing in the years prior to 1974, there is no need to take into account the differences in the reference periods of the estimates. Values of l(1) and l(5) have been taken from "North" model life tables of level 11.0 for females and 11.3 for males, and the smoothed survivorship probabilities from age 5 have been

TABLE 31 Smoothing the Adjusted Age-Specific Mortality Rates from the BRSFM (1974), Using the Logit Transformation: Bangladesh

	Males					Females				
Age x	Adjusted Death Rate $_5m_x$	$_5q_x$	l_x	Logit l_x	Standard ls_x	Adjusted Death Rate $_5m_x$	$_5q_x$	l_x	Logit l_x	Standard ls_x
5	.00327	.0162	1.0000	--	--	.00536	.0265	1.0000	--	--
10	.00231	.0115	.9838	-2.0527	-1.4300	.00330	.0164	.9735	-1.8027	-1.4403
15	.00278	.0138	.9725	-1.7828	-1.2157	.00588	.0290	.9576	-1.5589	-1.2205
20	.00232	.0115	.9591	-1.5772	-1.0452	.00422	.0209	.9299	-1.2922	-1.0565
25	.00281	.0140	.9480	-1.4517	-0.8672	.00417	.0206	.9104	-1.1595	-0.9119
30	.00260	.0129	.9348	-1.3312	-0.7242	.00658	.0324	.8916	-1.0538	-0.7795
35	.00328	.0163	.9227	-1.2399	-0.6011	.00491	.0243	.8638	-0.9194	-0.6548
40	.00480	.0237	.9077	-1.1430	-0.4845	.00508	.0251	.8419	-0.8361	-0.5366
45	.00745	.0366	.8862	-1.0261	-0.3659	.00619	.0305	.8208	-0.7607	-0.4267
50	.01057	.0515	.8538	-0.8823	-0.2440	.01147	.0558	.7958	-0.6800	-0.3234
55	.01826	.0873	.8098	-0.7244	-0.1126	.02220	.1052	.7514	-0.5530	-0.2121
60	.02534	.1191	.7391	-0.5207	.0346	.02851	.1331	.6724	-0.3594	-0.0813
65			.6511	-0.3119	.2105			.5829	-0.1673	.0826
70					.4300					.2940
75					.7235					.5722
80					1.1187					.9367

Fitted line for males: $\alpha = -0.611$, $\beta = .980$. See Figure 5.

Fitted line for females: $\alpha = -0.317$, $\beta = .970$. See Figure 5.



[a]From Coale-Demeny "North" family, mortality level 10.

FIGURE 5 Plots of logit transformations of adjusted and standard survivorship functions from age 5 by sex, from BRSFM 1974: Bangladesh.

grafted onto these bases. The resulting composite life tables are shown in Table 32. Expectation of life at birth has increased by 3 years for males and by 2.1 years for females relative to the PGE estimates, almost entirely as a result of the apparent decline in mortality over age 5. The male-female differential in expectation of life at birth has also increased from one year to almost two years.

Further information about the level of adult mortality is available from the data on the survival of the mother and father of each respondent and on the survival of the first spouse of each ever-married respondent. Techniques based on models have been developed to convert proportions with surviving parents or spouses into life

TABLE 32 Composite Life Tables by Sex, BRSFM 1974: Bangladesh

	Males		Females	
Age x	l(x)	q(x)	l(x)	q(x)
0	1.000	.1474	1.000	.1293
1	.853	.1119	.871	.1104
5	.757	.0176	.775	.0314
10	.744	.0091	.750	.0164
15	.737	.0104	.738	.0174
20	.729	.0150	.725	.0203
25	.719	.0163	.710	.0237
30	.707	.0178	.694	.0279
35	.694	.0209	.674	.0323
40	.680	.0261	.652	.0361
45	.662	.0328	.629	.0401
50	.640	.0434	.604	.0505
55	.612	.0601	.573	.0699
60	.576	.0898	.533	.1045
65	.524	.1421	.477	.1629
70	.450	.2401	.400	.2573
75	.342	.3910	.297	.3881
80	.208	--	.182	--
Life Expectancy at Birth (e_0)	51.6		49.7	
Life Expectancy at Age 10 (e_{10})	58.9		55.7	

table survivorship probabilities by allowing for the effects of non-mortality factors such as the age pattern of fertility or mortality (Brass and Hill, 1973; Hill, 1977; Hill and Trussell, 1977). New and, it is hoped, improved techniques of analysis have recently been developed for each of these types of data except survival of father, and the new techniques (Hill et al, 1981) have been used here. In the case of survival of father, the original methodology was used, but the calculations were repeated for respondents of both sexes, rather than just females, to which the analysis was limited in the Survey Report (Blacker, 1977).

Orphanhood Data

Table 33 shows the estimates of female adult survivorship derived from information on survival of mother, and Table 34 shows the corresponding estimates of male mortality. Once again, the logit transformation provides a method for examining the consistency of the estimates with survivorship probabilities from model life tables; model tables of mortality level 10 from the "North" family were used as the reference standard. Figure 6 shows the logit transformations of estimated survivorship probabilities plotted against those of the standard.

For both males and females, the points in Figure 6 lie approximately on straight lines, if the point for the oldest age group is excluded in each case. However, the parameters of the straight lines--a slope of 1.28 and intercept of -0.195 for males and a slope of 1.16 and intercept of -0.050 for females--are not even remotely consistent with those estimated in Figure 5 from corrected deaths; the estimates based on orphanhood data indicate both generally heavier mortality and an age pattern in which mortality increases much more rapidly with age.

Both these inconsistencies could be explained by changes in adult mortality over the period during which the deaths were occurring among the respondents' parents. For both fathers and mothers, the age range of respondents for whom data were used was 15 to 49, which means that the exposure periods for the parents at risk ranged from 15 to 50 years before the survey. If adult mortality had been changing, the estimates of mortality derived from orphanhood data would refer to times in the past, and as age of respondent increases, the reference

TABLE 33 Estimates of Female Adult Survivorship from Data on Survival of Mother, BRSFM 1974: Bangladesh

Age Group of Respondent	Proportion with Surviving Mother	N	l(25 + N) / l(25)	Logit l(25 + N) / l(25)	Standard Logit l(25 + N) / l(25)
15-19	.9064	20	.9014	-1.1063	-.7397
20-24	.8585	25	.8565	-0.8933	-.5825
25-29	.7698	30	.7716	-0.6087	-.4285
30-34	.6579	35	.6623	-0.3368	-.2614
35-39	.5355	40	.5384	-0.0770	-.0658
40-44	.4190	45	.4142	0.1733	.1722
45-49	.3175	50	.3008	0.4218	.4710

Mean age at childbearing for mothers in the population = 27.1 years.

