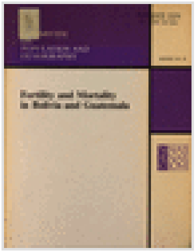

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Report No. 28

Fertility and Mortality in Bolivia and Guatemala

Fertility and Mortality in Bolivia: 1950–1976

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Panel on Latin America

Fertility and Mortality in Guatemala: 1950–1973

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Committee on Population and Demography
Commission on Behavioral and Social
Sciences and Education
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, and about the factors determining reductions in fertility.

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 the most reliable estimates of those levels and trends.

It was to examine these questions that the Committee on Population and Demography was established within the Commission of Behavioral and Social Sciences and Education of the National Research Council. It was funded for a period of five and one-half years by AID under Contract No. AID/pha-C-1161 and Grant No. AID/DSPE-G-0061, the latter for work on fertility determinants. Chaired by Ansley J. Coale, the Committee undertook three major tasks:

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

FERTILITY AND MORTALITY IN BOLIVIA: 1950-1976

SUMMARY

Located in central South America, Bolivia occupies approximately one million square kilometers and had a population of almost 4.8 million in 1976. The population is distributed among three well-defined ecological zones: the Altiplano (a high plateau region of the Andes mountains) with 53 percent of the population, the Valle (the eastern facing slopes of the Andes) with 27 percent, and the Llano (relatively low-lying plains to the east of the mountains) with 20 percent. Almost 60 percent of the population lives in rural areas.

A better picture of the characteristics of Bolivia's population is conveyed by the recent values of various socioeconomic indicators, displayed in Table 1. These indicate that Bolivia is a country characterized by a low level of development and by high levels of mortality and fertility.

This study estimates Bolivian mortality and fertility on the basis of demographic information available for the period 1950-76. The basic information used comes from the following sources: population censuses undertaken in 1950 and 1976; 1975 National Demographic Survey (EDEN); and registered deaths in 1951, classified by age and sex. Prior to the National Demographic Survey in 1975, little was known about the demographic characteristics of the population of Bolivia. The only sources of information at that time were the 1950 census (of dubious quality) and the number (probably incomplete) of registered deaths, classified by age and sex, collected for one isolated year, 1951, by the social security system. The 1975 EDEN and the 1976 census, both of which included questions on fertility and mortality, have opened up new possibilities for demographic estimation in Bolivia. Table 2 summarizes the estimation techniques used in this study. The final estimates are shown in Table 3.

The fertility estimates indicate a total fertility rate of around 6.5 births per woman for the early 1970s and show no signs of change. The somewhat tentative estimates available for the period preceding the 1950 census show very similar levels, the birth rate of 46 per 1,000 agreeing closely with the value of 45.4 per 1,000 for the early 1970s. Bolivia appears to be characterized by a fairly high and constant level of fertility over the period studied.

Unlike fertility, mortality appears to have fallen from around 1950 to the period 1960-76. In 1950, expectation of life at birth was

around 38 years for both sexes, with an infant mortality rate around 210 per 1,000 live births. By the period 1960-76, expectation of life at birth had increased to about 47.5 years, with an infant mortality rate around 150. However, it seems that the improvement in mortality occurred mainly in the 1950s, with child mortality remaining approximately constant from the early 1960s onward.

The rate of natural increase has risen from around 2.1 percent in 1950 to around 2.6 percent in the late 1960s and early 1970s, but the rate of population growth has been slowed by substantial net emigration at an annual rate of possibly as much as two per 1,000. The observed growth rate between the 1950 and 1976 censuses is around 2.1 percent, in broad agreement with the estimates obtained. The level of child mortality in the early 1970s, with nearly 25 percent of children dying before the age of 5, is very high by Latin American standards and offers plenty of room for improvement. If child mortality does start to decline again, as seems likely, the rate of population growth is likely to increase in the short run, since there is no evidence of recent declines in fertility.

CHAPTER 1

MORTALITY

MORTALITY AROUND 1950

The only demographic information available for around 1950 comes from the 1950 census, which provides a distribution of the population by age and sex, and from the vital registration system, run by the social security administration, which provides deaths by age and sex in 1951. In this study, several recently-developed techniques have been used to assess the completeness of death registration relative to census coverage on the basis of the age distribution of deaths and population (Brass, 1975; Preston and Hill, 1980; Preston et al., 1980).

Brass Growth Balance Equation Method

The Brass growth balance equation method was applied to the deaths registered in 1951 and to the population as enumerated in 1950. This method allows the estimation of the population's growth rate (r) and of the completeness (c) of death registration with respect to the completeness of enumeration of the census population.

In any population closed to migration the growth rate is equal to the difference between the birth rate and the death rate. This relationship can be generalized for every open-ended age interval. In general, for the population aged x and over, the growth rate would be the difference between the rate of entry to that age group (equivalent to the birth rate for the population age 0 and over) and the partial death rate for the same age group, that is:

$$r(x+) = \frac{N(x)}{N(x+)} - \frac{D(x+)}{N(x+)} \qquad (1)$$

where $N(x)$ is the population of exact age x, $N(x+)$ is the population aged x and over, and $D(x+)$ is the number of deaths among the population aged x and over. In a stable population (see glossary), $r(x+)$ is constant for all values of x, and therefore Equation 1 can be rewritten as follows:

$$\frac{N(x)}{N(x+)} = r + \frac{D(x+)}{N(x+)}. \qquad (2)$$

Assuming that the observed population is approximately stable, that the age structure of the enumerated population is correct, and that completeness of death registration relative to census enumeration, denoted by c, is constant with respect to age, Equation 2 can be rewritten as follows:

$$\frac{N^0(x)}{N^0(x+)} = r + \frac{1}{c}\frac{D^0(x+)}{N^0(x+)}, \qquad (3)$$

where the superscript 0 indicates an observed value. A straight line can then be fitted to the points for serial values of x, provided, of course, that the distribution of the points is approximately linear. The intercept of the fitted line then provides an estimate of r, the rate of natural increase, and the slope of the line provides an estimate of 1/c, a correction factor for registered deaths.

Two alternative procedures have been proposed for applying the method, using different approaches to the estimation of $N^0(x)$. The approach used here is to estimate the numbers reaching exact age x in a year as one tenth of the numbers in the two five-year age groups on either side of x. The alternative is to estimate $N^0(x)$ as one fifth of the number in a five-year age group (x-2.5, x+2.5), and to calculate both $N^0(x+)$ and $D^0(x+)$ for values of x in the center of each five-year age group. The second procedure is slightly preferable theoretically, but is much more affected by age heaping, so the first has been used here.

Table 4 and Figures 1 and 2 show the application of the method. According to the assumptions of the method, the partial growth rates of the population segments over each age x, r(x+), should be constant. However, data errors and deviations from the assumptions result in fluctuations in the partial growth rates. The behavior of such rates, which may be estimated by Equation 4,

$$r(x+) = \frac{N^0(x)}{N^0(x+)} - \frac{D^0(x=)}{N^0(x+)} \qquad (4)$$

was used in order to choose the points to which the linear trend would be fitted. Analysis of these partial growth rates led to the exclusion of the last three points (those for values of x of 70 and over), for which the growth rates deviated from the general pattern. Straight lines were then fitted to the remaining points using a group-average procedure; the parameters of the lines are shown in Table 5. (A value less than 1.0 for the correction factor indicates that census enumeration is less complete than death registration.) Table 5 also shows the expectation of life at age 5 for each sex, obtained by constructing a life table from the deaths after adjustment by f, and the implied mortality levels in the West family of the Coale-Demeny model life tables (see glossary). The results, if taken at face value, are surprising, implying as they do that the coverage of the 1950 census was some 5 percent lower than that of death registration.

The West family was chosen for comparison purposes here and elsewhere in this report because what evidence there is suggests that this family provides the best representation of the true mortality pattern in Bolivia. The evidence is not overwhelming, however. The age-specific mortality rates for the age range 5-55, calculated for 1950-51 after adjustment for coverage (as outlined below in Table 6), agree most closely with the West or East mortality patterns. Of the two, West was chosen on the grounds that it gives both the most internally consistent child mortality estimates and the best agreement between child and adult mortality. The conclusion is weak, however, since the child mortality estimates need not be internally consistent if, for instance, mortality has been changing; the child and adult mortality estimates refer to very different time periods and therefore again need not be consistent.

Somoza (1979) and Mezza (1978) have suggested a truncated variant of the Brass method that does not require the cumulation of data to the last open-ended age interval. It is true of any population segment that the rate of new arrivals into the segment is equal to the sum of the rate of departures from the segment and the segment growth rate. In a population segment aged a to b, the new arrivals in a year are those who celebrate an a-th birthday; the departures are the deaths that occur during the year between the ages of a and b plus those who celebrate a b-th birthday. A variation of the Brass equation for a stable population can therefore be written:

$$\frac{N(a)}{{}_bN_a} = r + \frac{{}_bD_a}{{}_bN_a} + \frac{N(b)}{{}_bN_a} \qquad (5)$$

Equation 5 can be applied for any age group (a, b), but the results are likely to be erratic if there is substantial age misreporting. Progressive cumulation is therefore adopted. If it is assumed that deaths and population are reasonably well recorded for an age range (p, q), Equation 5 can be evaluated either by cumulating downward (that is, starting with b equal to q and taking a successively as q-5, q-10, and so on until a = p) or by cumulating upward (that is, by starting with a equal to p, and taking b successively as p+5, p+10, and so on until b = q). Cumulating downward overweights the values near q, whereas cumulating upward always includes the values near p.

Table 6 and Figure 3 show the results obtained when the age range 30-55 is considered. The points appear to lie more or less on a straight line, the line that is fitted having a slope almost exactly equal to 1.0. However, the growth rate (r) obtained when Equation 5 is used is approximately 2.6 percent, a value that is probably somewhat too high for the country in 1950 in view of the presumed very high level of mortality.

If the apparent implication of this method, that the coverage of the death registration system was approximately equal to the coverage of the census, were accepted, the age-specific mortality rates shown in Table 7 would be implied for the age range 30-55. Table 7 also shows the mortality levels in the West model life tables implied by each age-specific rate; the consistency is reasonable, the average level being 12.6 for males and 13.0 for females, the corresponding expectations of life at birth being about 46 years and 50 years, respectively. However, given the very short age range of the points, and their small number, not much confidence can be felt in the results, particularly in view of the implausibly high growth rate obtained.

Preston-Coale Method

Preston (Preston and Hill, 1980) has proposed an alternative procedure for estimating the completeness of death registration. Preston's method is based on comparing the age structure of deaths and the age structure of the population under the assumption of stability, using an estimate of the growth rate. A development of the original procedure (presented in Preston et al., 1980) has been applied to the data for Bolivia for 1950 and 1951. In any population, the number of persons aged x is equal to the number of deaths that will occur to those people in the future, since they will all die ultimately. In a stable population with complete death registration, the number of deaths that will occur to persons aged x will be equal to the sum of the deaths at each age above x, after the deaths have been inflated by the stable growth rate to allow for the fact that the deaths recorded above age x reflect not only smaller numbers of survivors but also smaller original cohorts. Given an age distribution of deaths and a growth rate, it is therefore possible to estimate the population at each age. If the reporting of deaths is not complete, but the omission is proportionately the same at all ages, the ratio of the population estimated at each age (or above each age, to provide some smoothing) to the population enumerated at (or above) that age provides an estimate of the completeness of death registration. If completeness estimates are computed for a range of ages, it is even possible to confirm or modify the assumed growth rate on the basis of the trend in the estimates with age, as long as the basic data are reasonably coherent.

The method has been applied to Bolivia by computing ratios of estimated to observed populations of ages x and over, $N^*(x+)/N^0(x+)$. One problem with the application of the method is the treatment of the open interval. The deaths registered in 1951 are available by five-year age groups up to 80-84, the last category being age 85 and over. However, comparison of the age distributions of both the population and deaths with those from a West model stable population of mortality level 9 and growth rate of 2 percent indicate systematic distortions of both distributions, as shown in Figure 4, which plots the observed proportion (of persons or deaths) in each age group against the corresponding proportion in the West stable population.

For males, the population ratios are close to 1.0 below age 60 (ranging from a high of 1.08 to a low of 0.87, with an average value of 0.96), whereafter they fluctuate widely at levels all above unity, suggesting substantial age exaggeration that increases with age. For male deaths, the ratios below age 60 are more variable (ranging from 1.23 to 0.73, tending to decrease somewhat with age) and they are somewhat lower, averaging 0.90. Above age 60, the death ratios are less variable than the population ratios; the former remain close to unity until the open interval, age 80 and over. The patterns are similar for females, though with somewhat less pronounced exaggeration over age 60 for the population ratios. Thus, an open interval of 55 and over was used for both sexes to minimize the effects of age-misreporting. An estimate of the growth rate was then obtained by finding the growth rate that gives a plot of expected to observed populations that is as close to horizontal as possible.

For females, the closest approximation to a horizontal line is obtained using a growth rate of 1.85 percent, a not implausible value, implying an average level of completeness of 84.9 percent. The plot of completeness estimates for female death registration by age is shown in Figure 5. For male deaths, the use of an open interval of age 55 and over does not produce as satisfactory a straight line, though the imposition of a growth rate of 1.85 percent produces a sequence of points that does not deviate greatly from the horizontal, and produces a completeness estimate for male death registration of 87.5 percent, acceptably close to the estimate for females. The completeness estimates for males are also plotted against age in Figure 5.

The completeness levels in Figure 5 have been accepted as the best estimates that can be arrived at on the basis of the 1951 deaths by age. These completeness estimates were used to produce adjusted age-specific mortality rates for 1951, which are shown in Table 8. The rates shown for age groups up to 50-54 were adjusted upward by 1.143 in the case of males and 1.178 in the case of females. The rates above age 55 are not shown, because of doubts about the distortions introduced by age errors.

Table 8 also shows the mortality level of each rate in all four regional families of the Coale-Demeny life tables. One rather gratifying result of the adjustments made is that the fit of the West family of model rates to the observations is improved relative to its fit to the unadjusted rates (Table 7), and is clearly superior to the fit of the other families, except for East, which fits the female rates better, but fits the male rates much worse. The average mortality level in the West family implied by the adjusted mortality rates is 10.5 for males and 10.8 for females. Given the degree of approximation involved, level 10.5 in the West family is taken to be the best representation of mortality above age 10 for Bolivia around 1951.

Table 8 also presents age-specific mortality rates for the age groups 0-4 and 5-9. The completeness of death registration in these age groups may be very different from that of adult deaths, and the Preston-Coale assessment technique cannot provide satisfactory estimates of completeness of recording of child deaths. However, if the same correction factors are applied to deaths under 10 as were applied to deaths over 10, the age-specific mortality rates under 10 indicate West mortality levels that are about one and one-half levels lower than those corresponding to the mortality rates over age 10. (A lower number mortality level implies higher actual mortality rates among the population.) This evidence by itself is an inadequate basis for concluding that child mortality was actually higher relative to adult mortality than is the case in the West model life tables, but evidence of a similar differential for the period 1960-76 (in that case, a difference of two and one-half levels) points in the same direction.

Complete life tables for 1951 were therefore calculated by splicing together West level 8 models for childhood ages (0-9) and West level 10.5 models for later life, with the results shown in Table 9. Expectation of life at birth is 37.0 years for males and 39.9 years for females, though it should be remembered that the childhood portions of the life tables are highly speculative.

MORTALITY DURING 1960-1976

Estimates of recent mortality are based on data from the 1975 National Demographic Survey (EDEN), which included questions especially designed to estimate both childhood and adult mortality, and from the 1976 census.

Childhood Mortality

The basis for estimating child mortality is data on the survival of children ever born, classified by age of mother. The 1975 EDEN collected information on children ever born and children surviving, classified by sex of child; similar information, though not classified by sex, is available for the 1976 census data. When such information is available, it is possible to calculate the proportion dead by the time of the survey of the children ever borne by women classified by five-year age groups. This proportion is, by itself, an indicator of childhood mortality, though it is affected by factors other than mortality and cannot, therefore, be taken directly as a mortality measure.

Brass (1964) developed a way of transforming these proportions into probabilities of dying between birth and exact age x. Variations on the original technique have been proposed by a number of authors (for example, Sullivan, 1972; Trussell, 1975; Feeney, 1980), but in general the results obtained by applying any of these techniques are quite consistent. In this report, estimates were obtained using Trussell's variation (United Nations, 1983).

Trussell's variant allows the estimation of the probability of dying between birth and exact ages 1, 2, 3, 5, 10, 15, and 20, using the following relation:

$$q(x) = k_i D_i, \qquad (6)$$

where q(x) is the probability of dying between birth and exact age x; D_i is the proportion dead among the children ever borne by women in age group i (i=1 for women 15-19, i=2 for women 20-24, i=3 for women 25-29, and so on); and k_i is a multiplying factor that converts the proportion of children dead, D_i, into probabilities of dying, q(x), by allowing for the time distribution of the births of the reported children. A regression equation is used to obtain the values of the multiplying factors (k_i) from indicators of the age pattern of fertility. For the Trussell variant being used here, the form of this equation is:

$$k_i = a_i + [b_i (P_1/P_2)] + [c_i (P_2/P_3)] , \qquad (7)$$

where P_1, P_2, and P_3 are the average numbers of children ever born per woman for age groups 15-19, 20-24, and 25-29, respectively; and a_i, b_i, and c_i are regression coefficients calculated by Trussell using model cases whose values are tabulated for each of the four families of Coale-Demeny model life tables. As already noted, the West model was considered the most appropriate for Bolivia. The value of the multiplying factor k_i depends upon both the mortality pattern and the shape of the fertility schedule up to the age group of the women reporting, but the latter plays a predominant role. For this reason, Equation 7 incorporates the values of P_1/P_2 and P_2/P_3 as indicators of the age pattern of childbearing among young women.

Table 10 shows the estimates of mortality risks in childhood obtained by applying Trussell's method to the 1975 EDEN and 1976 census data. The consistency of the individual estimates is indicated by showing the mortality levels in the Coale-Demeny West model life tables to which each corresponds. The values obtained from both sources show more or less the same mortality level. The small difference detected cannot be regarded as a basis for establishing trends, especially considering the fact that the two sources of information are only one year apart.

Some inferences concerning trends can be drawn from the internal pattern of the estimates, however. The children borne by women of a particular age have been exposed to the risk of dying for different lengths of time, and on average the older the women the longer the period during which their children have been exposed to risk. Child mortality estimates derived from child survival information do not therefore necessarily reflect child mortality at the time of the survey, but rather represent averages of child mortality experience during the childbearing lives of the women. If child mortality was changing steadily over the period during which the women being considered were bearing children, it is possible to estimate the time before the survey to which each estimate refers. Several authors have proposed procedures for making such estimates, including Brass (1975), Coale and Trussell (1977), Preston and Palloni (1977), Sullivan and Udofia (1979), and Feeney (1980). The different procedures generally give very similar answers. The Coale-Trussell procedure, which estimates the number of years before the survey (t*) when the period mortality risk was equal to that obtained from the proportion of children dead reported by each age group of women, has been applied to the data from the 1975 survey and the 1976 census. These results are also shown in Table 10, and Figure 6 plots child mortality levels in the West model against calendar years.

It will be noticed that the mortality estimates derived from the 1976 census data are somewhat higher (indicated by lower model levels) than those derived from the 1975 survey; they are also much more consistent. However, neither series shows any clear mortality trend. The 1975 series could be construed as showing a slight upward trend, but the estimates for the distant past should not be interpreted too rigorously, since they are likely to be affected by differential omission of dead children. The 1976 series appears to show a rise in child mortality immediately before the census, but the most recent estimates are based on reports by young women and tend to be distorted by differentials in child mortality by age of mother. The child survivorship information thus gives no indication of any changes in child mortality from around 1960 to the mid-1970s. However, due to the nature of the data, changes shortly before the surveys and fluctuations from year to year throughout the period cannot be ruled out. It is possible, of course, that differential omission of dead children increases with age of mother, thus concealing a true fall in child mortality. The average parities shown in Tables 11 and 12 give some indication of omission of children ever born on the part of women over 40, but up to age 40 there is no indication of substantial omission. The points in Figure 6 for the early 1960s may be distorted, therefore, but those for the late 1960s and early 1970s are unlikely to be. Thus there is no evidence of any trend from 1960 onward and evidence of the absence of change from the mid-1960s to the early 1970s.

The estimates of child mortality by sex obtained from the 1975 EDEN, shown in Table 10, indicate a differential rather more favorable to females than the differences embodied in the West model life tables, the average male level being 10.6 and the average female level being 11.0. The estimates are somewhat more variable than those for both sexes together, as might be expected given the smaller numbers involved, but they are adequately consistent to be convincing.

Female Adult Mortality

Information on female adult mortality was obtained in the National Demographic Survey (EDEN) by asking about the survival of each respondent's mother, the question used being "Is your mother alive?" The proportion of respondents in each age group whose mother was alive at the time of interview can be calculated on the basis of this information. This proportion is by itself an indicator of adult female mortality, but it is also affected by other factors not related to mortality. All respondents have been exposed to the risk of being maternally orphaned since birth, so the period of the mother's exposure to the risk of dying at the time of the survey is equal to the respondent's age. The incidence of maternal orphanhood amongst respondents of a given age will also depend on the age distribution of the mothers at the time the respondents were born; if all the mothers were young, fewer of them would die (other things being equal) during a given exposure period than if they were older. The age pattern of the mothers at the time the respondents were born depends on the age pattern of childbearing and on the female age distribution.

Brass (Brass and Hill, 1973) used demographic models to develop a method that allows for these more important factors, making it possible to estimate the female probability of surviving from age 25 to age 25+x based on the proportion of respondents in the age groups (x-5, x-1) and (x, x+4) whose mother was alive at the time of interview. Hill and Trussell (United Nations, 1983) have proposed a modification of the technique using the following equation:

$$\frac{l(25+x)}{l(25)} = a(x) + b(x)\,\bar{M} + c(x)\,{}_5PNO_{x-5}\,, \qquad (8)$$

where $\bar{M}$ is the mean age of mothers at the birth of their children (an age-distribution-weighted mean age of childbearing); ${}_5PNO_{x-5}$ is the proportion of respondents of age group (x-5,x-1) whose mother was alive at the time of the survey (proportion not orphaned); and a(x), b(x), and c(x) are regression coefficients estimated by Hill and Trussell from a large number of model cases. Table 13 shows the results obtained when this method was applied to the 1975 EDEN data. For each survivorship probability, the implied mortality level within the West family of Coale-Demeny model life tables has been calculated to provide a basis for comparison with other estimates.

Mortality estimates obtained from data on survival of mother are estimates of the average mortality experience of the mothers throughout the period of exposure, and thus will not reflect mortality at the time of the survey unless mortality has effectively been constant. If mortality has been changing, the mortality estimates obtained from data on survival of mother will refer to time points in the past. If mortality has been changing in a regular way, it is possible to devise methods similar to those described above for child mortality to locate estimates of adult female mortality in time. Brass and Bamgboye (1981) have proposed a flexible procedure that can be applied to date the mortality estimates obtained from parental or spouse survival. The method has been applied to the maternal orphanhood information collected by the 1975 EDEN, and the results are shown in column 5 of Table 13. The estimated West mortality levels are plotted against time in Figure 6.

The estimate based on respondents aged 45-49 is clearly out of line, probably as a result of under-reporting of dead mothers. The remaining estimates indicate a level of adult mortality around 14 (consistent with an expectation of life at birth, e_0, of 52.5 years) around 1961, rising to about 16 (e_0 of 57.5) by 1965, and to over 18 (e_0 of 62.5) by the late 1960s.

Even though these estimates refer only to adult mortality, for which e_0 is not a valid yardstick, the implied increase in mortality level (decrease in actual mortality rates) from 1961 to the late 1960s is too rapid to be believable. Furthermore, if the mortality decline had really been that rapid, the assumption of a regular change would not be tenable, and if adult female mortality had declined rapidly more recently after a period of constancy, the mortality estimates would refer to time periods still closer to the present, further accentuating the apparent pace of the decline. Therefore, the time trend of mortality indicated by the orphanhood data cannot be accepted. It is probable that the estimates based on reports of younger respondents are too low, a universal feature of estimates based on maternal survival information from respondents under 15. The most reliable segment of the orphanhood estimates seems to be that based on respondents aged 25-45, giving estimated mortality levels in the range of 13.7 to 16.2 for the period 1960-64. The average of these estimates, a level of 14.8, indicates much lower mortality than the estimates of child mortality also plotted in Figure 6. It is possible that the West mortality pattern does not adequately represent the true relationship between child and adult mortality in Bolivia, though the contrast between the implausibly rapid decline in adult mortality shown by the orphanhood-based estimates and the broadly constant child mortality levels shown by child survival data casts doubt on the validity of the orphanhood-based results.

It is concluded that the maternal orphanhood estimates provide no reliable information on recent mortality levels or trends. Application of the Preston-Coale death distribution procedure to the 1950 age distribution and 1951 age distribution of registered deaths produced estimates of age-specific mortality rates similar to those of a West model life table of level 10.5 (see Table 8). The orphan-hood estimates seem to indicate a West level of around 14 for the early 1960s, and the child mortality estimates indicate a level of around 10.5 for the period from around 1960 to the early 1970s, with no indication of any trend over the period. If the lack of trend in child mortality is accepted, and the relationship between child and adult mortality has not changed, then adult mortality will also have remained broadly constant over the period. However, there is no strong evidence either one way or the other concerning possible changes in the relationship between child and female adult mortality, so any conclusions must inevitably be tentative.

Male Adult Mortality

The 1975 EDEN included a question on the survival of the first husband of each ever-married woman, making it possible to calculate the proportion of ever-married women in each age group whose first spouse was alive at the time of interview. These proportions are by themselves indicators of male adult mortality, but, like the corresponding female measures derived from questions on survival of mother, they are also affected by factors not related to mortality. However, it is possible to obtain from these proportions a conventional measure of mortality, such as the probability of surviving from one exact age to another. Hill and Trussell (United Nations, 1983) have proposed a way of transforming the observed proportions into conditional survivorship probabilities by allowing for the main effects of male and female ages at marriage. The estimating equation proposed is:

$$\frac{l(x+5)}{l(20)} = a(x) + b(x)\ SMAM_f + c(x)\ SMAM_m + d(x)\ {}_5PNW_x, \quad (9)$$

where $SMAM_f$ and $SMAM_m$ are the singulate mean ages at marriage among females and males, respectively; $_5PNW_x$ is the proportion of females aged x to x + 4 whose first husband was alive at the time of interview (proportion not widowed); and a(x), b(x), and c(x) are regression coefficients estimated from an extensive set of model cases. The results obtained by applying this method are presented in Table 14, along with the mortality level in the West family of Coale-Demeny model life tables implied by each survivorship ratio.

Proportions of respondents with a surviving first husband reflect mortality rates throughout the married lives of the women, so if mortality has been changing over time, mortality estimates derived from such proportions will not refer to the time of the survey, but rather to some earlier period related to the average exposure to risk of the first husbands. Brass and Bamgboye (1981) have proposed a procedure for estimating the time reference of such mortality estimates under the assumption of a regular mortality trend. The method was applied to the widowhood data collected by the 1975 survey, and the results are shown in column 5 of Table 14. The mortality estimates, converted into levels in the West model life tables for the sake of comparability, are plotted against time in Figure 6.

Once put in their time context, the mortality estimates obtained from widowhood show mortality levels rather similar to those obtained from orphanhood for the early 1960s, suggesting, despite substantial fluctuations, a mortality level around 15 in the West model life tables. From the mid-1960s to the early 1970s, the estimates show a fairly steady trend toward lower mortality, the mortality decreasing by about one and one-half levels over eight and one-half years, a not unreasonable rate of improvement.

Conclusions Concerning Mortality, 1960-76

The orphanhood-based estimates of adult female mortality and the widowhood-based estimates of adult male mortality are rather consistent for the early to mid-1960s, and the trend in adult male mortality indicated by the widowhood estimates into the early 1970s is not unreasonable. (The trend in female adult mortality indicated by orphanhood is, however, unacceptably rapid.) The problem that arises is the inconsistency between the child and adult mortality estimates: the child mortality estimates show no trend from the early 1960s to the early 1970s and indicate a West level of around 10.5, while the adult mortality estimates show a trend of declining mortality, from a level of around 15 in the early 1960s to a level around 16.5 in the early 1970s.

The adjusted death rates for 1951 are fitted adequately by the West mortality pattern up to age 55, although, as already noted, there is some indication that child mortality may have been somewhat heavier than adult mortality relative to the West pattern. Given that the available evidence both for 1951 and for the early 1960s also indicates that child mortality was heavier than adult mortality, the conclusion is drawn that such a differential probably does exist. Although neither piece of evidence is worth much in isolation, the two pieces together are considerably more convincing than separately. An analysis of the 1950 and 1976 age distributions, described in Chapter 3, further supports the existence of the differential.

A complete life table covering the period 1960-75 has been derived by splicing a West model life table of level 10.5 up to age 10 to a West model life table of level 13.0 from age 10 upward. The resultant life table, shown in Table 15, is the best approximation that can be made at present to recent mortality conditions in Bolivia, although the adult portion of the table is somewhat tentative; the section of the table up to age 10 is the most reliable part of the final product.

ESTIMATES OF INTERCENSAL MORTALITY FROM THE 1950 AND 1976 AGE DISTRIBUTIONS

Despite the complications introduced by migration, it is of interest to examine the mortality implications of the numbers enumerated by the 1950 and 1976 censuses. The normal approaches to estimating mortality from two age distributions are to calculate cohort survivorship probabilities from one census to the next, or to project the initial population to the time of the second census using different mortality levels, obtaining a range of estimates on the basis of the final population over given ages. However, the long intercensal interval, and the fact that it is not a multiple of five, make the standard approaches inconvenient. Preston (1981) has recently proposed a procedure using the intercensal growth rates of each age group to reduce an average of the two population age distributions to a stationary form, from which standard life-table measures can be derived. The application of the method to the 1950 and 1976 census age distributions is shown in Table 16.

The mortality estimates derived from the Preston procedure are affected by age errors, changes in census coverage, and migration in much the same way as those obtained by intercensal survival using cumulated numbers. Age-reporting errors which affect both age distributions in similar ways will have little effect on the age-specific growth rates, but will distort the estimates through their effect on the average age distribution. The age-specific growth rates in Table 15 show reasonable consistency, but the West mortality levels show a strong upward trend from middle adulthood, suggestive of age exaggeration. A reasonable mortality estimate that refers mainly to adulthood can be obtained by averaging the mortality levels obtained for the population under age 40. The resultant estimate for males is West level 11.6 and for females level 10.6. These estimates suggest slightly heavier mortality for the intercensal period than the estimates presented above of around 10.5 for 1950 and around 13 for the period 1960-76. The intercensal mortality estimates would be biased toward lower mortality levels by net emigration over the period, and should thus be regarded as lower limits for the true level. Steady emigration at a rate of two per 1,000 at all ages would increase the estimates by about 2 levels, to around 13.5 for males and 12.5 for females. Thus intercensal change between 1950 and 1976 indicates a level of mortality which does not agree closely with the selected estimates, but which does not contradict them. The only slight puzzle is the lower level indicated for females than for males, a feature which cannot plausibly be accounted for by migration, but that may arise as a result of more severe exaggeration of age for males than for females.

CHAPTER 2

FERTILITY

The estimation of fertility is based on two types of information, one being retrospective data concerning fertility gathered by the 1975 EDEN and the 1976 census, and the other being the age distributions available from the same sources. The retrospective data available from both the EDEN and the census are the number of children ever born reported by women at the time of the survey and the number of births that occurred during the year prior to it. These data were evaluated and compared for consistency using the P/F ratio method, which produces estimates of age-specific fertility rates and total fertility. Age distributions from both the EDEN and a sample of the census were used in applying the own-children method of estimating fertility, which is a refinement of the reverse survival procedure that uses reverse projection of the number of reported children in order to estimate births in the recent past (see glossary).

ESTIMATES BASED ON THE P/F RATIO METHOD

Brass (1964) has suggested a procedure (usually known as the P/F ratio method) to check the consistency of reports on lifetime fertility in the form of information on children ever born with reports on current fertility in the form of number of births in the year before the survey. Age-specific fertility rates calculated from the latter can be cumulated to obtain measures of children ever born by exact ages. Average parity equivalents (which can be compared with reported average parities) can then be estimated by interpolating between the cumulated fertility values. Brass also suggested that if fertility were constant, the P/F ratio comparison could provide a technique for adjusting the information on current fertility in view of the errors likely to characterize the two different types of information. For example, if the most important error in the recent fertility information were a tendency to report births occurring during a period somewhat longer or shorter than 12 months, and the tendency to error were roughly constant for women of different ages, then the age pattern of recent fertility would be correct, but not its level. If the most important error in information on children ever born were a tendency among older women to fail to report some of their children, then average parities for younger women might be more or less correct, whereas those for the older women would be too low. If fertility had been constant, so that recent and lifetime fertility were more or less the same, the age pattern of fertility calculated from the data on recent births could be adjusted to match the level of fertility indicated by the average parities of younger women, thus combining the most reliable features of the two types of information to obtain a refined final estimate of fertility.

The estimation of F(i), the synthetic parity equivalent for women of age group i, is carried out by using a set of multipliers k(i) such that:

$$F(i) = \phi(i-1) + k(i)f(i) , \qquad (10)$$

where $\phi(i-1)$ is cumulated fertility to the upper limit of age group i-1, such that:

$$\phi(i-1) = 5 \sum_{j=1}^{i-1} f(j) . \qquad (11)$$

Details of the application of this method are presented in Tables 11 and 12 for both the 1975 survey and the 1976 census. Table 17 shows the P/F ratios, the fertility schedules after adjustment by the average of the P/F ratios for the age groups 20-24 and 25-29, and the relative distributions of current fertility.

The adjusted fertility levels implied by the two data sources (EDEN and census) appear rather consistent. In terms of total fertility (TF), Bolivian women would expect to have some 6.7 or 6.8 children on average if the fertility rates observed in 1975-76 were to remain constant throughout their lives. However, Figure 7 shows that the two sets of fertility estimates are consistent only so far as total fertility is concerned; the age patterns of fertility implied by the EDEN and the census are markedly different.