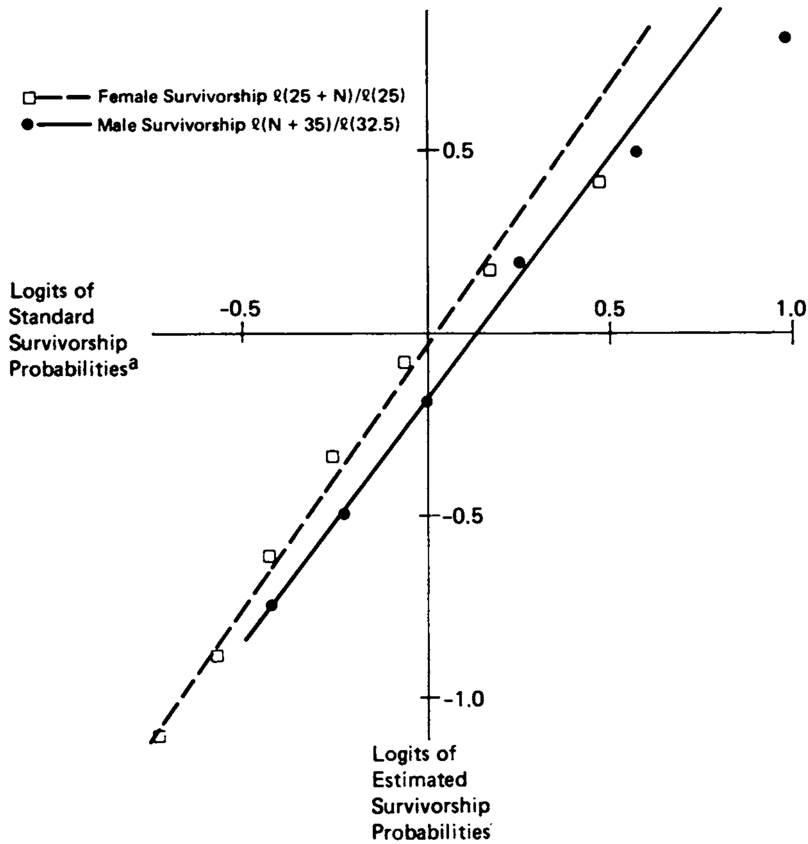
TABLE 34 Estimates of Male Adult Survivorship from Data on Survival of Father, BRSFM 1974: Bangladesh

Age Group of Respondent	Proportion with Surviving Father	N	l(N + 35) / l(32.5)	Logit l(N + 35) / 32.5	Standard Logit ls(N + 35) / ls(32.5)
15-19	.8172	20	.8145	-.7396	-.4344
20-24	.7289	25	.7298	-.4969	-.2269
25-29	.5971	30	.5971	-.1967	-.0040
30-34	.4498	35	.4228	.1556	.2518
35-39	.3261	40	.2669	.5053	.5728
40-44	.2122	45	.1568	.8411	.9859
45-49	.1477	--	--	--	--

Mean age at childbearing for fathers in the population = 36 years.

time would recede further into the past. Thus if adult mortality had been declining, estimates based on reports of older respondents would reflect higher and higher average mortality risks; even the difference in slope by sex would be explained if male adult mortality had declined faster than female adult mortality.

If assumptions are made about the regularity of mortality trends in the past, it is theoretically possible to identify the "time ago" of a period life



[a]From Coale-Demeny "North" family, mortality level 10.

FIGURE 6 Plots of logit transformations of standard survivorship probabilities against those estimated from orphanhood data, BRSFM 1974: Bangladesh.

table that has the survivorship probabilities implied by different indirect mortality estimators. Brass (1980) has recently developed a method for converting data on proportions with mother surviving in each age group into estimates of female survival from age 25 to age 60, l(60)/l(25), and for estimating the length of time before the survey of the period life table having each value of l(60)/l(25). The method has been applied to the maternal survivorship data from the BRSFM, and the results are shown in Table 35. Brass has also developed a method for

TABLE 35 Survivorship Estimates and Their Time Location, Derived from Data on Survival of Mother, BRSFM 1974: Bangladesh

Age Group of Respondent	Estimates of Female Survival from Age 25 to Age 60 l(60/l(25)	Reference Period t* (years before survey)
15-19	.748	7.7
20-24	.736	9.5
25-29	.696	11.2
30-34	.662	13.1
35-39	.645	14.8
40-44	.647	16.4
45-49	.674	17.2

Source: Brass (1980).

estimating the time location of measures of male mortality obtained from data on survival of father, but since the estimates do not resolve the problems inherent in the results obtained, they are not presented here.

The estimates suggest that female adult mortality fell quite sharply over the period 15 years to 8 years before the survey. From that point up to the survey, however, it seems to have remained steady. The estimate for the period 7.7 years before the survey is 0.748, which matches closely an estimate of 0.751 from the BRSFM female life table (Table 32) that has a reference date of half a year before the survey. The adjusted PGE female life table (Table 26), which refers to the period approximately 9.7 years before the BRSFM, is less consistent with the "dated" orphanhood estimate, the value of l(60)/l(25) being 0.704, compared with the orphanhood-based estimate of 0.736 for 9.5 years before the survey.

Once put in an appropriate time frame, therefore, the female adult mortality estimates derived from data on survival of mother seem to indicate somewhat lower mortality than the adjusted age-specific death rates used to derive the life tables summarized in Tables 26 and 32. In view of uncertainties about the accuracy of parental survival data, the mortality levels summarized in the life tables are preferred to the lower mortality estimates indicated by maternal orphanhood. Unfortunately, no technique has yet been developed for estimating the reference period of male survivorship probabilities obtained from data on survival of father.

Widowhood Data

Table 36 shows estimates of female adult mortality derived from information on survival of first wife by age of male respondent, and Table 37 shows estimates of male adult mortality derived from information on survival of first husband by age of female respondent. Brass has developed a procedure for estimating the reference period of mortality estimates derived from widowhood data, but since the results do not resolve any of the problems posed by the estimates, they have not been included here.

The logit transformation can again be used as a way of looking at the consistency of the estimates; the results are shown in Figure 7. The first two female mortality points, based on data from male respondents aged 25 to 34, show unrealistically heavy mortality, though the remaining points do fall on a reasonably straight line; a line fitted by group means has a slope of 0.98, similar to other estimates, and an intercept of -0.092, indicating heavier female adult mortality than other estimates. Given the lack of adjustment for reference period, which ought to affect the estimates, it is surprising that the slope is close to unity. It seems likely that a tendency on the part of older male respondents to overreport surviving first wives has counterbalanced the heavier mortality risks such wives should have experienced, and the result is a not implausible age pattern of survivorship.