The census results and the EDEN results appear to imply quite different patterns of fertility, both in terms of age-specific fertility rates and in terms of average parities. The current fertility rates from the EDEN are lower at younger ages, as are the average parities, which fall below the census values until age 30 but exceed the census values thereafter. The current fertility rates obtained from the EDEN are also lower below age 25, and higher thereafter, than those obtained from the census, even allowing for the generally slightly higher level of the census rates. The two sources thus provide internally consistent age patterns of fertility, as is indicated by the reasonable stability of the P/F ratios, but the age patterns between sources are quite different.

The high average parities for young women that are implied by the census data could be accounted for by the treatment of nonresponse by the census. The parities for women for whom there was no recorded information concerning children ever born were imputed on the basis of the experience of women for whom there was information. The incidence of nonresponse is typically high for young women, often for a reason first suggested by El-Badry (1961) and since widely confirmed by empirical observation: young childless women are recorded as cases of nonresponse because no fertility information is recorded for them, (that is, their response of "none" is sometimes recorded as a blank, which is later interpreted as a nonresponse). Under such circumstances, the use of imputation is likely to exaggerate true average parity, since the nonresponse category includes a disproportionate number of women who are in fact childless. In the case of the Bolivia census, it is not possible to assess the magnitude of the problem since the only results available are those obtained after imputation.

Table 17 shows that the estimate of total fertility derived from the 1976 census is 6.7 if an average adjustment factor based on the age groups 20-24 and 25-29 is used, but is only 6.5 if the adjustment factor for women 25-29 is used. There are reasons to suppose that P(3)/F(3), which implies a total fertility of 6.5, should be preferred as a correction factor. Analysis of the age structure of the female population enumerated by the census suggests that there is a tendency to underreport age among the age groups 20-24 and 25-29, which probably leads to net downward transfers from the 25-29 group to the 20-24 group, and from the 20-24 group to the 15-19 group. A transfer of women aged 25-29 to the 20-24 age group would tend to inflate the ratio P(2)/F(2), since their parity is on average higher while their age-specific fertility rates are not much different. The effect that a net transfer from age group 20-24 to 15-19 would have is less clear. If it is mainly the younger women in the age group 20-24 who are transferred, the value of P(2) would increase, but the value of F(2) would also tend to be increased, since the women who remain in age group 20-24 would probably have higher fertility, and the fertility rate for women 15-19 would also be increased. The likely overall effect would appear to be an exaggeration of P(2)/F(2), which would be consistent with the observed behavior of the ratios, since there is a sharp decline between 20-24 and 25-29 (from 1.19 to 1.13), the decline thereafter being more gradual.

Another reason for using the P(3)/F(3) ratio for adjusting the census information arises from the procedure used for imputing the number of children ever born for women who did not provide the information. Since the criteria used for imputing missing data are based on the characteristics of women who do declare their parity, an upward bias on average parity is possible if the women classified as cases of nonresponse are imputed to have as many children as the women who did provide information. This bias would affect mostly the P(i) values for the age groups 15-19 and 20-24, where the proportion of childless women is highest. As noted earlier, the census data before imputation were not kept, so it is impossible even to examine the actual incidence of nonresponse.

EVALUATION OF P/F RATIOS FOR FIRST BIRTHS

Recent and lifetime fertility can be compared for births of any order. If marital fertility is changing, comparing first-birth rates with the proportions of women reporting at least one child may reveal such a change. Although there is no evidence of recent fertility change in Bolivia, P/F ratios for first births have been calculated as a further check on data consistency.

This method is based on the comparison of the proportion of women who are mothers [$P_1(i)$], obtained on the basis of a question on the number of children ever born (females who have had at least one child), with an equivalent measure obtained by cumulating first birth rates constructed on the basis of the first-order births observed in a given year. This measure, denoted by $F_1(i)$, is estimated by the equation

$$F_1(i) = \phi_1(i-1) + k_1(i)f_1(i) , \qquad (12)$$

where $F_1(i)$ is the proportion of mothers in age group i, constructed by the cumulation and interpolation of first-birth rates for a given year; $\phi_1(i-1)$ is cumulated first-birth rates to the upper limit of age group (i-1), that is,

$$\phi 1(i-1) = 5 \sum_{j=1}^{i=1} f(j) , \qquad (13)$$

where $f_1(i)$ is the age-specific fertility rate for first births obtained from information on first births occurring during a given year; and $k_1(i)$ are tabulated multipliers to interpolate between cumulated proportions of mothers for point ages, $\phi_1(i)$.

This variant of the P/F ratio method is less affected by recent changes in marital fertility, especially when those changes occur at older ages or at high birth orders and hence do not affect the incidence of first births. However, it is not possible to assume that the errors observed in reports of first births are similar to those affecting all births, so it cannot be used to obtain an adjustment factor for overall fertility. The method was applied, therefore, only as an additional test for the presence or absence of reference-period errors. The method is rather sensitive to the effects of rising age at first marriage and provides a useful indicator of such changes.

The results obtained when applying this method are summarized in Table 18. (The details of the application are shown in Table 19.) The proportion of mothers observed in age group 45-49 (92 percent) is similar for both the EDEN survey and the census sample and is consistent with normal expectations. However, the proportions of women who will ultimately become mothers, obtained by cumulating first-birth rates from the EDEN (68 percent) and from the census (76 percent), are lower than would be expected.

This fact confirms that there is some reference-period error (or underreporting of births in the year before the survey) and that this error was larger in the EDEN than in the census. However, there is still uncertainty concerning the adjustment factor that should be used to correct all births. The P/F ratio selected from first-birth data may not be appropriate for births of all orders. The first-birth ratios from the EDEN are somewhat lower than the corresponding all-birth ratios, as is normally the case. The first-birth ratios from the census, however, are on average slightly higher than those for all births, an anomalous feature of the Bolivian data. Rising age at marriage would tend to inflate the ratios for young women relative to those for women aged 25 and over; the EDEN ratios show no such trend, whereas the census ratios are high for women aged 15-19, and, to a lesser extent, for women aged 20-24. As a result of this inconsistency, no firm conclusions can be drawn about recent changes in age at marriage.

FERTILITY ESTIMATES OBTAINED FROM OWN-CHILDREN REVERSE PROJECTION

The method of estimating recent fertility by reverse projection of young children to their birth year is well known (see reverse projection in glossary). One of its fundamental limitations is that the ages of the mothers of the enumerated children are not known, which makes it impossible to estimate age-specific fertility rates.

The own-children method proposed by Cho (Cho and Feeney, 1978) attempts to solve this problem by using information on household structure to identify the mothers of all the enumerated children living with their mothers on the basis of age, relationship to the head of the household, and other information. This assignment can be based on survey identification of the mother of each child or can be carried out by a special computer program which allocates all the children in a household to the woman most likely, on the basis of pre-established criteria, to be their mother. Children for whom a mother cannot be found according to these criteria are called "non-own children" and are later allocated following the proportional distribution of "own children" by age of mother.

This method was applied to data from both the EDEN and a sample of the 1976 census. Since no specific information was available to identify the mother of each child, the computer assignation procedure was used. In both cases the percentage of children assigned was acceptable: 91 percent for EDEN, 90 percent for the census sample. Appendix Tables A-1 and A-2 show the basic tabulations.

For the reverse projection of the children, a West model life table of level 10.5 for both sexes was used for the entire period 1960-75. The choice of mortality level for reverse-projecting the mothers is much less important to the final estimates, but a level 13 West model life table was assumed to represent adult female mortality over the period.

Table 20 shows the age-specific fertility rates and the corresponding total fertility rates for three-year periods obtained from the EDEN and from the census. Figure 8 shows the estimates of total fertility by year and source, together with the estimates obtained by applying the P/F ratio method. The irregularities observed in the general trend arise largely from errors in age reporting among children. There is a clear preference for ages ending in even numbers, with 12 apparently being the most attractive. However, there is no clear fertility trend if the estimates based on children aged 0, 1, and 2 are excluded; these ages generally are excluded from consideration because typically they are seriously distorted by age misreporting and/or omission of young children.

CONCLUSIONS REGARDING FERTILITY

As a result of the procedure used in allocating children to mothers, the age structure of fertility obtained by the own-children method may be biased toward older ages. It was therefore decided that the best available estimate of both level and age pattern of fertility is that obtained by applying the Brass P/F ratio method to the 1976 census data and using the ratio P(3)/F(3) as the adjustment factor. Table 21 shows the adjusted age-specific fertility rates selected as the best available estimates of fertility in Bolivia during the recent past. The main difference between the estimates based on the census questions on fertility and those based on the own-children method is in age pattern. The average level of total fertility obtained by the own-children method (excluding the estimates based on children aged 0, 1, and 2) is 6.5 from the EDEN survey and 6.4 from the 1976 census, which agree well with the 6.5 obtained from the application of the P/F ratio method to the census. However, the accepted estimates of age-specific fertility rates show a rather earlier age pattern of fertility and a rather lower spread than do the own-children estimates. There is no evidence of any sustained trend in fertility from the early 1960s to the early 1970s, and the apparent downturn in the mid-1970s indicated by the own-children estimates must be discounted because of the likely bias introduced by errors of age reporting or coverage that typically affect information concerning young children. There is some indication however that age-specific fertility rates for women under 20 have declined modestly over the period, perhaps as a result of rising age at marriage.

CHAPTER 3

STRUCTURE AND GROWTH OF THE POPULATION

The Bolivian population cannot be regarded as closed to migration; for the period 1970-75, CELADE has estimated the annual migration rate to be -1.7 per 1,000. However, given the fact that Bolivian fertility has been effectively constant and that mortality has declined only very slowly, it seems worthwhile to calculate the birth rate, death rate, rate of natural increase, and age structure of a stable population experiencing the vital rates estimated for Bolivia.

Life tables have been constructed for 1950-51 and for the period 1960-76, but fertility estimates are available only for the latter period. However, since the own-children fertility results show no evidence of any trend in fertility, it seems reasonable to construct a stable population age structure for the earlier period using the age-specific fertility rates summarized in Table 21.

Table 22 summarizes the stable population generated for 1950, comparing its age distribution to that of the enumerated population. The comparison is shown graphically in Part A of Figure 9. The age distribution of the stable population is somewhat younger than that of the reported population, particularly for females; for example, the stable proportion under 30 is 68.2 percent instead of 65.4 percent for females, and 69.5 percent instead of 68.3 percent for males. The stable population has a rate of natural increase younger than the observed, and by a rather similar amount: the stable proportion of females under 30 is 69.8 percent as opposed to the observed 67.5 percent, the comparable figures for males being 70.8 percent against 69.6 percent. A stable population using the same mortality rates but calculated using a growth rate of 2.25 percent fits the observed age distributions very closely, suggesting that the actual rate of growth of the population was lower than the rate of natural increase implied by the available estimates of fertility and mortality. This lower growth rate probably results from net emigration.

The observed intercensal growth rate between 1950 and 1976 was 2.08 percent for both males and females, consistent with the rates of growth of the stable populations which best fit the observed 1950 and 1976 age distributions, 1.75 percent and 2.25 percent, respectively. However, they are not consistent with the calculated rates of natural increase for those years, the rates of natural increase being some quarter of a percent higher than the growth rates suggested by intercensal growth and the two age distributions. If the various possible explanations of this discrepancy are considered--that mortality has been underestimated, that fertility has been overestimated, that the census enumeration was some 7 percent less complete in 1976 than in 1950, or that steady emigration of young adults of both sexes was slowing the rate of population growth--the last is the only one for which there is any evidence. Of all the estimates available, those of the level of child mortality from the mid-1960s to the early 1970s are probably the strongest, given the agreement between the EDEN and the census results, so it is unlikely that mortality has been substantially underestimated. As for fertility, the agreement between the own-children and the parity-based P/F ratio estimates makes it unlikely that fertility was overestimated. Underenumeration in 1976 might explain the growth rate discrepancy, but cannot explain the discrepancy with the age distributions. The final possibility, emigration, is supported qualitatively by birthplace information from censuses of neighboring countries, particularly Argentina, though the quantitative value of such information is limited by reporting deficiencies.

TABLES AND FIGURES: BOLIVIA

TABLE 1 Socioeconomic Indicators, 1971-76: Bolivia

Population living in rural areas (1976)	58%
Population illiterate among those aged 10 and over (1976)	33%
Population with no schooling or with only basic schooling among those aged 5 and over (1976)	76%
Population aged 5 to 25 attending school	53%
Labor force engaged in agriculture	46%
Labor force that is either self employed or works on an unpaid basis within the family	61%
GNP derived from agriculture (1976)	15%
GNP per capita (1976) (in 1970 U.S. dollars)	$318
Average number of years of schooling among those aged 15 and over (1976)	3.6
Average number of inhabitants per square kilometer (1976)	4.2

Sources: Proyecto Politicas de Poblacion (1973) and CEPAL (1978).

TABLE 2 Summary of Data Sources and Analytical Methods Used in Estimating Fertility and Mortality Measures: Bolivia

Sources	Data	Method	Result
Part A. Estimation of Mortality			
1950 Census and 1951 Vital Statistics	Population classified by age and sex Deaths classified by age and sex	Age structure of deaths (Brass-Preston) and a truncated variant (Somoza)	Expectation of life at birth and at age 5
1975 EDEN and 1976 Census	Females classified by age group Children ever born Children surviving	Brass-Sullivan, Feeney, and Trussell child mortality estimation procedures	Probability of dying between birth and exact age 2 [q(2)] and trend in infant mortality
1975 EDEN	Population classified by age group Number of persons with surviving mother	Hill-Trussell "orphanhood" estimation procedure	Probability of surviving from age 25 to age 25 + N for N = 20, 25,...50 among females [l(25+N)/l(25)]
1975 EDEN	q(2) l(25+N)/l(25)	Brass logit life table system	Life table for females
1975 EDEN	Ever-married female population classified by five-year age groups Number of females with surviving first spouse	Hill-Trussell "widowhood" estimation procedure	Probability of surviving from age 20 to age N + 5, for N = 20, 25,...55 among males [l(N+5)/l(20)]
1975 EDEN	q(2)	Brass logit life table system	Life table for males

Part B. Estimation of Fertility

1975 EDEN and 1976 Census	Female population classified by five-year age groups Children ever born Births during the year preceding the census or survey	Brass P/F ratio consistency check	Age-specific fertility rates and total fertility rate
1975 EDEN	Female population by five-year age groups Proportion of mothers (women with at least one child) First births during the year preceding the survey	Brass P_1/F_1 ratio consistency check	Estimation of reference-period error in the reporting of recent births
1975 EDEN and 1976 Census	Female population by five-year age groups Population between ages 0 and 15, classified by single years of age of mother Life tables for children, adult females	Own-children variant of reverse survival	Age-specific fertility rates, total fertility rates, and fertility trends

TABLE 3 Demographic Indicators, Circa 1950 and 1960-76: Bolivia

Indicator	1950	1960-76
Expectation of life at birth (years)		
Males	37.0	46.0
Females	39.9	49.0
Both sexes	38.4	47.5
Infant mortality rate (per 1,000)		
Males	227[a]	165
Females	195[a]	141
Both sexes	211[a]	152
Total fertility rate	--	6.5
Gross reproduction rate (percent)	--	3.2
Birth rate (per 1,000)	46.0[a]	45.4
Death rate (per 1,000)	24.7[a]	19.1
Rate of natural increase (per 1,000)	21.4[a]	26.3
Net reproduction rate (percent)	--	2.1

[a]Figures based on extrapolation of adult mortality estimates.

TABLE 4 Growth Balance Equation Method Applied to 1951 Registered Deaths and 1950 Census Population: Bolivia

	Male			Female		
Age	b(x)	d(x)	r(x)	b(x)	d(x)	r(x)
5-9	0.03687	0.01174	0.02513	0.03386	0.01120	0.02266
10-14	0.03653	0.01297	0.02356	0.03159	0.01224	0.01935
15-19	0.03561	0.01464	0.02097	0.03007	0.01348	0.01659
20-24	0.03625	0.01651	0.01974	0.03633	0.01509	0.02124
25-29	0.04189	0.01858	0.02331	0.04173	0.01696	0.02477
30-34	0.04304	0.02150	0.02154	0.04342	0.01946	0.02396
35-39	0.04506	0.02435	0.02071	0.04539	0.02208	0.02331
40-44	0.04950	0.02862	0.02088	0.05035	0.02596	0.02439
45-49	0.04889	0.03271	0.01618	0.05090	0.03047	0.02043
50-54	0.05385	0.03780	0.01605	0.05684	0.03639	0.02045
55-59	0.05585	0.04566	0.01019	0.06018	0.04436	0.01582
60-64	0.07330	0.05093	0.02237	0.07221	0.05376	0.01845
65-69	0.10257	0.06704	0.03553	0.09553	0.07318	0.02235
70-74	0.09255	0.08116	0.01139	0.08915	0.09131	-0.00216
75-79	0.10316	0.10390	-0.00074	0.10973	0.12559	-0.01586
80-84	0.10321	0.12009	-0.01688	0.10814	0.15292	-0.04478

Note: $b(x) = \frac{N^0(x)}{N^0(x+)}$, $d(x) = \frac{D^0(x+)}{N^0(x+)}$, $r(x) = b(x) - d(x)$.