The estimates of male adult mortality are somewhat erratic, especially for respondents in their 20s, but they do lie around a straight line. Once again, a line has been fitted to group means, using points for respondents over 30, the line having a slope of 1.22 and intercept 0.04. Thus for female respondents, the expected pattern of higher estimates of mortality from the older respondents does appear. It may be noticed in passing that the overall level of the male adult mortality estimates based on widowhood is higher than that of the estimates based on survival of father, despite a reference period that would be closer to the present; thus, it seems likely that the number of surviving fathers has been exaggerated.

In conclusion, it may be said that the performance of

TABLE 36 Estimates of Female Adult Survivorship from Data on Survival of First Wife, BRSFM 1974: Bangladesh

Age Group of Male Respondents	Proportion with Surviving First Wife	N	l(N) / l(20)	Logit l(N) / l(20)	Standard Logit ls(N) / ls(20)
25-29	.9526	25	.9498	-1.4701	-1.6600
30-34	.9316	30	.9152	-1.1894	-1.2641
35-39	.9150	35	.8961	-1.0773	-1.0088
40-44	.8763	40	.8518	-0.8744	-0.8117
45-49	.8409	45	.8133	-0.7358	-0.6506
50-54	.7916	50	.7577	-0.5701	-0.5117
55-59	.7586	55	.7177	-0.4665	-0.3712

Singulate mean ages at marriage: male = 24.33 years, female = 16.37 years.

TABLE 37 Estimates of Male Adult Survivorship from Data on Survival of First Husband, BRSFM 1974: Bangladesh

Age Group of Female Respondents	Proportion with Surviving First Husband	N	l(N) / l(20)	Logit l(N) / l(20)	Standard Logit ls(N) / ls(20)
20-24	.9583	25	.9667	-1.6842	-1.5282
25-29	.9408	30	.9520	-1.4937	-1.1560
30-34	.8948	35	.8889	-1.0398	-0.9244
35-39	.8386	40	.8609	-0.9114	-0.7399
40-44	.7507	45	.7832	-0.6422	-0.5727
45-49	.6765	50	.7259	-0.4870	-0.4147
50-54	.5452	55	.6153	-0.2348	-0.2551
55-59	.4394	60	.5326	-0.0653	-0.0850

Singulate mean ages at marriage: male = 24.33 years, female = 16.37 years.

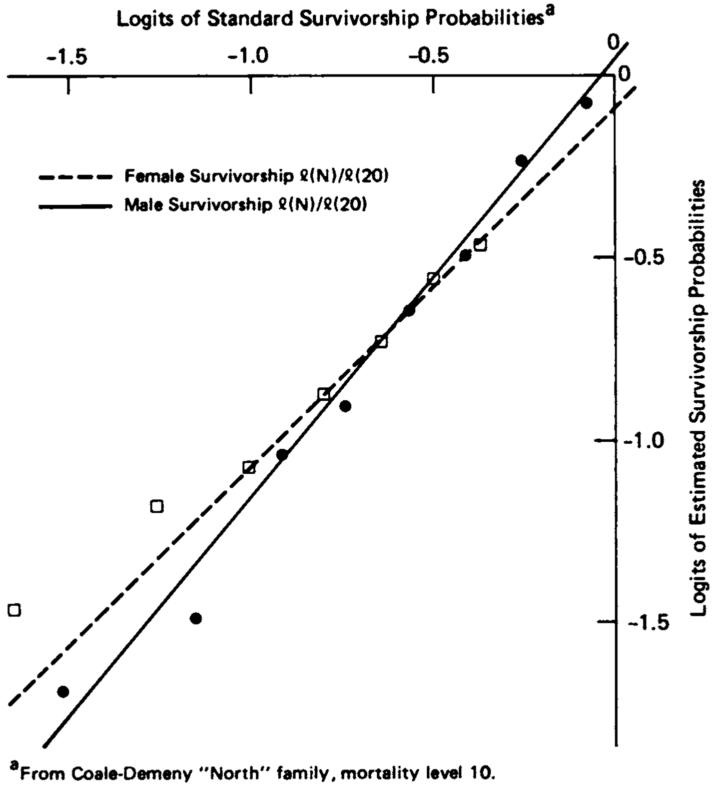


FIGURE 7 Plots of logit transformations of standard survivorship probabilities from age 20 against those estimated from widowhood data, BRSFM 1974: Bangladesh.

the indirect procedures for estimating adult mortality is disappointing, partly because of the effects of changes in adult mortality during the reference period and partly because of shortcomings of the data.

THE BANGLADESH FERTILITY SURVEY (BFS)

The fertility histories collected by the BFS make possible the estimation of child mortality both directly, by relating the deaths of children born in a particular year to all the births recorded in that year, and indirectly, by analyzing the information on the proportion dead among children ever born at the time of the survey.

Table 38 shows the number of births for each calendar year from 1960 to 1974 and the number of deaths occurring to those births by ages 1, 2, and 5. For each year, a life table survivorship function l(x), for values of x of 1, 2, and 5, has been calculated for that year's birth cohort. (For recent years, of course, the life tables are incomplete, since not all the children have reached the relevant ages.) There is little indication of a sustained trend in child mortality over the period, although the heaviest mortality is for the years 1961 and 1962; thereafter, despite some fluctuations the level remains essentially constant through to the early 1970s. The age pattern of child mortality, with higher risks between ages 2 and 5 than between 1 and 2 in all cases, provides a further indication that "North" model life tables are the best representation of Bangladeshi mortality among the Coale-Demeny regional families,

TABLE 38 Direct Estimates of Infant and Child Survivorship Probabilities from Fertility Histories, BFS 1976: Bangladesh

Year	Number of Births	Number of Deaths			Survivorship Probabilities		
		Under 1	Under 2	Under 5	l(1)	l(2)	l(5)
1960	775	117	137	170	.849	.823	.781
1961	867	154	178	223	.822	.795	.743
1962	892	157	171	215	.824	.808	.759
1963	1,016	145	169	207	.857	.834	.796
1964	1,116	160	182	247	.857	.837	.779
1965	1,158	163	183	236	.859	.842	.796
1966	1,333	181	224	291	.864	.832	.782
1967	1,310	176	220	286	.866	.845	.798
1968	1,403	177	203	275	.874	.855	.804
1969	1,418	182	214	305	.872	.849	.785
1970	1,481	200	246	325	.865	.834	.780
1971	1,486	207	253	*	.861	.830	*
1972	1,282	185	226	*	.856	.824	*
1973	1,335	196	227	*	.853	.830	*
1974	1,304	156	*	*	.880	*	*

*Not calculated because not all children in the group would have been exposed to the risk of dying for the full age range.