TABLE 5 Results Obtained by Applying the Brass Growth Balance Equation, 1950-51: Bolivia

	Rate of Growth r	Adjustment Factor f	Expectation of Life at Age 5 e(5)	West Mortality Level
Males	0.023	0.933	53.7	13.0
Females	0.022	0.962	55.9	13.0

TABLE 6 Application of the Truncated Version of the Growth Balance Equation Method, 1950-51: Bolivia

Part A. "Decreasing" Equation, with x + n = 55

x	n	$\frac{N(x)}{{}_nN_x}$	$\frac{N(55)}{{}_nN_x}$	$\frac{{}_nD_x}{{}_nN_x}$	$\frac{N(55)+{}_nD_x}{{}_nN_x}$
30	25	0.0606	0.0234	0.0109	0.0343
35	20	0.0698	0.0316	0.0118	0.0435
40	15	0.0914	0.0484	0.0132	0.0616
45	10	0.1174	0.0787	0.0146	0.0934
50	5	0.2209	0.1739	0.0162	0.1901
55	0	--	--	--	--

Part B. "Increasing" Equation, with x = 30

x	n	$\frac{N(30)}{{}_nN_{30}}$	$\frac{N(30+n)}{{}_nN_{30}}$	$\frac{{}_nD_{30}}{{}_nN_{30}}$	$\frac{N(30+n)+{}_nD_{30}}{{}_nN_{30}}$
30	0	--	--	--	--
35	5	0.2327	0.1982	0.0085	0.2067
40	10	0.1174	0.0857	0.0088	0.0945
45	15	0.0863	0.0497	0.0094	0.0590
50	20	0.0700	0.0343	0.0101	0.0445
55	25	0.0606	0.0234	0.0109	0.0343

TABLE 7 Observed Mortality Rates for 1950 and Corresponding Levels in Coale-Demeny West Model Life Tables: Bolivia

	Male		Female	
Age Group	Observed $_5m_x$	West Mortality Level	Observed $_5m_x$	West Mortality Level
30-34	0.0090	11.9	0.0081	12.4
35-39	0.0096	12.9	0.0086	12.9
40-44	0.0127	12.3	0.0095	13.0
45-49	0.0158	12.3	0.0111	13.0
50-54	0.0190	13.6	0.0140	13.8

TABLE 8 Adjusted Age-Specific Mortality Rates in 1951, Adjusted for Estimated Coverage Error, and Implied Mortality Levels in the Coale-Demeny Regional Families: Bolivia

Age Group	Adjusted $_5m_x$	Model Life Table Mortality Level			
		North	South	East	West
Females[a]					
0-4	.07041	8.7	10.3	10.2	9.0
5-9	.00669	13.7	10.3	9.3	9.3
10-14	.00446	12.4	8.9	7.8	10.7
15-19	.00552	11.1	10.1	8.8	11.4
20-24	.00774	9.1	9.1	8.1	10.5
25-29	.00800	10.3	9.6	9.4	11.3
30-34	.00953	10.1	8.3	8.8	10.9
35-39	.01017	10.8	8.3	9.1	11.3
40-44	.01121	10.9	7.8	8.9	11.3
45-49	.01312	10.1	6.9	8.5	11.0
50-54	.01645	10.0	7.6	9.3	11.8
Average		10.7	8.8	8.9	10.8
Males[b]					
0-4	.07354	9.5	10.6	11.1	9.7
5-9	.00677	14.1	9.8	8.9	8.7
10-14	.00433	12.6	7.5	5.9	9.8
15-19	.00662	9.7	7.4	6.0	8.9
20-24	.00816	11.4	9.7	8.2	10.5
25-29	.00768	12.7	10.3	9.1	12.1
30-34	.01016	10.2	7.5	7.2	10.7
35-39	.01102	10.8	7.8	8.7	11.6
40-44	.01456	9.7	6.7	8.0	10.9
45-49	.01803	9.4	6.2	8.2	10.8
50-54	.02176	9.9	7.3	9.3	11.9
Average		10.9	8.3	8.2	10.5

[a]Adjustment factor 1.178.
[b]Adjustment factor 1.143.

TABLE 9 Summary Life Tables by Sex, 1951: Bolivia

Age x	$_nq_x$	l_x	$_nL_x$	e_x
Males				
0	.22706	100,000	84,787	37.049
1	.13142	77,294	282,278	46.836
5	.03547	67,136	329,728	49.718
10	.02006	64,755	320,527	46.454
15	.02818	63,456	312,808	42.354
20	.03992	61,667	302,183	38.510
25	.04409	59,206	289,503	35.007
30	.05067	56,595	275,808	31.507
35	.05977	53,728	260,610	28.055
40	.07318	50,516	243,340	24.680
45	.08814	46,820	223,783	21.430
50	.11446	42,693	201,248	18.260
55	.14609	37,806	175,223	15.298
60	.20058	32,283	145,228	12.487
65	.26980	25,808	111,633	9.993
70	.36788	18,845	76,893	7.761
75	.49976	11,912	44,678	5.823
80	1.00000	5,959	24,685	4.142
Females				
0	.19518	100,000	87,313	39.902
1	.13126	80,482	294,050	48.495
5	.03747	69,918	343,040	51.616
10	.02248	67,298	332,707	48.528
15	.02998	65,785	323,995	44.587
20	.03790	63,813	313,017	40.887
25	.04270	61,394	300,417	37.400
30	.04832	58,773	286,765	33.956
35	.05362	55,933	272,167	30.553
40	.05891	52,934	256,875	27.143
45	.06625	49,816	240,827	23.685
50	.08706	46,515	222,453	20.189
55	.11346	42,466	200,283	16.875
60	.16495	37,647	172,713	13.715
65	.22646	31,438	139,390	10.930
70	.32578	24,318	101,785	8.399
75	.45262	16,396	63,427	6.249
80	1.00000	8,975	39,024	4.348

TABLE 10 Child Mortality Estimates Derived from Proportion Dead Among Children Ever Born, 1975 EDEN and 1976 Census: Bolivia

Age Group of Mother	x	Proportion Dead	Estimated $_xq_0$	Estimated Time Ago t*	West Mortality Level
Part A. Estimates for Both Sexes Combined					
1975 EDEN					
15-19	1	0.137	0.156	0.9	11.2
20-24	2	0.200	0.218	2.1	10.1
25-29	3	0.208	0.213	3.8	11.2
30-34	5	0.236	0.243	5.9	10.8
35-39	10	0.263	0.274	8.2	10.4
40-44	15	0.273	0.282	10.9	10.7
45-49	20	0.289	0.296	13.9	10.9
P(1)/P(2) = 0.114			P(2)/P(3) = 0.397		
1976 Census					
15-19	1	0.163	0.177	1.0	9.9
20-24	2	0.201	0.212	2.3	10.4
25-29	3	0.228	0.229	4.1	10.5
30-34	5	0.250	0.253	6.4	10.4
35-39	10	0.264	0.272	8.9	10.5
40-44	15	0.282	0.287	11.6	10.5
45-49	20	0.298	0.301	14.5	10.7
P(1)/P(2) = 0.149			P(2)/P(3) = 0.456		
Part B. Estimates by Sex from 1975 EDEN					
Males					
15-19	1	0.155	0.175	1.0	10.8
20-24	2	0.227	0.248	2.1	9.4
25-29	3	0.212	0.218	3.7	11.5
30-34	5	0.241	0.249	5.8	11.1
35-39	10	0.272	0.285	8.1	10.4
40-44	15	0.297	0.307	10.7	10.1
45-49	20	0.304	0.312	13.7	10.7
P(1)/P(2) = 0.115			P(2)/P(3) = 0.392		
Females					
15-19	1	0.118	0.135	0.9	11.8
20-24	2	0.171	0.186	2.1	11.0
25-29	3	0.203	0.205	3.8	10.9
30-34	5	0.230	0.236	5.9	10.6
35-39	10	0.253	0.263	8.3	10.4
40-44	15	0.247	0.254	11.0	11.4
45-49	20	0.273	0.279	14.0	11.2
P(1)/P(2) = 0.113			P(2)/P(3) = 0.403		

TABLE 11 Estimation of Fertility Using the P/F Ratio Method, 1975 EDEN: Bolivia

Age at Survey x, x+4	Index i	Current Fertility f(i)	Multiplier k(i)	Average Parity Equivalent F(i)	Reported Average Parity P(i)	P/F Ratio	Adjusted Age-Specific Fertility Rates[a]: Reported Age Groups	Adjusted Age-Specific Fertility Rates[a]: True Age Groups
15-19	1	0.0444	1.752	0.0778	0.1143	1.469	0.0625	0.0776
20-24	2	0.1703	2.804	0.6995	1.0017	1.432	0.2396	0.2541
25-29	3	0.2511	2.995	1.8255	2.5228	1.382	0.3533	0.3566
30-34	4	0.2174	3.077	2.9979	4.0925	1.365	0.3059	0.2995
35-39	5	0.1596	3.192	3.9254	5.4064	1.377	0.2246	0.2148
40-44	6	0.0786	3.380	4.4797	6.0151	1.343	0.1106	0.1027
45-49	7	0.0468	3.915	4.7902	6.1694	1.288	0.0658	0.0570
Total Fertility		4.875					6.8	6.8

[a]Adjustment factor = 1/2(P(2)/F(2) + P(3)/F(3)).

TABLE 12 Estimation of Fertility Using the P/F Ratio Method, 1976 Census: Bolivia

Age at Survey x, x+4	Index i	Current Fertility f(i)	Multiplier k(i)	Average Parity Equivalent F(i)	Reported Average Parity P(i)	P/F Ratio	Adjusted Age-Specific Fertility Rates		
							$_5f_{x-0.5}$[a]	$_5f_x$[a]	$_5f_x$[b]
15-19	1	0.0693	1.860	0.1289	0.1779	1.380	0.0803	0.0978	0.0952
20-24	2	0.2321	2.824	1.0019	1.1909	1.188	0.2689	0.2805	0.2732
25-29	3	0.2689	3.003	2.3146	2.6120	1.129	0.3115	0.3123	0.3042
30-34	4	0.2459	3.084	3.6100	4.0254	1,115	0.2849	0.2805	0.2732
35-39	5	0.1934	3.202	4.7002	5.1153	1.088	0.2241	0.2159	0.2103
40-44	6	0.1047	3.403	5.4043	5.7279	1.060	0.1213	0.1126	0.1097
45-49	7	0.0430	4.014	5.7441	5.8765	1.023	0.0498	0.0412	0.0402
Total Fertility		5.26					6.7	6.7	6.5

[a]Adjustment factor = 1/2(P(2)/F(2) + P(3)/F(3)).
[b]Adjustment factor = P(3)/F(3).

TABLE 13 Estimation of Female Adult Mortality Based on Orphanhood Information, 1975 EDEN: Bolivia

Age x	Proportion with Mother Alive $_5PNO_{x-5}$	Probability of Surviving from Age 25 $\frac{l(25+x)}{l(25)}$	West Mortality Level	Time Reference of Estimates (years before survey)
20	0.9252	0.9292	18.7	7.7
25	0.8807	0.8919	18.2	9.4
30	0.7896	0.8102	16.2	11.1
35	0.6915	0.7225	15.1	12.5
40	0.5737	0.6121	14.2	13.8
45	0.4467	0.4837	13.7	14.9
50	0.3546	0.3831	15.3	15.1
Average Level				15.9

Note: Mean age of mothers at childbearing ($\bar{M}$) = 28.8 years.

TABLE 14 Estimation of Male Adult Mortality Based on Widowhood Information, 1975 EDEN: Bolivia

Age x	Proportion of Respondents with Husband Alive $_5PNW_x$	Probability of Surviving from Age 20 $\frac{l(x+5)}{l(20)}$	West Mortality Level	Time Reference (years before survey)
20	0.9798	0.9739	14.6	a
25	0.9729	0.9582	16.7	2.1
30	0.9514	0.9332	16.6	4.5
35	0.9170	0.8970	16.0	6.8
40	0.8735	0.8543	15.7	8.9
45	0.8195	0.8029	15.5	10.7
50	0.7054	0.6931	13.5	12.6
55	0.6520	0.6451	15.0	13.8
Average Level			15.5	

Note: $SMAM_f$ = 22.78, $SMAM_m$ = 25.27.

[a]The computed value is negative.

TABLE 15 Summary Life Tables by Sex, 1960-75: Bolivia

Age	Male				Female			
x	$_nq_x$	l_x	$_nL_x$	e_x	$_nq_x$	l_x	$_nL_x$	e_x
0	0.1652	100,000	89,100	46.0	0.1409	100,000	90,840	49.0
1	0.0609	83,485	80,485	54.1	0.0536	85,907	83,190	56.0
2	0.0293	78,399	77,184	56.5	0.0260	81,301	80,182	58.1
3	0.0159	76,105	75,476	57.2	0.0142	79,191	78,607	58.7
4	0.0090	74,895	74,544	57.1	0.0080	78,069	77,743	58.5
5-9	0.0242	74,221	366,619	56.7	0.0216	77,442	383,019	58.0
10-14	0.0138	72,427	359,639	53.0	0.0124	75,766	376,484	54.2
15-19	0.0201	71,429	353,551	48.7	0.0181	74,828	370,748	49.9
20-24	0.0279	69,992	345,073	44.7	0.0253	73,471	362,717	45.7
25-29	0.0291	68,037	335,239	40.9	0.0265	71,615	353,340	41.9
30-34	0.0311	66,058	325,155	37.0	0.0284	69,721	343,655	37.9
35-39	0.0343	64,004	314,525	33.1	0.0315	67,741	333,369	34.0
40-44	0.0405	61,806	302,766	29.2	0.0374	65,607	321,900	30.0
45-49	0.0485	59,300	289,311	25.3	0.0450	63,153	308,660	26.1
50-54	0.0650	56,424	272,946	21.5	0.0608	60,311	292,389	22.2
55-59	0.0891	52,754	252,026	17.8	0.0840	56,645	271,331	18.4
60-64	0.1338	48,056	224,206	14.3	0.1276	51,888	242,881	14.9
65-69	0.1981	41,626	187,517	11.2	0.1917	45,265	204,633	11.7
70-74	0.3036	33,380	141,566	8.3	0.2985	36,588	155,636	8.9
75-79	0.5504[a]	23,246	84,245	5.8	0.4472	25,666	99,635	6.6
80-84	0.6211[a]	10,452	36,030	4.9	0.6185	14,188	49,002	4.9
85+	1.0000	3,960	14,866	3.8	1.0000	5,413	20,847	3.9

[a]Values adjusted to achieve consistency with corresponding values for females.

TABLE 16 Mortality Estimates Derived from Intercensal Mortality Change, 1950-76: Bolivia

Age Group x, x+4	Enumerated Population 1950	1976	$_5r_x$	$_5L_x$	e(x)	West Mortality Level
Males						
0	215,614	369,849	0.0208	308,321	n.a.	n.a.
5	193,742	322,530	0.0196	300,745	48.25	9.20
10	141,117	279,488	0.0263	374,799	45.84	10.03
15	135,033	240,690	0.0222	277,129	42.82	10.86
20	116,107	195,092	0.0200	255,070	39.20	11.08
25	103,600	171,393	0.0194	248,677	36.35	11.75
30	77,516	136,372	0.0217	214,345	34.18	13.28
35	77,182	121,810	0.0175	219,992	31.50	14.71
40	54,562	91,622	0.0199	177,489	28.88	16.56
45	48,864	93,507	0.0250	193,392	26.17	18.55
50	38,757	63,598	0.0190	155,206	22.30	18.70
55	30,473	54,432	0.0223	142,771	20.87	22.63
60	38,044	48,810	0.0096	158,171	15.92	20.81
65	18,813	35,038	0.0239	106,637	12.12	19.03
70	15,079	19,540	0.0100	74,614	11.83	25.00
75	21,540	36,057	0.0198	139,827	n.a.	n.a.
Females						
0	210,049	371,469	0.0219	307,143	n.a.	n.a.
5	185,428	320,168	0.0210	297,302	51.98	10.44
10	124,902	272,877	0.0301	265,753	50.52	11.91
15	133,000	247,831	0.0239	291,201	46.30	11.80
20	130,267	216,618	0.0196	295,715	38.98	8.95
25	117,735	172,446	0.0147	269,483	35.24	8.58
30	89,232	141,445	0.0177	232,296	34.33	10.87
35	86,613	130,439	0.0157	237,649	31.71	11.82
40	64,813	102,749	0.0177	199,475	28.65	12.50
45	55,283	100,716	0.0231	205,648	25.99	14.22
50	47,413	74,169	0.0172	177,258	22.13	14.08
55	33,188	59,249	0.0223	148,754	20.56	18.54
60	39,069	52,517	0.0114	160,327	16.87	18.73
65	19,209	36,323	0.0245	106,335	13.54	19.14
70	18,050	27,596	0.0163	96,798	12.54	23.86
75	23,744	41,376	0.0214	157,961	n.a.	n.a.

TABLE 17 Fertility Estimates Obtained by Applying the P/F Ratio Method to the 1975 EDEN and 1976 Census Data: Bolivia

		1975 EDEN			1976 Census			
Age Group	i	Ratio P(i)/F(i)	Adjusted Age-Specific Fertility Rates f(i)[a]	Relative Distribution	Ratio P(i)/F(i)	Adjusted Age-Specific Fertility Rates f(i)[a]	Adjusted Age-Specific Fertility Rates f(i)[b]	Relative Distribution
15-19	1	1.469	0.0776	5.7	1.380	0.0978	0.0952	7.3
20-24	2	1.432	0.2541	18.7	1.188	0.2805	0.2732	20.9
25-29	3	1.382	0.3566	26.2	1.129	0.3123	0.3042	23.3
30-34	4	1.365	0.2995	22.0	1.115	0.2805	0.2732	20.9
35-39	5	1.377	0.2148	15.8	1.088	0.2159	0.2103	16.1
40-44	6	1.343	0.1027	7.5	1.060	0.1126	0.1097	8.4
45-49	7	1.288	0.0570	4.1	1.023	0.0412	0.0402	3.1
Total Fertility			6.81			6.70	6.53	
Mean				30.6				30.3
Standard Deviation				7.4				7.6

[a]Adjusted by $1/2(P_2/F_2 + P_3/F_3)$.
[b]Adjusted by P_3/F_3.

Sources: Tables 11 and 12.

TABLE 18 Results Obtained by Applying the P/F Ratio Method to First Births, 1975 EDEN and 1976 Census: Bolivia

Age Group	Index	$P_1(i)/F_1(i)$ EDEN	$P_1(i)/F_1(i)$ Census
15-19	1	1.385	1.400
20-24	2	1.327	1.261
25-29	3	1.389	1.210
30-34	4	1.365	1.185
35-39	5	1.364	1.218

Source: Table 19.

TABLE 19 Comparison of First-Birth Fertility Rates with Observed Proportions of Mothers, 1975 EDEN and 1976 Census: Bolivia

Age at Survey x, x+4	Index i	Current First-Birth Rates $f_1(i)$	Multiplier (i)	Constructed Proportion of Mothers $F_1(i)$	Reported Proportion of Mothers $P_1(i)$	First-Birth P_1/F_1 Ratio
1975 EDEN						
15-19	1	0.0322	1.8525	0.0597	0.0827	1.385
20-24	2	0.0603	3.1417	0.3504	0.4651	1.327
25-29	3	0.0274	3.4542	0.5571	0.7738	1.389
30-34	4	0.0109	4.2849	0.6462	0.8823	1.365
35-39	5	0.0049	--	0.6785	0.9253	1.364
1976 Census						
15-19	1	0.0468	2.1021	0.0984	0.1378	1.400
20-24	2	0.0676	3.1749	0.4486	0.5656	1.261
25-29	3	0.0266	3.5057	0.6653	0.8052	1.210
30-34	4	0.0102	4.4177	0.7501	0.8892	1.185
35-39	5	0.0005	--	0.7585	0.9240	1.218

TABLE 20 Fertility Estimates Based on the Own-Children Method, 1975 EDEN and 1976 Census: Bolivia

	Calendar Period and Ages of Children				
Age Group	1961-63 12-14	1964-66 9-11	1967-69 6-8	1970-72 3-5	1973-75 0-2
Part A. Age-Specific Fertility Rates from 1975 EDEN					
15-19	0.133	0.100	0.098	0.091	0.060
20-24	0.281	0.245	0.270	0.252	0.206
25-29	0.322	0.276	0.301	0.301	0.248
30-34	0.286	0.255	0.282	0.269	0.218
35-39	0.192	0.196	0.210	0.195	0.147
40-44	0.112	0.097	0.124	0.112	0.084
45-49	0.034	0.044	0.041	0.035	0.032
Total Fertility	6.80	6.07	6.63	6.28	4.97
Part B. Age-Specific Fertility Rates From Sample of 1976 Census					
15-19	0.132	0.112	0.116	0.115	0.094
20-24	0.266	0.243	0.269	0.262	0.233
25-29	0.285	0.267	0.300	0.289	0.258
30-34	0.252	0.231	0.247	0.254	0.232
35-39	0.190	0.170	0.193	0.183	0.163
40-44	0.124	0.098	0.129	0.118	0.098
45-49	0.060	0.057	0.090	0.086	0.069
Total Fertility	6.54	5.89	6.72	6.54	5.73

TABLE 21 Estimation of Fertility Using the Brass P/F Method, 1971-76: Bolivia

Age Group	Age-Specific Fertility Rates
15-19	0.0952
20-24	0.2732
25-29	0.3042
30-34	0.2732
35-39	0.2103
40-44	0.1097
45-49	0.0402
Total Fertility Rate	6.5
Mean Age of Childbearing	30.3
Standard Deviation of the Fertility Distribution	7.6

TABLE 22 Age Distributions and Vital Rates of the Reported Population and a Stable Population, 1950: Bolivia

	Proportion Under Age x			
	Male		Female	
Age x	Enumerated	Generated Stable	Enumerated	Generated Stable
5	.1626	.1786	.1524	.1739
10	.3087	.3118	.2870	.3054
15	.4151	.4282	.3776	.4201
20	.5170	.5302	.4742	.5204
25	.6045	.6186	.5687	.6073
30	.6826	.6946	.6541	.6822
35	.7411	.7598	.7189	.7466
40	.7993	.8154	.7817	.8017
45	.8405	.8622	.8288	.8487
50	.8773	.9008	.8689	.8882
55	.9065	.9317	.9033	.9206
60	.9295	.9557	.9274	.9466
65	.9582	.9735	.9557	.9669
70	.9724	.9862	.9697	.9819
75	.9838	.9942	.9828	.9920
80	.9891	.9983	.9886	.9976
Birth Rate		47.3		44.9
Death Rate		25.8		23.5
Growth Rate		21.4		21.4

Note: All rates shown are per 1,000.

TABLE 23 Age Distributions and Vital Rates of the Reported Population and a Stable Population, 1976: Bolivia

	Proportion Under Age x			
	Male		Female	
Age x	Enumerated	Generated Stable	Enumerated	Generated Stable
5	.1624	.1831	.1557	.1784
10	.3029	.3228	.2901	.3167
15	.4263	.4427	.4035	.4353
20	.5351	.5458	.5100	.5371
25	.6224	.6337	.5995	.6240
30	.6958	.7084	.6749	.6980
35	.7545	.7718	.7343	.7609
40	.8053	.8252	.7885	.8141
45	.8464	.8696	.8318	.8586
50	.8885	.9057	.8748	.8954
55	.9180	.9345	.9069	.9254
60	.9414	.9571	.9318	.9496
65	.9616	.9743	.9545	.9688
70	.9755	.9866	.9702	.9831
75	.9845	.9943	.9819	.9926
80	.9912	.9983	.9894	.9978
Birth Rate		46.6		44.2
Death Rate		20.3		18.0
Growth Rate		26.3		26.2

Note: All rates shown are per 1,000.

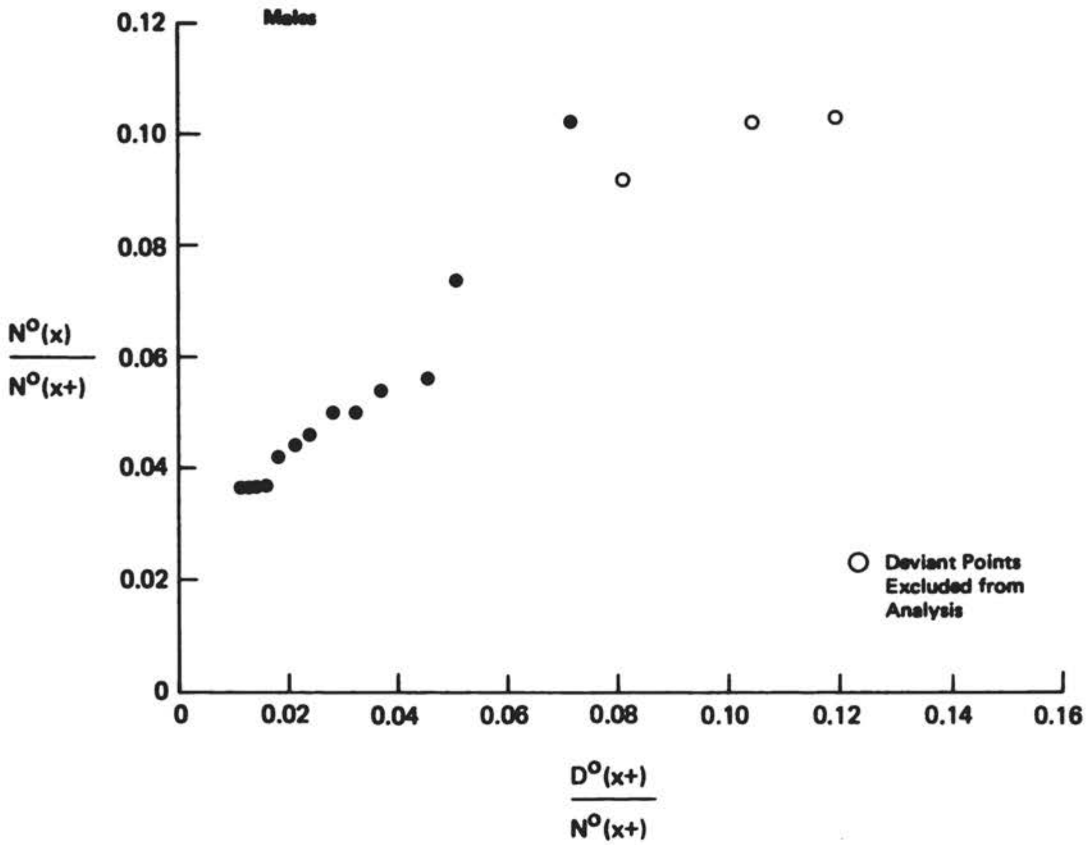

FIGURE 1 Growth Balance Equation Method Applied to 1951 Registered Deaths and 1950 Census Population, Males: Bolivia

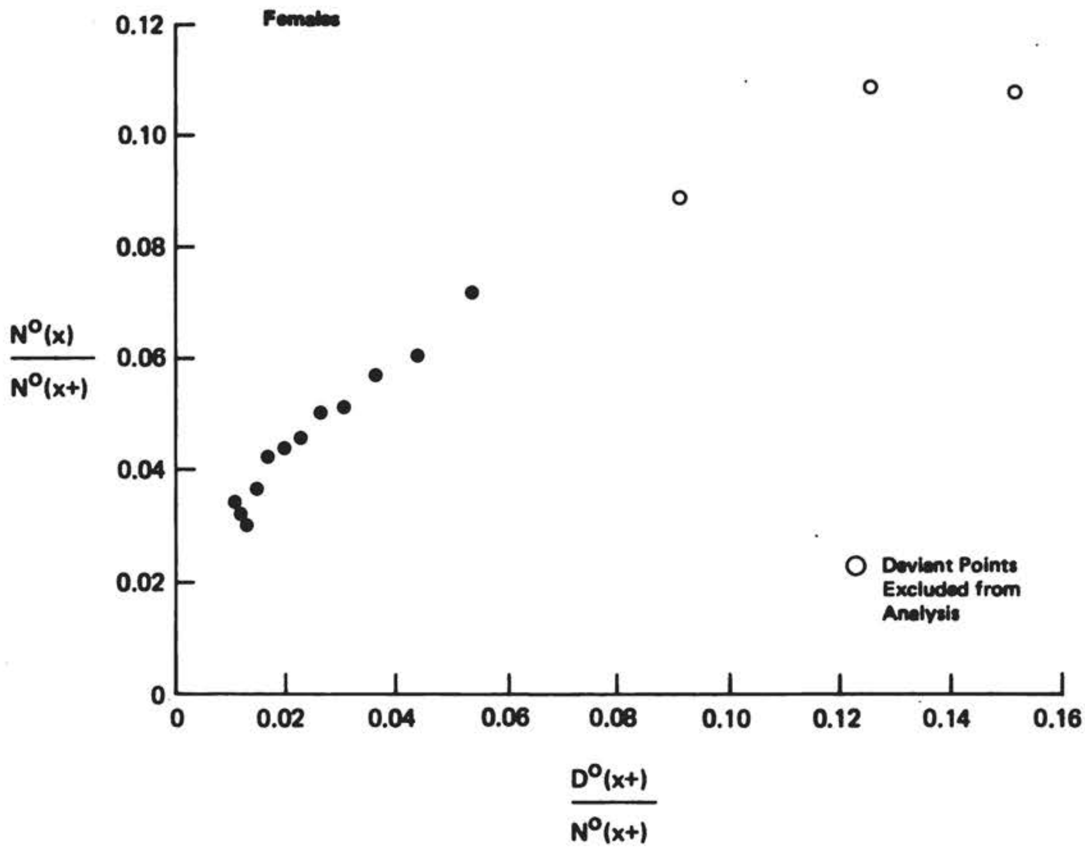

FIGURE 2 Growth Balance Equation Method Applied to 1951 Registered Deaths and 1950 Census Population, Females: Bolivia

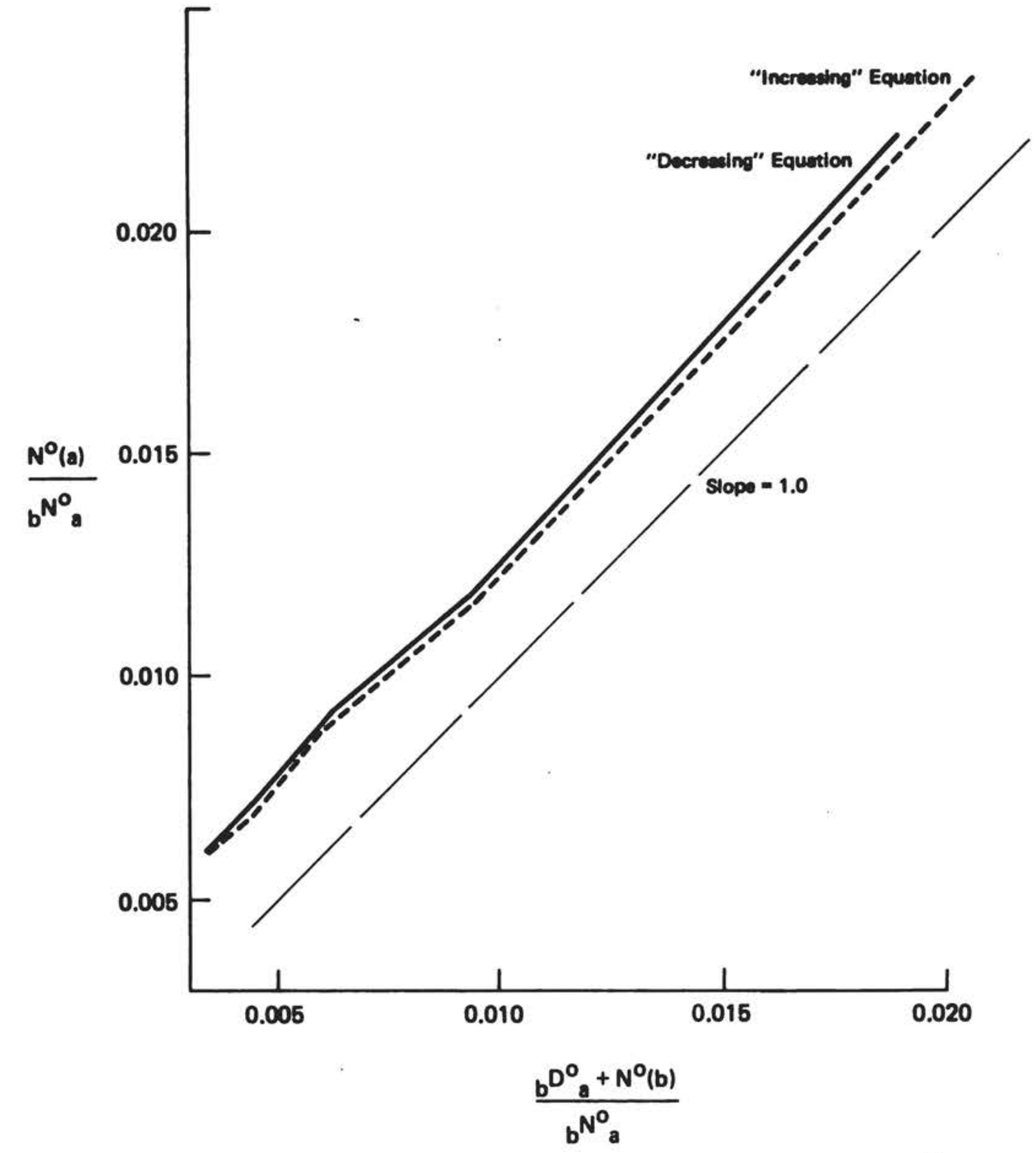

FIGURE 3 Application of a Truncated Variant of the Growth Balance Equation Method, 1950-51, Both Sexes, Age Range 30-55: Bolivia