TABLE 39 Child Mortality Estimates Derived from Data on Children Dead Among Those Ever Born, BFS 1976: Bangladesh

Age Group of Women	Proportion of Children Dead	Age x	Probability of Dying by Age x q(x)	Time Reference of Estimate (years before survey) t*	Mortality Level Implied[a]	Equivalent Infant Mortality Rate[a] (per thousand)
20-24	.2054	2	.1874	2.80	10.2	152
25-29	.2305	3	.2104	4.69	11.0	141
30-34	.2385	5	.2308	6.85	11.9	129

Note: Average parity ratios used in applying the child mortality estimation procedure: P(1)/P(2) = 0.2540, P(2)/P(3) = 0.5552.

[a]From Coale-Demeny "North" model life tables.

though the observed $_1q_1$ is rather low relative to the infant mortality rate $_1q_0$.

Table 39 shows the estimation of child mortality from the proportions dead among children ever born, using Trussell's procedure (Hill et al., 1981), outlined above. The estimates by age group are not remarkably consistent, implying mortality levels ranging from 10.2 to 11.9 and infant mortality rates ranging from 129 per thousand to 152 per thousand; however, the variations are not surprising in view of the real fluctuations in child mortality from year to year. The general level of the estimates is consistent with the results of the BRSFM (Table 27) and with the year-by-year estimates from the BFS, shown in Table 38.

THE CHOLERA RESEARCH LABORATORY (CRL)

The CRL's Demographic Surveillance System in Matlab thana provides a wealth of mortality data for this area of Bangladesh, though the levels and patterns of mortality are less likely to be representative of the country as a whole than are those of fertility, given the above-average medical services available there. Table 40 shows crude death rates and infant mortality rates for the period 1966-77. The rates show clearly the impact of natural disasters and political events during the period, with very high mortality in 1971-72, during the War of Liberation, and again in 1975, after the 1974 famine. In general, the Matlab data indicate a slightly lower mortality level than that estimated for the country as a whole, but show no sign of any marked trend over time.

The Demographic Surveillance System in Teknaf thana gives mortality estimates for the period 1976-77, the infant mortality rate being 161 for males and 155 for females, the crude death rate being 16.1 for males and 16.9 for females (Rahman et al., 1980). These estimates are very consistent with the general level of mortality found for Bangladesh as a whole, though of course Teknaf cannot be regarded as representative of the whole country.

TABLE 40 Crude Death Rates and Infant Mortality Rates, from CRL 1966-77: Matlab Thana, Bangladesh

Period	Crude Death Rate (per thousand)	Infant Mortality Rate (per thousand)
1966-67	15.0	111
1967-68	16.6	125
1968-69	15.0	124
1969-70	14.9	128
1970-71	14.8	131
1971-72	21.0	147
1972-73	16.2	128
1973-74	14.2	not available
1974	16.5	138
1975	20.8	174
1976	14.8	112
1977	13.6	114

Source: Chowdhury and Sheikh (1980).

SUMMARY

Child Mortality

Most information about child mortality in Bangladesh comes in the form of reports by women on the survival of their children. Pregnancy history surveys from the DSEP, NIS, and BFS provide this information in such a way that it can either be aggregated into proportions dead by age of woman at the time of the survey or disaggregated into births and child deaths by period. Simpler retrospective surveys, such as the BRSFM, provide only the aggregated information. Additional information about child mortality is available from the adjusted sample registration of the PGE and unadjusted registration in a small study area, part of Matlab thana in central southern Bangladesh.

The estimates available are all remarkably consistent, with the single exception of those derived from the NIS data. The infant mortality rate seems to have been somewhere in the neighborhood of 130 to 160 per thousand from the mid-1950s to the mid-1970s. There is some variation from year to year but little sign of an underlying trend, though there is some indication that child mortality may have fallen in the early 1950s. Child mortality between the ages of 1 and 4 seems to be fairly high relative to infant mortality. Lower female mortality in infancy seems to be reversed between the ages of 1 and 4. Estimates of infant mortality from the Matlab study area are somewhat lower than those obtained for the country as a whole, but again show no obvious trend.

Adult Mortality

Estimates of adult mortality in Bangladesh are based either upon registered or recorded deaths by age or upon reports on the survival of close relatives, specifically parents or spouses. The completeness of death reporting can be tested by comparing the age distribution of deaths with that of the population, and the reported deaths can be adjusted by the estimate of completeness prior to smoothing and calculation of life tables. Such a test for completeness indicated that the number of deaths reported by the PGE, after adjustment for omission, was somewhat too high and that the number recorded by the BRSFM as occurring in the 12 months before the survey was substantially too low. After correction, the two sources gave rather similar mortality estimates, though indicating that adult mortality had declined somewhat from 1964-65 to 1973-74, the decline for males being somewhat larger than that for females.

The mortality estimates derived from information on the survival of near relatives were less satisfactory because they were less internally consistent and because of uncertainties about the time period to which they refer. When the reference period of adult female mortality estimates derived from data on survival of mother was taken into account, the estimates were seen to be rather lower than those available from other sources for similar periods. The adult mortality estimates based on adjusted recorded deaths from the PGE were therefore preferred.

Overall Mortality

The final life tables (Tables 26 and 32) show the expectation of life at birth rising from 48.6 to 51.6 for males and from 47.6 to 49.6 for females over the period 1964-65 to 1973-74. Over the same period, expectation of life at age 10 rose from 56.0 to 58.9 for males, and from 53.1 to 55.7 for females. These life tables should probably be regarded as embodying minimum estimates of mortality in Bangladesh, because the methods used are believed to underestimate rather than overestimate.

5 Regional Variation in Fertility and Mortality

Very little information is available on regional variation in fertility and mortality in Bangladesh. The population censuses provide a substantial amount of data on age and sex distributions for geographical subdivisions of the country, but little demographic use can be made of these distributions because of the distortions introduced by internal migration. Of the major demographic surveys, the PGE and NIS provide no regional estimates within Bangladesh, and the BFS sample is too small to provide estimates for the four divisions of the country. Thus the only source of regional estimates of fertility and mortality are the BRSFM and 1974 census data on children ever born by age of mother.