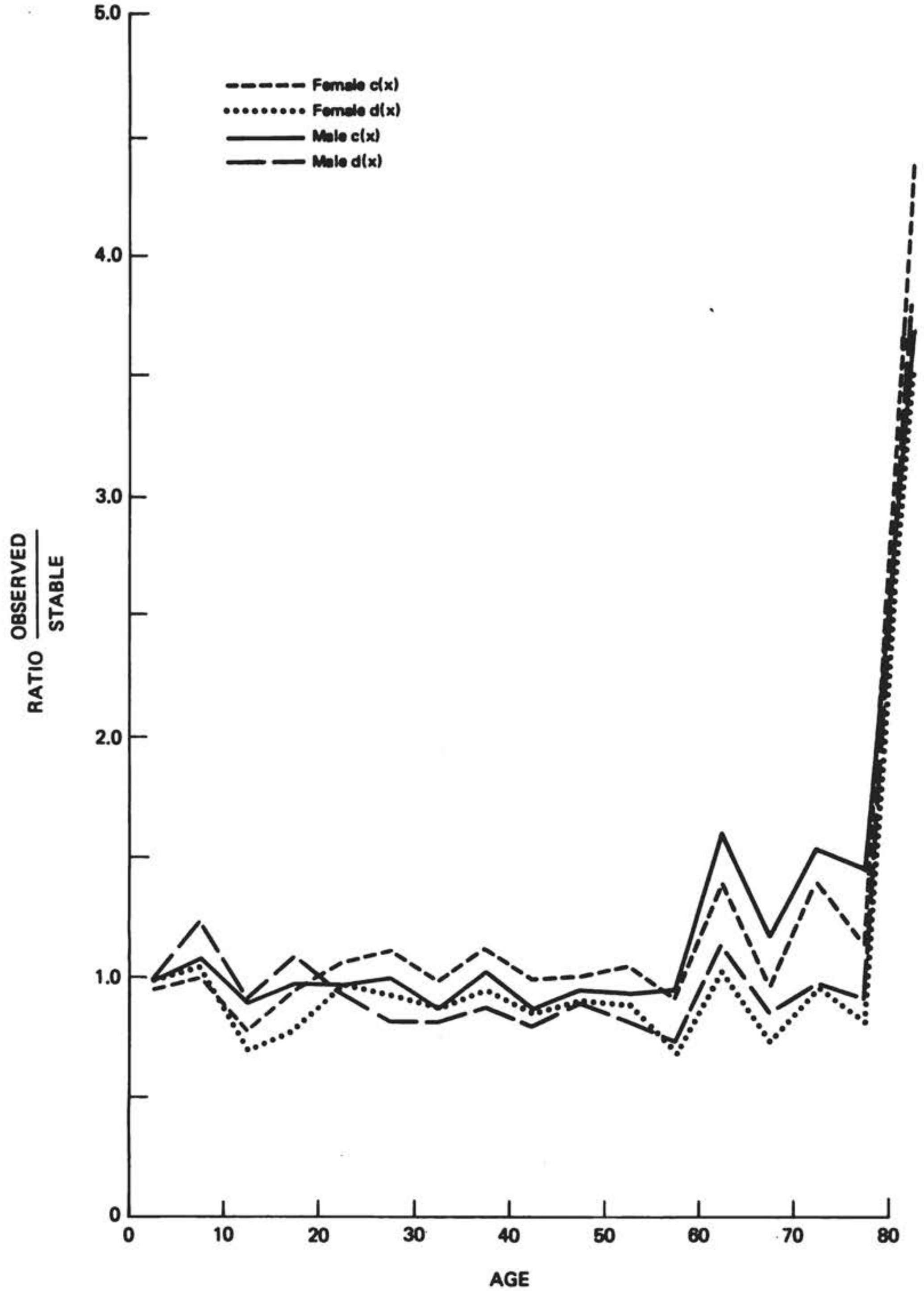

FIGURE 4 Ratios of Observed to Stable Proportions of Population and Deaths in Each Age Group by Sex, 1950-51: Bolivia

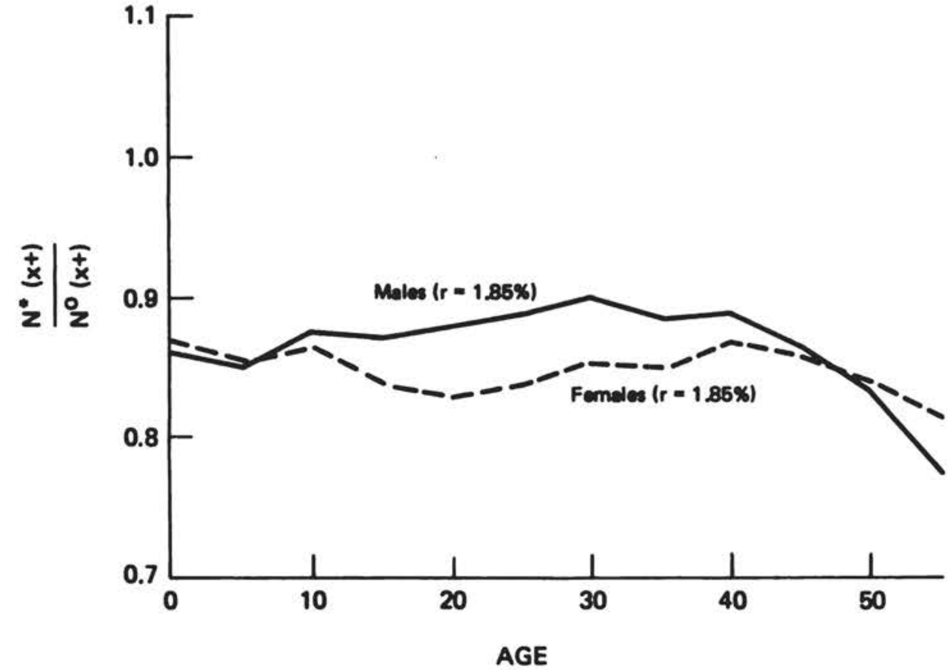

FIGURE 5 Ratios of Expected Population Over Age x Based on Recorded Deaths to Enumerated Population Over Age x, 1950-51: Bolivia

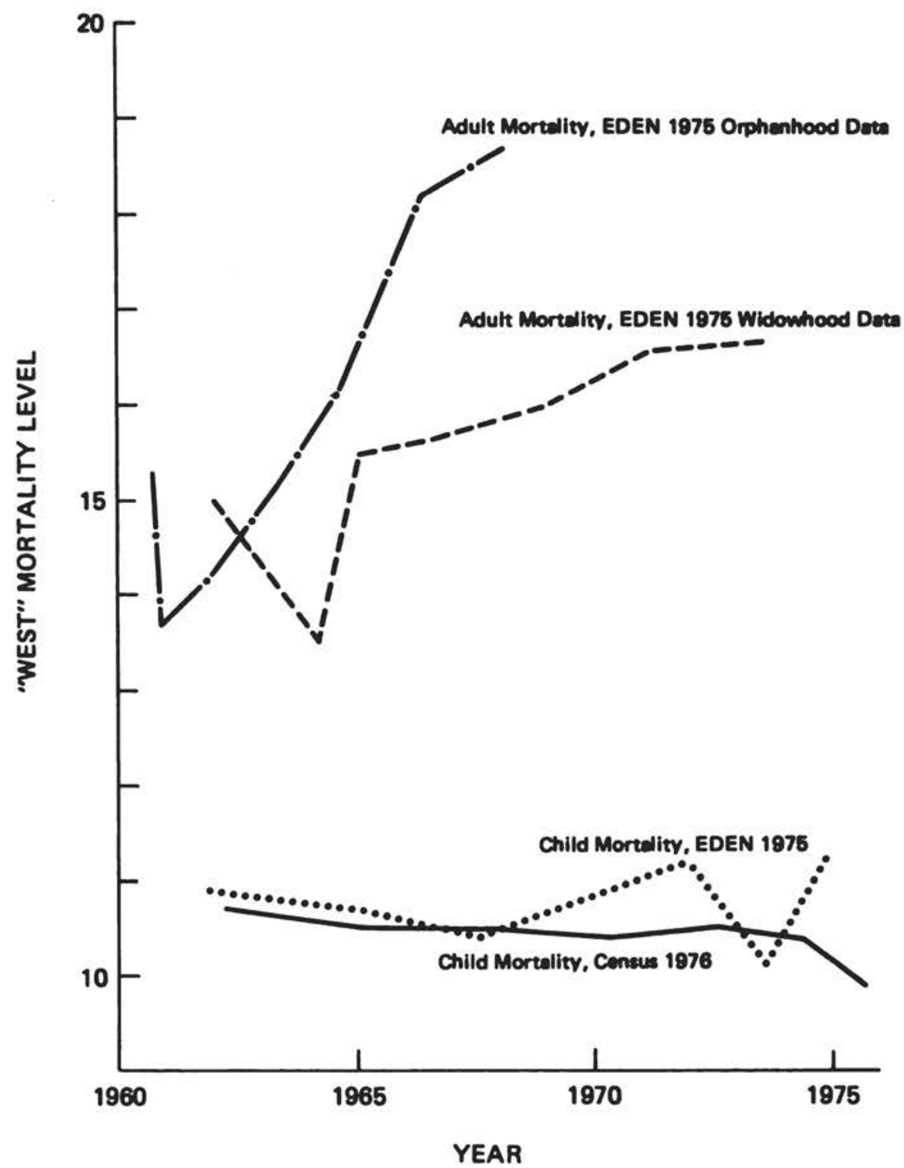

FIGURE 6 Estimates of West Mortality Level by Time Period and Source: Bolivia

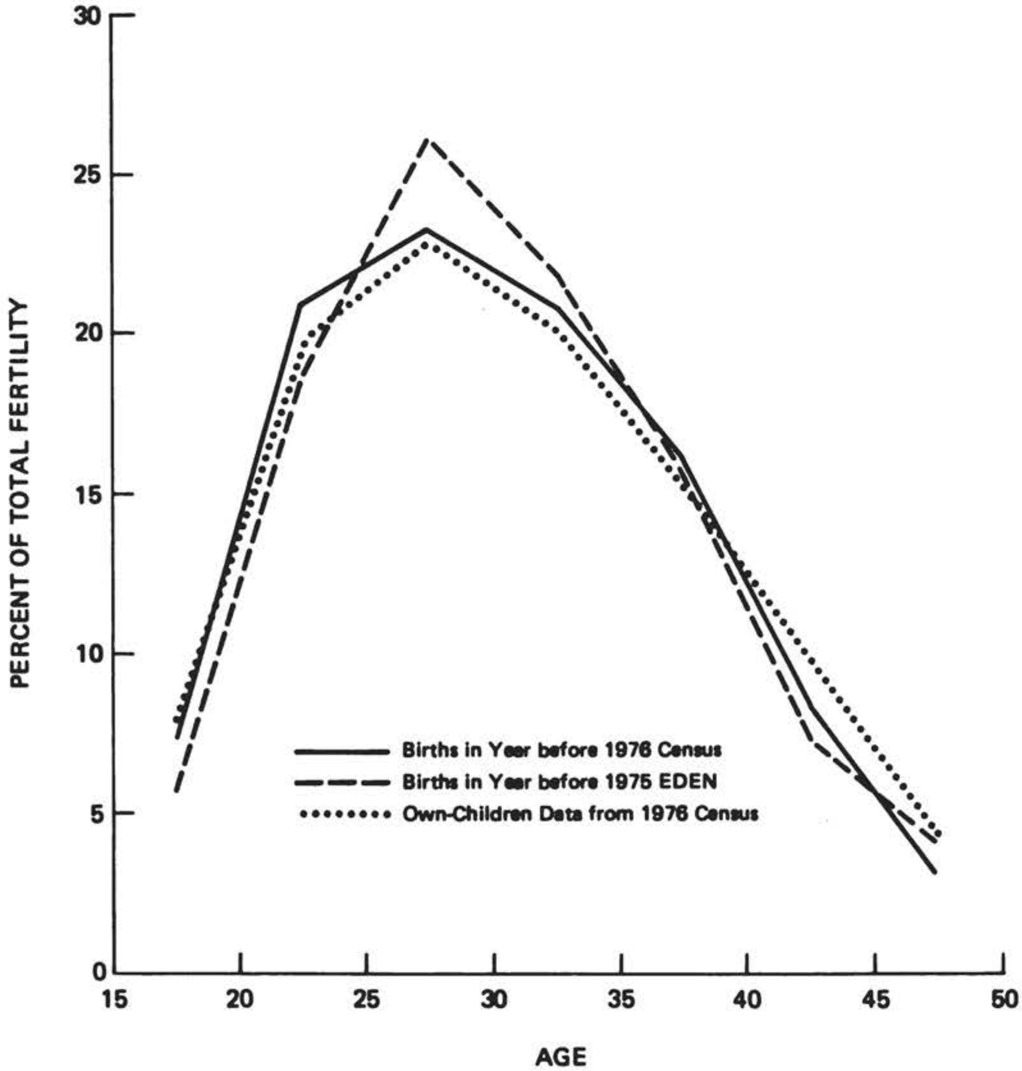

FIGURE 7 Relative Distribution of Age-Specific Fertility Rates Estimated by Different Procedures: Bolivia

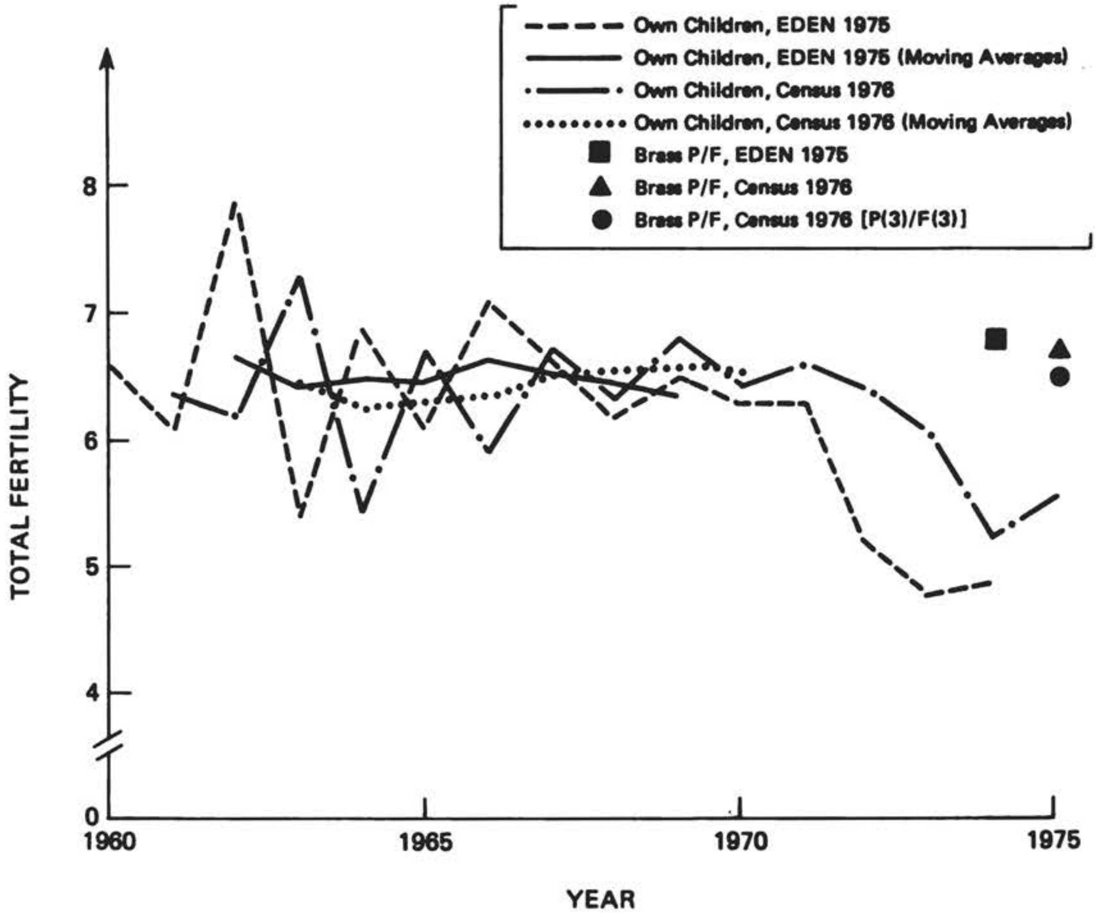

FIGURE 8 Estimates of Total Fertility, 1960-75: Bolivia

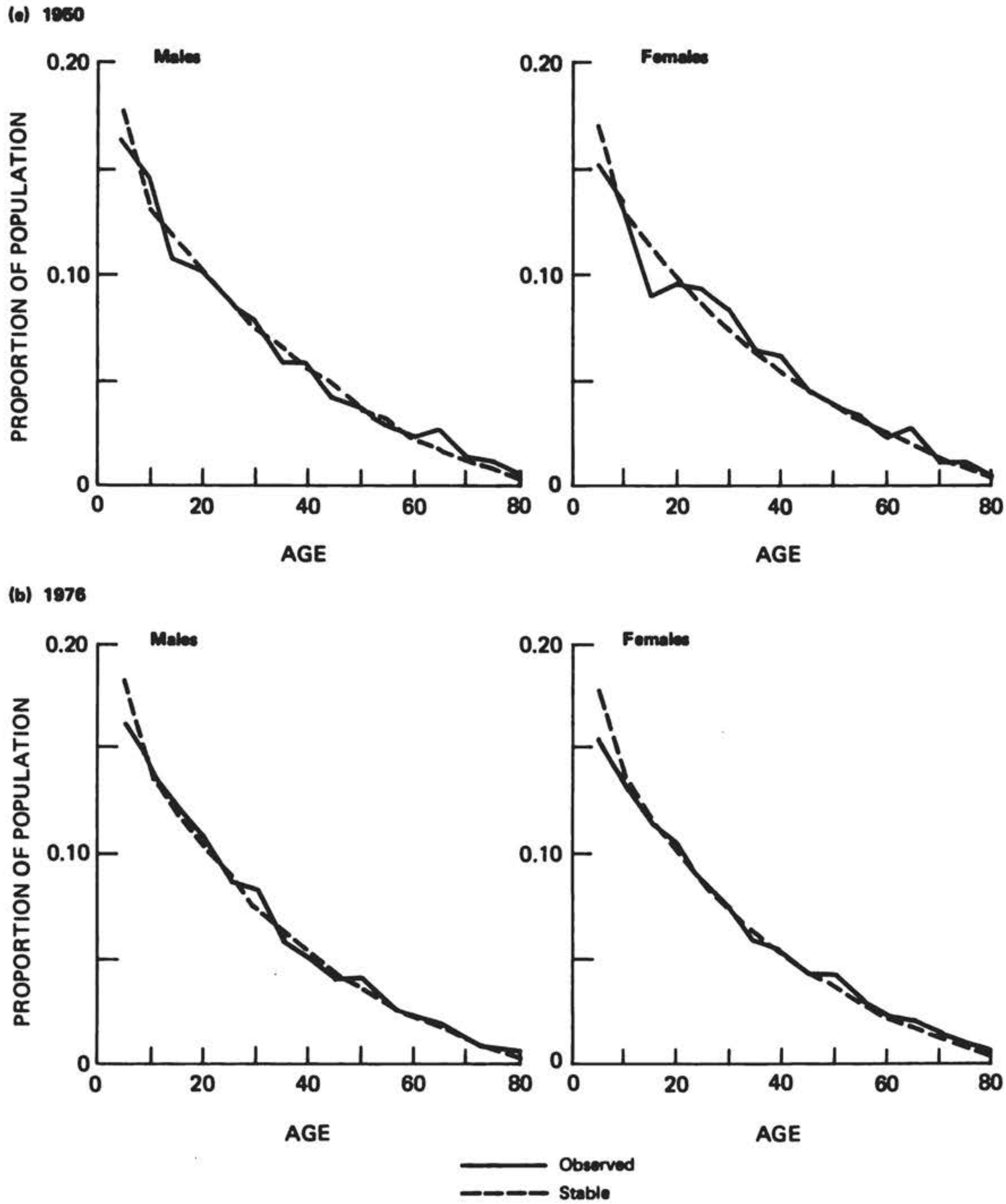

FIGURE 9 Observed and Stable Age Distributions, 1950 and 1976: Bolivia

TABLE A-1 Basic Own-Children Tabulation of Assigned Children by Age and Age of Mother, 1975 EDEN: Bolivia

Age of Mother	Number of Women	Age of Children 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	708	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
16	663	8	4	--	--	--	--	--	--	--	--	--	--	--	--	--
17	572	17	8	3	--	--	--	--	--	--	--	--	--	--	--	--
18	646	46	16	11	12	--	--	--	--	--	--	--	--	--	--	--
19	484	47	27	22	22	7	--	--	--	--	--	--	--	--	--	--
20	649	74	59	41	44	24	13	--	--	--	--	--	--	--	--	--
21	361	49	47	33	29	26	9	9	--	--	--	--	--	--	--	--
22	548	82	78	60	55	47	24	29	20	--	--	--	--	--	--	--
23	433	67	75	57	62	40	33	18	18	14	--	--	--	--	--	--
24	413	71	77	85	60	85	49	40	23	21	10	--	--	--	--	--
25	552	101	81	105	99	95	79	66	43	35	20	26	--	--	--	--
26	376	83	72	75	73	53	69	65	33	30	24	11	8	--	--	--
27	336	77	70	67	67	72	66	47	53	36	28	30	12	15	--	--
28	386	87	76	73	105	72	86	65	64	59	43	41	14	24	12	--
29	282	59	62	61	66	60	62	59	57	51	46	29	21	26	16	11
30	525	104	94	95	107	105	106	102	97	92	78	85	48	65	33	35
31	175	32	36	30	43	40	43	37	46	32	33	26	27	23	12	12
32	321	66	47	61	63	62	86	59	77	76	52	60	43	61	42	38
33	223	37	35	43	44	60	37	44	38	54	42	41	39	52	45	28
34	226	42	33	40	50	61	41	53	42	59	44	51	48	28	51	29
35	494	75	76	64	89	81	97	95	96	115	86	111	71	99	89	85
36	295	47	39	46	50	62	60	55	64	63	56	52	51	68	72	55
37	205	20	27	28	32	38	47	42	34	42	38	43	34	56	35	41
38	416	55	61	59	70	77	86	73	78	90	81	99	75	113	71	77
39	209	25	22	35	33	44	39	32	43	56	41	45	41	57	57	47

TABLE A-1 (continued)

Age of Mother	Number of Women	Age of Children 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
40	453	37	33	44	55	59	59	71	77	95	63	76	55	106	85	95
41	120	13	8	13	18	15	23	19	21	23	21	27	20	21	24	27
42	277	19	24	9	35	31	33	29	44	56	42	50	41	74	51	55
43	169	14	12	18	14	22	33	22	33	31	28	29	28	43	37	39
44	173	6	8	10	24	19	24	21	23	31	25	29	25	42	34	38
45	523	18	31	31	38	50	44	59	60	63	64	89	60	107	82	105
46	181	8	6	6	12	11	21	12	25	21	25	21	29	35	31	47
47	139	6	1	2	9	6	11	14	19	13	20	13	21	22	25	22
48	269	5	5	8	14	13	23	19	29	28	30	30	41	46	34	39
49	169	17	4	5	11	12	16	19	15	26	18	27	21	28	16	33
50	403	6	7	13	11	17	22	19	27	30	29	35	29	47	48	43
51	70	--	--	2	3	1	3	3	4	7	10	10	6	20	5	13
52	156	--	1	4	5	9	4	9	10	9	12	7	8	18	21	16
53	100	--	--	--	2	3	2	3	2	10	3	5	11	14	12	11
54	121	--	--	--	5	4	--	10	6	5	7	11	7	16	10	12
55	251	--	--	--	--	5	1	8	10	6	11	15	10	22	9	22
56	137	--	--	--	--	--	4	3	3	3	4	10	8	11	10	8
57	63	--	--	--	--	--	--	1	--	2	1	1	3	5	--	4
58	143	--	--	--	--	--	--	--	7	3	4	5	8	10	4	7
59	70	--	--	--	--	--	--	--	--	--	1	--	3	8	1	4
60	330	--	--	--	--	--	--	--	--	--	8	7	7	7	12	18
61	35	--	--	--	--	--	--	--	--	--	--	1	1	1	1	2
62	79	--	--	--	--	--	--	--	--	--	--	--	1	2	3	2
63	68	--	--	--	--	--	--	--	--	--	--	--	--	3	2	2
64	53	--	--	--	--	--	--	--	--	--	--	--	--	--	1	4
65	224	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3
Unassigned	--	67	47	62	86	88	100	148	160	190	167	217	142	197	136	165
Total	15,274	1,587	1,409	1,421	1,617	1,576	1,555	1,479	1,501	1,577	1,315	1,465	1,117	1,602	1,229	1,294

TABLE A-2 Basic Own-Children Tabulation of Assigned Children by Age and Age of Mother, 1976 Census: Bolivia

Age of Mother	Number of Women	Age of Children 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	49,914	480	--	--	--	--	--	--	--	--	--	--	--	--	--	--
16	53,942	1,291	570	--	--	--	--	--	--	--	--	--	--	--	--	--
17	48,085	2,522	1,261	810	--	--	--	--	--	--	--	--	--	--	--	--
18	53,951	4,688	2,343	1,981	990	--	--	--	--	--	--	--	--	--	--	--
19	41,939	5,105	3,335	2,310	2,043	1,080	--	--	--	--	--	--	--	--	--	--
20	52,158	8,803	5,977	4,983	4,264	2,311	1,622	--	--	--	--	--	--	--	--	--
21	39,327	6,965	5,283	4,772	4,026	2,701	1,413	1,231	--	--	--	--	--	--	--	--
22	46,752	8,829	6,903	7,475	5,165	4,683	2,764	1,892	1,321	--	--	--	--	--	--	--
23	40,597	9,040	6,876	6,729	6,248	4,771	4,444	2,912	1,500	1,050	--	--	--	--	--	--
24	37,784	8,532	7,209	6,037	7,093	6,127	4,053	4,055	1,804	1,742	901	--	--	--	--	--
25	43,298	8,886	8,290	7,896	7,663	6,724	5,856	4,956	3,334	2,761	1,653	1,682	--	--	--	--
26	35,763	7,807	7,057	7,327	7,089	7,090	6,245	5,915	4,052	3,182	2,374	1,922	810	--	--	--
27	31,732	6,965	6,123	6,908	6,424	6,729	6,065	5,166	4,595	3,902	2,402	2,613	1,471	1,470	--	--
28	34,924	8,317	6,275	7,869	7,120	7,179	7,385	6,524	5,349	5,253	3,674	3,242	1,834	1,923	1,321	--
29	26,729	5,645	4,985	5,017	5,889	5,705	5,526	5,316	4,804	4,806	3,546	2,822	2,071	1,953	1,412	811
30	48,226	9,612	8,435	9,882	9,189	10,115	8,894	9,578	8,049	9,097	6,700	6,693	4,264	5,134	3,784	2,674
31	20,839	4,594	3,694	4,836	4,205	4,834	4,503	4,415	4,236	4,203	3,546	3,183	3,006	2,432	1,981	1,382
32	28,180	6,097	5,860	5,530	5,949	6,341	6,154	7,058	6,460	6,220	4,505	5,502	3,905	4,568	2,526	2,463
33	22,495	4,447	4,323	4,233	4,772	4,776	4,714	4,444	4,264	4,864	4,027	4,446	3,243	3,813	3,181	2,344
34	21,705	4,175	3,772	3,665	4,290	5,102	4,261	4,984	4,472	4,413	4,055	3,781	3,693	3,963	3,812	2,881
35	37,745	6,487	5,973	6,633	6,967	7,264	7,242	8,075	7,086	7,809	6,605	6,908	5,732	6,668	5,466	5,372
36	26,706	4,745	3,726	4,115	4,896	5,314	5,078	5,286	5,046	5,525	5,018	6,067	5,437	5,530	4,147	4,836
37	18,233	2,343	2,796	2,586	3,425	3,157	3,787	3,694	3,937	4,025	3,336	3,457	3,753	3,723	3,545	3,125
38	29,797	4,475	3,578	4,537	5,467	5,319	5,081	5,859	6,098	5,827	5,919	5,678	4,985	6,939	4,605	5,976
39	17,958	2,221	1,981	2,704	2,222	2,852	2,794	2,913	3,214	3,575	3,392	3,066	2,673	3,423	3,064	3,183

TABLE A-2 (continued)

Age of Mother	Number of Women	Age of Children 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
40	38,909	3,453	3,031	4,773	4,714	5,220	5,434	5,705	5,494	6,305	5,434	6,904	5,194	7,206	5,403	6,305
41	12,641	1,290	1,530	1,230	1,920	2,013	1,891	1,830	2,282	1,770	2,282	2,670	1,982	2,942	2,791	2,341
42	19,551	1,623	1,440	2,435	2,401	2,643	2,912	3,273	2,764	3,302	2,792	3,336	3,063	4,502	3,572	3,393
43	16,665	1,351	1,532	1,501	1,953	2,072	2,282	2,822	2,492	2,885	2,732	3,214	2,823	3,243	3,000	3,332
44	14,983	932	1,053	1,530	1,411	1,350	1,952	2,281	2,343	2,581	2,192	2,762	2,221	3,423	2,073	2,641
45	33,761	1,805	1,444	2,375	3,572	3,937	3,430	4,111	3,905	4,570	3,965	4,391	3,697	5,593	4,929	5,285
46	18,919	571	1,022	1,230	1,112	1,771	1,983	2,222	1,772	1,891	3,032	2,914	2,193	3,153	3,003	3,094
47	12,700	450	602	811	1,050	1,382	1,230	1,383	1,411	1,592	1,652	1,562	1,863	2,611	1,741	2,162
48	23,538	662	990	1,171	1,410	1,472	1,773	2,220	1,980	2,703	2,042	3,453	2,431	3,902	3,363	3,723
49	11,798	240	300	540	690	480	811	1,230	1,050	1,531	1,261	1,530	1,260	1,951	1,681	1,532
50	32,280	812	871	1,022	1,290	1,171	1,530	1,951	2,524	2,374	2,162	3,093	2,311	4,864	2,613	3,061
51	8,737	120	1,800	3,600	1,500	1,500	4,210	6,900	540	751	481	1,051	722	1,620	1,200	990
52	13,334	--	451	421	210	451	390	780	510	720	662	1,201	901	1,652	1,743	1,501
53	9,701	--	--	330	210	331	420	390	512	600	391	511	721	1,231	1,021	992
54	10,117	--	—	--	210	90	210	420	450	630	301	750	932	810	1,141	1,354
55	20,063	--	--	--	--	572	722	811	841	961	781	1,292	1,352	1,713	1,744	2,043
56	13,122	--	--	--	--	--	330	631	570	631	390	811	751	1,081	1,023	930
57	6,336	--	--	--	--	--	--	150	150	240	180	270	330	422	330	360
58	13,299	--	--	--	--	--	--	--	570	570	570	840	540	660	870	961
59	6,429	--	--	--	--	--	--	--	--	360	302	300	180	270	240	450
60	28,796	--	--	--	--	--	--	--	--	--	751	870	631	1,110	1,202	1,261
61	4,654	--	--	--	--	--	--	--	--	--	--	120	60	240	210	210
62	7,629	--	--	--	--	--	--	--	--	--	--	--	331	271	360	240
63	5,342	--	--	--	--	--	--	--	--	--	--	--	--	330	241	330
64	6,096	--	--	--	--	--	--	--	--	--	--	--	--	--	240	90
65	17,260	--	--	--	--	--	--	--	--	--	--	--	--	--	--	450
Unassigned		6,935	7,118	8,676	9,275	10,809	10,894	13,659	14,234	14,410	13,842	15,697	14,560	19,336	18,586	20,956
Total	1,315,439	156,380	132,691	141,804	139,049	136,620	129,391	133,383	111,781	115,221	96,008	104,907	83,366	106,339	84,578	84,078

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PART II

FERTILITY AND MORTALITY IN GUATEMALA: 1950-1973

SUMMARY AND CONCLUSIONS

Located in the northernmost part of Central America, Guatemala is the most populous country in the region. In 1975, approximately 6 million people lived on its 108,889 square kilometers. According to the 1973 census, 64 percent of the population lived in rural areas, and 44 percent of the population was of indigenous origin, one of the highest proportions in Latin America. Table 1 shows the enumerated populations by sex, from the 1950, 1964, and 1973 censuses, with the average annual growth rates for the intercensal periods. Provisional results from the 1981 census are also given.

The socioeconomic indicators listed in Table 2 give a general idea of living conditions in Guatemala, which is one of the less-developed countries in Latin America. Fertility and mortality levels are both relatively high, and the annual rate of population increase rose to 3 percent per annum in the early 1970s, largely due to declines in mortality that have not been accompanied by substantial declines in fertility. The intercensal growth rates in Table 1, showing rapid growth between 1950 and 1964, and much slower growth between 1964 and 1973, are distorted by changes from census to census in completeness of enumeration. Although mortality has been declining steadily, the level in the early 1970s was still high by Latin American standards, with an expectation of life at birth of about 53 years and an infant mortality rate around 115 per 1,000 live births. Fertility was also high, despite indications of some decline in the late 1960s and early 1970s, with a birth rate in the low 40s and a total fertility rate over 6. Expectation of life at birth increased by about half a year per year between 1950 and 1972, though the decrease in adult mortality seems to have been faster than the decrease in child mortality. The main findings of this report are summarized in Table 3.

CHAPTER 1

DATA SOURCES

The objective of this report is to develop estimates of fertility and mortality using all the relevant information available for the country for the period from 1950 to 1973. The basic demographic data sources available for the period are the population censuses of 1950, 1964, and 1973, registration records of deaths by age group and sex, and births by age of mother for the period 1950-73.

Although the majority of developing countries are characterized by poor vital registration, Guatemala seems to be an exception. With the exception of infant deaths, it seems that the omission of vital events is very slight throughout the period considered (Camisa, 1969; Guatemala and CELADE, 1978b). This report is therefore largely devoted to the application of methods of analysis aimed at confirming the general quality of the registration data.