Table 41 shows the average number of children ever born per woman by age group and division from the BRSFM and the 1974 census; the rank of each division with respect to each value is also shown. Although the parity levels recorded by the BRSFM and by the census are not very consistent, the differentials by division, and hence their ranks, are consistent, though they are not very large. It appears that fertility is highest in Rajshahi, closely followed by Khulna; it is somewhat lower in Dacca, and lowest in Chittagong. It should be remembered that parities for older women are almost certainly too low as a result of omission; for this reason, not too much weight should be put on differentials among women

TABLE 41 Average Parity by Age Group and Division, from BRSFM (1974) and 1974 Census: Bangladesh

Parity Measures by Division	Data Source	Age Group of Woman 15-19	20-24	25-29	30-34	35-39	40-44	45-49
Average Parity								
Rajshahi	BRSFM	0.466	2.027	3.635	5.024	5.983	6.291	5.950
	Census	0.618	2.050	3.475	4.797	5.742	5.996	6.165
Khulna	BRSFM	0.399	1.844	3.529	4.979	5.948	6.329	6.196
	Census	0.563	1.983	3.429	4.759	5.738	5.995	6.279
Dacca	BRSFM	0.374	1.789	3.445	5.025	5.946	6.261	6.261
	Census	0.459	1.764	3.193	4.531	5.502	5.875	6.092
Chittagong	BRSFM	0.313	1.748	3.357	4.676	5.592	5.926	5.909
	Census	0.406	1.664	3.038	4.257	5.164	5.411	5.684
Parity Rank								
Rajshahi	BRSFM	1	1	1	2	1	2	3
	Census	1	1	1	1	1	1	2
Khulna	BRSFM	2	2	2	3	2	1	2
	Census	2	2	2	2	2	2	1
Dacca	BRSFM	3	3	3	1	3	3	1
	Census	3	3	3	3	3	3	3
Chittagong	BRSFM	4	4	4	4	4	4	4
	Census	4	4	4	4	4	4	4

over 35, because they may reflect differential degrees of omission rather than real differentials in fertility.

It is interesting to note in passing that fertility in Comilla district, where the Cholera Research Laboratory is situated, is somewhat below the national average, according to the evidence available. The average parity of women aged 30 to 34 was 4.295 in Comilla, some 6 percent below the national average of 4.563. The area of central Bangladesh covered by the Demographic Survey of East Pakistan, on the other hand, had fertility levels similar to the national average; weighting the 1974 census parities for the districts covered by the DSEP by the 1961 district populations gives an average parity for women aged 30 to 34 of 4.452, only 2 percent below the national average.

The only information available on variations in mortality by region comes from the child survival data from the BRSFM. Child mortality estimates were obtained by applying the Trussell procedure (Hill et al., 1981) to the observed proportions of children dead by age group of mother. The results are summarized in Table 42 in the form of average mortality level in the Coale-Demeny "North" family. On the basis of this evidence, there seems to be very little variation by division in the level of child mortality.

TABLE 42 Child Mortality Levels by Division, Estimated from Proportion Dead Among Children Ever Born, BRSFM 1974: Bangladesh

	Mortality Level in Coale-Demeny Model Life Table[a]	
Division	Males	Females
Rajshahi	11.7	11.2
Khulna	11.3	10.8
Dacca	11.1	11.1
Chittagong	11.2	10.7

[a]Obtained as the average of the levels of the mortality estimates derived from the proportion dead among children ever borne by women in the age groups 20-24, 25-29, and 30-34.

6 Population Growth in Bangladesh

The fertility and mortality rates estimated in earlier sections can be used, together with an age distribution, to calculate crude birth and death rates, which in turn imply a rate of natural increase of the population. However, distortions in the reported age distributions would affect the crude rates thus estimated--especially the death rate, since age reporting is apparently worst in the age categories where mortality rates are highest, in early childhood and old age. To minimize this problem, the reported age distributions from the PGE and the BRSFM were smoothed, as described below. Crude birth and death rates were then calculated by applying estimated age-specific fertility and mortality rates to the adjusted age distributions.

The smoothing procedure used was based on the relationships between the cumulated observed age distributions and cumulated stable population age distributions calculated from the composite life tables for 1964-65 and 1974 (Tables 26 and 32), together with an assumed population growth rate of 3 percent. For both cumulated age distributions, the proportions under successive ages--$p^{o}(a)$ for the observed distribution and $p^{m}(a)$ for the model distribution-- were transformed using the linearizing transformation

$$\rho a = \log_e \left[\frac{1 + p(a)}{1 - p(a)}\right].$$

For each value of a, the value of b necessary to satisfy the relationship

$$\rho^{o}(a) = b\ \rho^{m}(a)$$

was calculated. The average value of b across all values of a for which b was reasonably constant was then used to obtain smoothed proportions under each age a.

The results produced age distributions rather similar to those observed, as may be seen in Figure 8, which plots the relative differences in the proportions in each five-year age group by sex for both the PGE and the BRSFM age distributions. The proportions in each age group in the smoothed populations are shown in Table 43.

Crude death rates were calculated for the smoothed age distributions by applying to them the age-specific mortality rates implied by the life tables derived earlier (Tables 26 and 32). Crude birth rates were also calculated, the number of births being obtained by applying estimated age-specific fertility rates to the smoothed female age distributions, and the total population being obtained by taking the observed sex ratios of the surveyed populations. (For the PGE, the age-specific fertility rates used were those based on the adjusted CD births for 1964-65, from Table 9; for the BRSFM, they were those derived after adjustment by P/F ratios, from Table 13.) Birth rates by sex were obtained by assuming a sex ratio at birth of 1.05 males per female. Results are shown in Table 44.

The death rate is estimated to have declined by about 1 per 1,000 over the decade and the birth rate to have declined by about 2 per 1,000, allowing the rate of natural increase to fall by about 1 per 1,000. However, the change in the birth rate comes about almost entirely because the PGE age pattern of fertility is younger than that from the BRSFM; had the BRSFM fertility rates been used in calculating the PGE birth rate, the overall birth rate in 1964-65 would have been 50.9 instead of 52.6, and the change over the decade would have been negligible.

The population growth rates shown in Table 44 are extremely high, particularly for the 1964-65 period. Rates estimated in other ways are all significantly lower. Growth of the enumerated Muslim population between 1961 and 1974 was 3.05 percent for males and 3.08 percent for females. The growth rates obtained from the stable population analysis of the 1961 and 1974 Muslim age distributions work out to 2.26 and 2.42 for males and

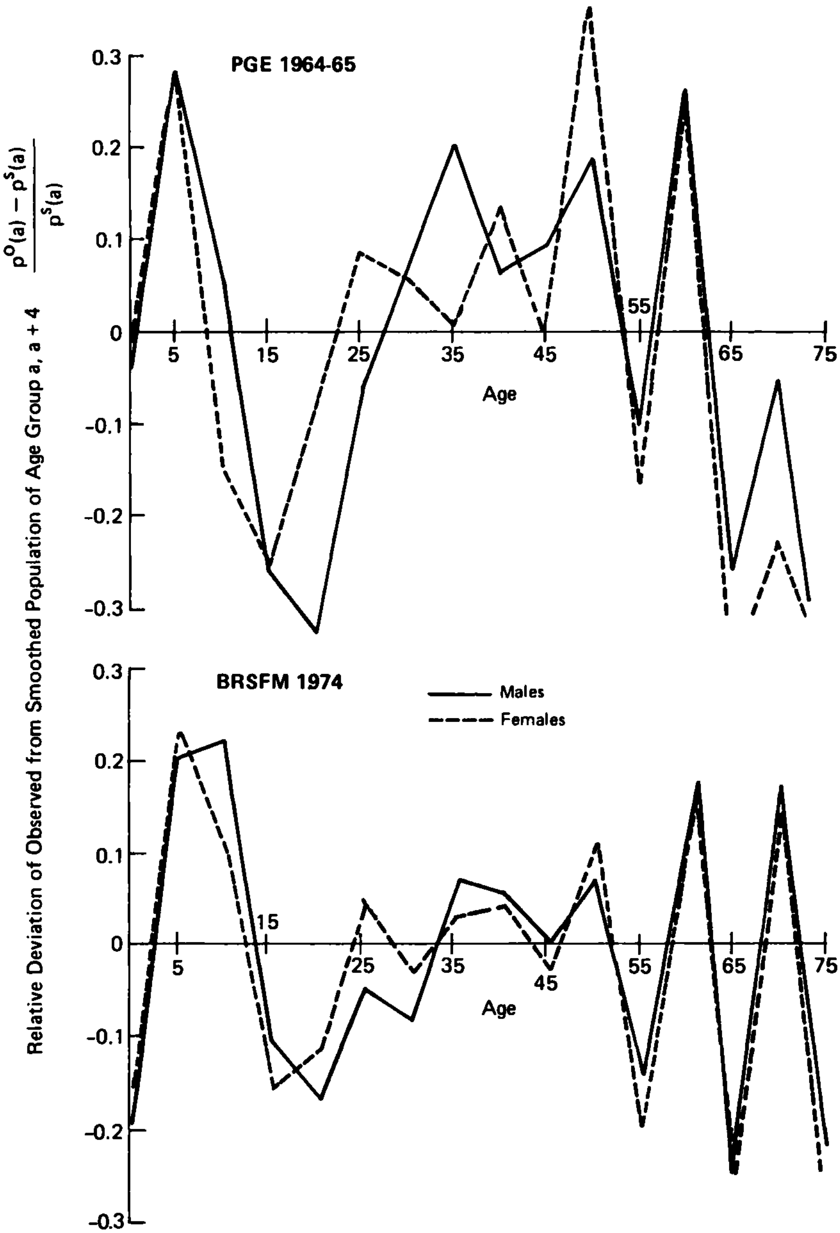


FIGURE 8 Relative deviations of observed age distributions from smoothed age distributions, 1964-65 and 1974: Bangladesh.

TABLE 43 Proportions in Each Age Group by Sex in Smoothed Age Distributions for 1964-65 and 1974: Bangladesh

Age Group	1964-65		1974	
	Males	Females	Males	Females
Under 1	.0412	.0438	.0412	.0437
1-4	.1346	.1439	.1346	.1435
5-9	.1400	.1471	.1390	.1467
10-14	.1189	.1232	.1181	.1227
15-19	.1016	.1039	.1008	.1033
20-24	.0865	.0872	.0859	.0866
25-29	.0734	.0729	.0730	.0725
30-34	.0621	.0606	.0618	.0603
35-39	.0525	.0502	.0523	.0499
40-44	.0441	.0413	.0440	.0412
45-49	.0368	.0337	.0369	.0339
50-54	.0305	.0274	.0307	.0275
55-59	.0247	.0217	.0250	.0221
60-64	.0195	.0167	.0201	.0172
65-69	.0146	.0120	.0153	.0126
70-74	.0099	.0078	.0108	.0085
75-79	.0058	.0043	.0065	.0050
80+	.0033	.0023	.0040	.0028

TABLE 44 Crude Death Rates, Crude Birth Rates, and Rates of Population Growth, 1964-65 and 1974: Bangladesh

	1964-65			1974		
	Males	Females	Total	Males	Females	Total
Crude Birth Rate	52.2	53.0	52.6	49.8	51.0	50.4
Crude Death Rate	18.3	18.0	18.2	16.6	17.1	16.8
Rate of Natural Increase	33.9	35.0	34.4	33.2	33.9	33.6

Note: All rates are per thousand.

2.79 and 2.82 for females. The growth-balance assessment of the age distribution of deaths gave growth rate estimates of 2.92 and 3.06 for males and females, respectively, for 1964-65 and 2.92 and 3.36 for males and females, respectively, for 1974. The smoothing procedure applied to the 1964-65 and 1974 age distributions showed that the male populations were slightly older than stable populations based on the estimated life tables and rates of growth of 3 percent, whereas the female populations were slightly younger, suggesting male growth rates slightly below 3 percent and female growth rates slightly above 3 percent. Between 1964-65 and 1974, both the male and female populations changed slightly in the direction of younger age distributions, relative to the stable population standards, suggesting in both instances a slight increase in the rate of population growth.

There are thus some rather serious inconsistencies between the growth rate estimates obtained by combining fertility and mortality estimates and those available from other sources. For the early 1960s, the possibilities range from 2.3 to 3.4 percent for males and from 2.8 to 3.5 percent for females; for the mid-1970s, the ranges are 2.4 to 3.3 percent for males and 2.8 to 3.4 percent for females. The estimates derived from stable population analysis are implausibly low, particularly for males, falling well below the observed intercensal rate of increase of the Muslim population. The estimates obtained for 1964-65 by combining the fertility and mortality estimates are, on the other hand, implausibly high, the birth rates being excessive. It is also possible that mortality has been somewhat underestimated in both 1964-65 and 1974, tending to inflate the calculated rate of natural increase for both periods.

On the basis of the evidence available, it is not possible to give a definitive figure for the growth rate. It is probable that the growth rate increased slightly between 1964-65 and 1974, with essentially constant fertility and child mortality but some decline in adult mortality. It is also probable that the growth rate of the female population was somewhat greater than that of the male population, despite heavier overall mortality, because of age distribution effects brought about by sex differences in the age pattern of mortality. The growth rate for males was probably in the range of 2.8 to 3.0 percent in the mid-1960s and probably increased to somewhere in the range of 2.9 to 3.2 percent by the mid-1970s; for females, comparable ranges are 2.9 to 3.1 percent and 3.0 to 3.2 percent. The growth rate had probably risen rapidly in the early and mid-1950s, as child mortality declined fairly rapidly. The increase in the growth rate during the late 1950s and early 1960s was probably rather slow and changed at all only as a result of continuing declines in adult mortality.

Glossary

AGE HEAPING A tendency for enumerators or respondents to report certain ages instead of others; also called age preference or digit preference. Preference for ages ending in 0 or 5 is widespread.

AGE PATTERN OF FERTILITY The relative distribution of a set of age-specific fertility rates. It expresses the relative contribution of each age group to total fertility.

AGE RATIO The ratio of the population in a given age group to the average of the populations in the two neighboring age groups, times 100.

AGE-SPECIFIC FERTILITY RATE The number of births occurring during a specified period to women of a specified age or age group, divided by the number of person-years-lived during that period by women of that age or age group. When an age-specific fertility rate is calculated for a calendar year, the number of births to women of the specified age is usually divided by the midyear population of women of that age.

AGE-SPECIFIC MORTALITY RATE The number of deaths occurring during a specified period to persons (usually specified by sex) of a specified age or age group, divided by the number of person-years-lived during that period by the persons of that age or age group. When an age-specific mortality rate is calculated for a calendar year, the number of deaths to persons of the specified age is usually divided by the midyear population of persons of that age. Age-specific mortality rates are generally denoted by ${}_nM_x$, the annual death rate to persons aged x to x + n.

AGE STANDARDIZATION A procedure of adjustment of crude rates (birth, death, or other rates) designed to reduce the effect of differences in age structure when comparing rates for different populations.

BIRTH HISTORY A report of the number and dates of all live births experienced by a particular woman; see also pregnancy history. The sex of each child, the survival of each child to the date of the interview, and, where pertinent, the date of death are also generally recorded.

BIRTH ORDER The ordinal number of a given live birth in relation to all previous live births of the same woman (e.g., 5 is the birth order of the fifth live birth occurring to the same woman).

BIRTH RATE See crude birth rate.

CHANDRASEKARAN-DEMING TECHNIQUE A procedure to estimate the coverage of two independent systems collecting information about demographic or other events, based on the assumption that the probability of an event being recorded by one system is the same whether or not the event is recorded by the other system. The events from both systems are matched to establish M, the number of events recorded by both systems; U_1, the number recorded only by system 1; and U_2, the number recorded only by system 2. The Chandrasekaran-Deming formula then estimates total events, N, as

$$\hat{N} = M + U_1 + U_2 + \frac{U_1 U_2}{M}.$$

CHILDBEARING AGES The span within which women are capable of bearing children, generally taken to be from age 15 to age 49 or, sometimes, to age 44.

CHILDREN EVER BORN(E) The number of children ever borne alive by a particular woman; synonymous with parity. In demographic usage, stillbirths are specifically excluded.

COHORT A group of individuals who experienced the same class of events in the same period. Thus an age cohort is a group of people born during a particular period, and a marriage cohort is a group of people who married during a particular period. The effects of a given set of mortality or fertility rates are often illustrated by applying them to hypothetical cohorts.

COHORT FERTILITY The fertility experienced over time by a group of women or men who form a birth or a marriage cohort. The analysis of cohort fertility is contrasted with that of period fertility.

CRUDE BIRTH RATE The number of births in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as births per 1,000 population. The crude birth rate for a single year is usually calculated as the number of births during the year divided by the midyear population.

CRUDE DEATH RATE The number of deaths in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as deaths per 1,000 population. The crude death rate for a single year is usually calculated as the number of deaths during the year divided by the midyear population.

CUMULATED FERTILITY An estimate of the average number of children ever borne by women of some age x, obtained by cumulating age-specific fertility rates up to age x; also often calculated for age groups.

DEATH RATE See crude death rate.

DE FACTO POPULATION A population enumerated on the basis of those present at a particular time, including temporary visitors and excluding residents temporarily absent. See de jure population.

DE JURE POPULATION A population enumerated on the basis of normal residence, excluding temporary visitors and including residents temporarily absent. See de facto population.

DIGITAL PREFERENCE See age heaping.

EXPECTATION OF LIFE AT BIRTH The average number of years that a member of a cohort of births would be expected to live if the cohort were subject to the mortality conditions expressed by a particular set of age-specific mortality rates. Denoted by the symbol e(o) in life table notation.

FERTILITY HISTORY Either a birth history or a pregnancy history.

FORWARD SURVIVAL A procedure for estimating the age distribution at some later date by projecting forward an observed age distribution. The procedure uses survival ratios, often obtained from model life tables. The procedure is basically a form of population projection without the introduction of new entrants (births) to the population.

GENERAL FERTILITY RATE The ratio of the number of live births in a period to the number of person-years-lived by women of childbearing ages during the period. The general fertility rate for a year is usually calculated as the number of births divided by the number of women of childbearing ages at midyear.

GROSS REPRODUCTION RATE The average number of female children a woman would have if she survived to the end of her childbearing years and if, throughout, she were subject to a given set of age-specific fertility rates and a given sex ratio at birth. This number provides a measure of replacement fertility in the absence of mortality.

GROWTH RATE The increase or decrease of a population in a period divided by the number of person-years-lived by the number of person-years-lived by the population during the same period. The increase in a population is the result of a surplus (or deficit) of births over deaths and a surplus (or deficit) of immigrants over emigrants. (The annual increase is often expressed as a fraction of the total population at the beginning of the year, but this convention has the inconvenient characteristic of not being readily defined for a five-year interval and of being unequal to the difference between the birth rate and the death rate even in the absence of migration.) See also rate of natural increase.

INFANT MORTALITY RATE The number of deaths of children under 1 year of age occurring in the same year; also used in a more rigorous sense to mean the number of deaths that would occur under 1 year of age in a life table with a radix of 1,000, in which sense it is denoted by the symbol ${}_1q_0$.

LIFE TABLE A listing of the number of survivors at different ages (up to the highest age attained) in a hypothetical cohort subject from birth to a particular set of age-specific mortality rates. The rates are usually those observed in a given population during a particular period of time. The survivors of the radix to age x are generally denoted by l(x). The tabulations commonly accompanying a life table include other features of the cohort's experience: its expectation of life at each age x, denoted by e(x); the probability of surviving from each age x to age x + n, denoted by ${}_nq_x$; the person-years-lived by the hypothetical cohort as it ages from age x to age x + n, denoted by ${}_nL_x$ (also equivalent to the population aged x, x + n in a stationary population experiencing a number of births each year equal to the radix of the life table); and the person-years-lived by the hypothetical cohort from age x onward, denoted by T(x).

LOGIT The logit of a proportion p is 1/2 ln[p/(1 - p)]. As a linearizing transformation, the logit has been proposed as the basis of a model life table system in which the logit of a probability of dying by age x ($_xq_0$) is related linearly to the logit of a standard probability of dying by age x ($_xq_0^s$) so that

$$\text{logit } ({}_xq_0) = \alpha + \beta\ [\text{logit } ({}_xq_0^s)],$$

where α is a measure of mortality level relative to the standard and β is a parameter that alters the shape of the standard mortality function.

MARITAL FERTILITY Any measure of fertility in which the births (in the numerator) are births to married women and in which the number of person-years-lived (in the denominator) also pertains to married women. In some instances, the designation "married" includes persons in consensual unions.

MEDIAN The value associated with the central member of a set that is ordered by size or some other characteristic expressed in numbers.

MEAN AGE OF CHILDBEARING The average age at which a mortality-free cohort of women bear their children according to a set of age-specific fertility rates.

MEAN AGE OF CHILDBEARING IN THE POPULATION The average age of the mothers of the children born in a population during a year. This measure incorporates the effects of both mortality and the age distribution.

MODEL LIFE TABLE An expression of typical mortality experience derived from a group of observed life tables.

MOVING AVERAGES The successive averaging of two or more adjacent values of a series in order to remove sharp fluctuations.

MYERS INDEX An index of digit preference that essentially sums in turn the population ending in each digit over some age range, often 10-89, expressing the total as a percentage of the total population, and which avoids the bias introduced by the fact that the population is not evenly distributed among all ages by repeating the calculations 10 times, once for each starting digit, and averaging the results. The difference between the average percentage for each digit and the expected value of 10 percent provides a measure of the preference for or avoidance of the digit over the age range considered.

NATURAL FERTILITY The age pattern of marital fertility observed in non-contraceptive populations where reproductive behavior is not affected by the number of children already born.

NET MIGRATION The difference between gross immigration and gross emigration.

NET REPRODUCTION RATE The average number of female children born per woman in a cohort subject to a given set of age-specific fertility rates, a given set of age-specific mortality rates, and a given sex ratio at birth. This rate measures replacement fertility under given conditions of fertility and mortality: it is the ratio of daughters to mothers assuming continuation of the specified conditions of fertility and mortality.

OWN-CHILDREN METHOD A refinement of the reverse-survival procedure for fertility estimation, whereby estimates of age-specific fertility rates for the recent past are obtained by relating mothers to their own children, using information on relationship and other characteristics available from a census or survey.

PARITY See children ever born.

PARTIAL BIRTH RATE The proportion of the population that enters (that is, is "born" into) a given age category in a year. The age categories used are normally open-ended, thus the partial birth rate x+ designates the proportion of the population becoming x years and older.

PARTIAL DEATH RATE The proportion of the population that leaves (that is, "dies" out of) a given age category in a year. See partial birth rate.

PERIOD FERTILITY The fertility experienced during a particular period of time by women from all relevant birth or marriage cohorts; see also cohort fertility.

P/F RATIO METHOD A consistency check for survey information on fertility. Information on recent fertility is cumulated to obtain measures that are equivalent to average parities. Lifetime fertility in the form of reported average parities by age group (P) can then be compared for consistency with the parity-equivalents (F) by calculating the ratio P/F for successive age groups. If certain assumptions about error patterns are met, an improved estimate of fertility can sometimes be obtained by correcting the age pattern of current fertility to agree with the level of lifetime fertility reported by younger women.

PREGNANCY HISTORY A report of the number and the dates of occurrence of all the pregnancies experienced by a particular woman. The outcome of the pregnancy--live birth, stillbirth, fetal death--is also recorded.

RADIX The hypothetical birth cohort of a life table. Common values are 1, 1,000, and 100,000.

RATE OF NATURAL INCREASE The difference between the births and deaths occurring during a given period divided by the number of person-years-lived by the population during the same period. This rate, which specifically excludes changes resulting from migration, is the difference between the crude birth rate and the crude death rate.

RETROSPECTIVE SURVEY A survey that obtains information about demographic events that occurred in a given past period, generally terminating at the time of the survey.

REVERSE PROJECTION See reverse survival.

REVERSE SURVIVAL A technique to estimate an earlier population from an observed population, allowing for those members of the population who would have died according to observed or assumed mortality conditions. It is used as a method of estimating fertility by calculating from the observed number of survivors of a given age x the expected number of births that occurred x years earlier. (In situations for which both fertility and mortality are known or can be reliably estimated, reverse survival can be used to estimate migration.)

ROBUSTNESS A characteristic of estimates that are not greatly affected by deviations from the assumptions on which the estimation procedure is based.

SEX RATIO AT BIRTH The number of male births for each female birth, or male births per 100 female births.

SINGULATE MEAN AGE AT MARRIAGE (SMAM) A measure of the mean age at first marriage, derived from a set of proportions of people single at different ages or in different age groups, usually calculated separately for males and females.

STABLE POPULATION A population exposed for a long time to constant fertility and mortality rates, and closed to migration, establishes a fixed age distribution and constant growth rate characteristic of the vital rates. Such a population, with a constant age structure and constant rate of growth, is called a stable population.

STATIONARY POPULATION A stable population that has a zero growth rate, with constant numbers of births and deaths per year. Its age structure is determined by the mortality rates and is equivalent to the person-years-lived ($_nL_x$) column of a conventional life table.

SURVIVAL RATIO The probability of surviving between one age and another; often computed for age groups, in which case the ratios correspond to those of the person-years-lived function, $_nL_x$, of a life table. Also called survivorship probabilities.

SURVIVORSHIP PROBABILITIES See survival ratio.

SYNTHETIC PARITY The average parity calculated for a hypothetical cohort exposed indefinitely to a set of period age-specific fertility rates.

TOTAL FERTILITY RATE (TFR) The average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given set of age-specific fertility rates; also referred to as total fertility. It is frequently used to compute the consequence of childbearing at the rates currently observed.

UNITED NATIONS AGE-SEX ACCURACY INDEX An index of age reporting accuracy that is based on deviations from the expected regularity of population size and sex ratio, age group by age group. The index is calculated as the sum of (1) the mean absolute deviation from 100 of the age ratios for males, (2) the mean absolute deviation from 100 of the age ratios for females, and (3) three times the mean of the absolute difference in reported sex ratios from one age group to the next. The United Nations defines age-sex data as "accurate," "inaccurate," or "highly inaccurate" depending on whether the index is less than 20, 20 to 40, or greater than 40.

WHIPPLE'S INDEX A measure of the quality of age reporting based on the extent of preference for a particular target digit or digits. The index essentially compares the reported population at ages ending in the target digit or digits with the population expected on the assumption that population is a linear function of age. For a particular age range, often 23 to 62, the population with ages ending in the target digits is divided by one-tenth of the total population, the result then being multiplied by 100 and divided by the number of different target digits. A value of 100 indicates no preference for those digits, whereas values over 100 indicate positive preference for them.

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