The quality of the censuses, in contrast, seems to be more variable. The 1964 census is the only one for which there exists a direct assessment of coverage through a post-enumeration survey that indicated a level of omission of 3.7 percent. The other two censuses appear to have been affected by higher levels of omission, particularly the 1973 census, for which a level of omission of more than 10 percent has been estimated (Guatemala and CELADE, 1978a; Guatemala, 1975). Provisional population totals from the latest census suggest that coverage may have declined further in 1981.

The 1950 census did not include any special questions intended for the indirect estimation of fertility or mortality. The 1964 census included only a question on number of children ever born alive, and the question was put only to those women who had had at least one child. The 1973 census collected much more information relevant to the estimation of fertility and mortality, with questions concerning children ever born and children surviving of all women aged 15 and over, the date of each mother's most recent live birth and survival of the child, and whether or not the respondent's mother was still alive.

The methods of analysis that have been applied are aimed mainly at the evaluation of the vital registration data, the evaluation of the coverage of the population censuses, and the independent estimation of child mortality, for which the data required for conventional measurement methods are weakest. Independent estimates of fertility and adult mortality are also given, both to provide additional confirmation for the results obtained and because of their methodological interest. Table 4 summarizes the available data.

CHAPTER 2

MORTALITY

INTRODUCTION

Registered deaths by age, group, and sex are available for 1949, 1964, and 1972. It is therefore possible to calculate conventional measures of mortality using the recorded deaths and the enumerated populations by age and sex from the 1950, 1964, and 1973 censuses. However, before such measures can be accepted, it is necessary to evaluate the completeness of death registration and the completeness of census coverage in order to establish that the measures are not distorted by error. The methods available for making such evaluations are quite different for the child and adult age ranges, and it is often found that completeness of registration or enumeration is markedly different for childhood and adulthood, therefore it is convenient to present the evaluation in two parts: mortality below age 10 (childhood) and mortality for ages 10 and over (adulthood, for want of a better word). Any adjustments necessary on the basis of these evaluations can then be made, and the two segments can be combined to provide a description of mortality risks for all ages. Adult mortality is presented first, as the results obtained have a bearing on the estimation of child mortality.

ADULT MORTALITY

Conventional age- and sex-specific mortality rates for ages 10 and over can be calculated from registered deaths by age group and sex and by mid-year populations also classified by age group and sex; the rates can then be used to calculate a life table beginning at age 10. Suitable information on deaths is available for Guatemala for 1949 (only broad age groups are available for 1950), 1964, and 1972, and enumerated population figures are available for 1950, 1964, and 1973. Thus, by making minor adjustments to the population figures, arriving at estimated mid-year populations for the years 1949, 1964, and 1972 from the enumerated figures, the basic data are available for calculating conventional measures for these three years. However, given the possibilities of error--in particular of underregistration of deaths, of misreporting of age at death, of underenumeration of the population, and of misreporting of age of the population--the rates calculated in this way cannot be accepted without careful evaluation. For the rates to be correct, it is not necessary for the deaths and population to be reported completely; it is only necessary that the proportional underreporting be the same for both, with the numerator and denominator errors thus cancelling out. An evaluation of death registration completeness relative to enumeration completeness for 1949, 1964, and 1972 is presented in the section below.

Further information on adult mortality is available for Guatemala. The enumerated populations themselves permit the estimation of adult mortality parameters from intercensal survival probabilities or similar methods. The estimates obtained in this way, however, are very sensitive to changes in completeness of enumeration from one census to the next. An evaluation of the completeness of enumeration of the three censuses considered, relevant not only to the estimation of adult mortality but also to the estimation of child mortality and fertility and to the interpretation of the growth of the enumerated population, is presented in this chapter. The 1973 census also collected information about whether the mother of each respondent was still alive; the proportions of respondents in each age group with surviving mother provide the basis for the estimation of adult female survival probabilities is described, followed by conclusions concerning adult mortality.

Evaluation of Death Registration Relative to Enumeration Completeness

A number of rather similar procedures have been developed in recent years for estimating the completeness of death registration after childhood relative to the completeness of coverage of the population at risk. These methods share several common features. The basis of the evaluation is a comparison of the age distribution of reported deaths with the age distribution of the population on the assumption that the underlying population is stable, that is, that it has an unchanging age structure arising from effectively constant fertility and mortality rates over an extended time period. It is also assumed that the completeness of recording of both deaths and population is the same at all ages after childhood and that the reporting of age both for deaths and population is not seriously biased.

The first such method to be widely applied was the Brass Growth Balance Equation (Brass, 1975). Brass showed that for a population fulfilling the conditions above, the ratio of deaths at each age a and over to the population aged a and over is linearly related to the ratio of the population reaching age a in a year to the population aged a and over, the slope of the line being equal to unity and its intercept being equal to the stable population growth rate. This relationship may be readily understood if the ratio of persons reaching age a in a given year to the population aged a and over is regarded as the "birth rate" b(a) of the population aged a and over, and the ratio of deaths at ages a and over to population aged a and over is regarded as the death rate d(a) of the population aged a and over. The results for each age a can then be regarded as special cases of the familiar equation that for a closed population the birth rate is equal to the rate of natural increase plus the death rate, the growth rate over age a r(a) being constant for all values of a in a stable population. If deaths are underreported relative to the population coverage by a constant factor k at all ages (from 10 and over in this case, in order to avoid the possibility of differential reporting completeness in childhood), the values of b(a) and d(a) will still be linearly related, the intercept still being equal to the stable growth rate r, but the slope being equal to the reciprocal, 1/k, of the recording completeness. Thus, for a stable population, and in the absence of other data errors, a plot of the b(a) and d(a) values for ages a from 10 and over provides estimates both of r, the stable growth rate, and k, the completeness of recording of deaths relative to population.

Preston (Preston and Hill, 1980) has proposed an alternative procedure for estimating the completeness of death registration. Preston's method is based on comparing the age structure of deaths and the age structure of the population under the assumption of stability, using an estimate of the growth rate. A development of the original procedure (Preston et al., 1980; United Nations, 1983) uses the same information rather differently. In any population, the number of persons aged x is equal to the number of deaths that will occur to those people in the future, since they will all die ultimately. In a stable population with complete death registration, the number of deaths that will occur to persons aged x will be equal to the sum of the deaths at each age above x, after the deaths have been inflated by the stable growth rate to allow for the fact that the deaths recorded above age x reflect not only smaller numbers of survivors but also smaller original cohorts. Given an age distribution of deaths and a growth rate, it is therefore possible to estimate the population at each age. If the reporting of deaths is not complete, but the omission is proportionately the same at all ages, the ratio of the population estimated at each age (or above each age, to provide some smoothing) to the population enumerated at (or above) that age provides an estimate of the completeness of death registration. If completeness estimates are computed for a range of ages, it is even possible to confirm or modify the assumed growth rate on the basis of the trend in the estimates with age, as long as the basic data are reasonably coherent.

Both the Brass and Preston methods described above assume that the population being studied is stable. Fertility seems to have been more or less constant in Guatemala for a considerable period, except possibly for some decline shortly before the 1973 census which would have had no effect on the population aged 10 and over. Mortality, on the other hand, appears to have declined for a considerable period, at least since 1950 and probably before, so the population cannot be regarded as truly stable. Model simulations have suggested that the Preston-Coale procedure is more robust to such departures from stability than the Brass procedure, so this evaluation uses the Preston-Coale procedure.

The application of the Preston-Coale procedure requires an assumed growth rate in order to estimate the population aged a, N*(a), from the deaths recorded at ages a and over. The ratios of estimated population aged a to observed population aged a, N*(a)/N(a), for different values of a then provide some indication of whether the assumed growth rate is suitable; if the ratios fall as age increases, the assumed growth rate is probably too high, whereas if the ratios rise with age, it is probably too low. The initially assumed value of the growth rate can thus be refined to obtain a sequence of ratios most closely approximating a horizontal line. Such refinement of the assumed growth rate is important, since the completeness estimates are very sensitive to the growth rate, and as in the case of Guatemala, the observed intercensal growth rates are clearly distorted. The closeness of fit of the observed ratios to a horizontal line provides a valuable clue to how well the other assumptions of the method are met.

The application of the method involves a further complication in the use of an open interval. In 1949, deaths were classified by five-year age groups up to age 75, with an open interval for all deaths at ages 75 and over; for 1964 and 1973, the open interval started at age 85. Model simulations have been used to develop algorithms to make possible the estimation of the population at the lower boundary of the open interval from deaths in the open interval and the assumed growth rate (United Nations, 1983). However, despite the fact that the error inherent in these algorithms has least impact the higher the starting age of the open interval, it does not follow that the open interval in the published data is the most appropriate choice because of the possible effects of age exaggeration. If age of both the dead and the living is increasingly exaggerated above some age x, the completeness estimates N*(a)/N(a) will rise sharply with age above age x; if the age of the dead is exaggerated to a greater extent than the age of the living, this rise will be even more pronounced. The effects of this type of age misreporting can be eliminated by using an open interval starting at age x.

In Guatemala, it is clear that age is exaggerated at older ages, both for the living and for the dead, and that distortions would be introduced by using the open intervals starting at age 75 or age 85. The first step in the application of the method, therefore, was to use plausible growth rates for 1949, 1964, and 1972, respectively, and experiment with different open intervals from age 45 to the highest possible age to find the highest open interval that produced results not clearly distorted by age exaggeration or other misreporting. In order to limit the effects of age misreporting, cumulation is used at this stage, and the completeness ratios estimated are of the population aged a and over, N*(a+)/N(a+). (Note that though the registered deaths were for 1949 and 1972 and the enumerated populations were for 1950 and 1973, no adjustment to the population figures is worthwhile since the procedure estimates completeness of death registration relative to population enumeration.) The results, using growth rates of 2.4 percent for 1949, 2.7 percent for 1964, and 3.0 percent for 1972, are summarized in Appendix 1. They suggest using an open interval of 55 and over for both males and females for all three years. Once the open interval has been selected, the next step is to iterate in each case to the growth rate that gives the sequence of ratios most closely approximating a horizontal line over the points from age 10 to five years below the lower age boundary of the open interval, that is, age 50. First estimates of completeness are then obtained by averaging the $N^*(a+)/N(a+)$ ratios over the same age range. Table 5 shows the estimates of completeness of death registration relative to population enumeration and population growth rates by sex for 1949 (relative to the 1950 enumeration), 1964, and 1972 (relative to the 1973 enumeration). Figure 1 shows the resulting sequence of $N^*(a+)/N(a+)$ ratios by age for each case.

The consistency of the results provides an indication of how well the evaluation has worked. If any of the assumptions are badly violated, such violation should show up in the results. Figure 1 shows that the sequences of ratios are satisfactorily flat, showing no major deviations with age; though the completeness estimates for males and females are not the same, the differences may reflect real differences in the completeness of death registration or the completeness of population enumeration. The procedure also provides estimates of the population growth rate, and these provide an additional consistency check since they should change plausibly over time and should be similar for males and females for the same year. The increase in the growth rates between 1949 and 1964 was considerably larger than between 1964 and 1973, consistent with the general conclusion of this report that mortality decline decelerated over the period, but the increase in the female growth rate was substantially faster than that in the male rate, from a lower growth rate in 1949 to higher growth rates in 1964 and especially in 1973. Even though declines in female mortality may have been more rapid than declines in male mortality, the difference could hardly account for such marked changes in the relative growth rates. It was therefore decided not to use the results obtained using iterated growth rates, but rather to use as final estimates the average completeness values obtained using growth rates for both sexes alike of 2.4 percent for 1949, 2.8 percent for 1964, and 3.0 percent for 1972. Another slight change was made in the cumulation procedure; to make the completeness estimates refer to the age range 10 to 55, the population aged 55 and over (though not the deaths at ages 55 and over) were ignored, the ratios calculated being for the age ranges a to 55, $_{55-a}N^*_a/_{55-a}N_a$. The completeness estimates obtained are shown in Table 6, and the sequences of the ratios by age are shown in Figure 2.

In summary, this evaluation suggests that for females, registered deaths in 1949 require an upward adjustment of some 4 percent to be consistent with the population enumerated in 1950; in both 1964 and 1973, registered deaths were approximately consistent with the enumerated population, requiring a slight upward adjustment of 1.5 percent in 1964 and a slight downward adjustment of the same magnitude in 1973. For males, registered deaths in 1949 need to be adjusted upward by some 10 percent for consistency with the 1950 enumeration; deaths in 1964 require a small upward adjustment of about 1.5 percent, while deaths in 1972 need a downward adjustment of

8 percent for consistency with the 1973 enumeration. These changes in enumeration and death registration need to be allowed for in calculating mortality rates, though it should be borne in mind that adjustments of the magnitude implied by this evaluation are essentially fine-tuning; an adjustment of deaths by 10 percent relative to the population changes expectation of life at age 10 by less than one year.

Intercensal Changes in Population Size

A sequence of complete enumerations of a closed population provides valuable information about adult mortality. If two enumerations are conducted x years apart, the population age a+x at the second census represents the survivors of the population age a at the first census. The ratio N(a+x,2)/N(a,1) thus represents the survival probability from age a to age a+x, and a conventional life table above age x can be constructed from the survival probabilities for different starting ages a. Age reporting errors distort the sequence of the ratios, but a number of techniques have been devised for smoothing the ratios to obtain plausible representations of intercensal mortality even in the presence of considerable age misreporting. However, the whole procedure is extremely sensitive to changes in enumeration completeness from one census to the next, and in Guatemala there are good reasons for supposing that such changes occurred between both 1950 and 1964 and 1964 and 1973. Table 1 shows an implausibly high annual growth rate of over 3 percent between 1950 and 1964, suggesting more complete enumeration by the latter census, and an implausibly low annual growth rate of only 2 percent between 1964 and 1973, suggesting a relative decline in enumeration completeness in 1973. Changes of such magnitude in enumeration completeness will have a large effect on mortality estimates derived from intercensal survival probabilities, so the traditional techniques have not been applied.

Fortunately, however, a technique has been devised that combines information on intercensal survival with additional information concerning registered deaths by age for the intercensal period to estimate both the coverage of one census relative to the other and the coverage of registered deaths relative to the coverage of one of the censuses (Preston and Hill, 1980). The method requires no assumption of stability, being based on the truism that in a closed population the number of people in a particular age group at a particular time is determined by the number of people who n years earlier were n years younger plus the deaths that occurred during the n years to the earlier cohort. This relationship can be expressed as:

$$N_{x+n}^{t+n} = N_x^t - D_{cx}^{t,t+n} \quad , \qquad (1)$$

where:

N_{x+n}^{t+n} is the number of people in the age cohort x+n at time t+n;

N_x^t is the number of people of the same cohort at time t;

$D_{cx}^{t,t+n}$ is the number of deaths between time t and time t+n to the persons making up the cohort under consideration.

Working with information from two censuses and from registered deaths it is necessary to take into consideration the coverage of both the censuses and of the deaths. If it can be assumed that omission from the enumerated populations and the omission of deaths from registration are all constant with age, Equation 1 can be rewritten in the following form:

$$\frac{N_x^t}{N_{x+n}^{t+n}} = \frac{E(t)}{E(t+n)} + \frac{E(t)\ D_{cx}^{t,t+n}}{C \quad N_{x+n}^{t+n}} , \qquad (2)$$

where:

E(t) is the percentage completeness of enumeration of the first census;

E(t+n) is the percentage completeness of enumeration of the second census; and

C is the percentage coverage of registration of deaths during the intercensal period.

If we then write a for $\frac{E(t)}{E(t+n)}$ and b for $\frac{E(t)}{C}$, it becomes clear that the ratio N_r^t/N_{x+n}^{t+n} and $D_{cx}^{t,t+n}/N_{x+n}^{t+n}$ will be linearly related for different values of x; the slope b is equal to the reciprocal of the coverage of death registration relative to enumeration completeness of the first census, and the intercept a is equal to the ratio of completeness of coverage of the first census to completeness of coverage of the second census. The application of the method to the two intercensal periods for Guatemala is shown in Appendix 1. The cohorts used in the calculations were cumulated populations aged x to 64 at the time of the first census, and the straight line was fitted to the successive points using a group average procedure. The results are summarized in Table 7.

The estimates obtained by this method concerning the relative coverage of the recent censuses confirm that the 1964 census was the most complete and that the census of 1973 was strongly affected by omission. If the estimate of coverage of the 1964 census, obtained from the post-enumeration survey (Guatemala, 1965), of approximately 96 percent is accepted, the omission from the 1973 census would be approximately 11 percent, consistent with the estimates of other recent evaluation studies (Guatemala, 1975; Guatemala and CELADE, 1978b).

The estimates of relative completeness of death registration given by this method are not so satisfactory, indicating much less complete death registration than that estimated in the section "Evaluation of Death Registration Relative to Enumeration Completeness." Other applications have shown that the Preston-Hill method does not give robust estimates of the relative coverage of census enumeration to completeness of death registration; the results obtained by the method vary widely according to the age range chosen for its application, and they are sensitive to any exaggeration of age. For example, if for the period 1964-73 the age range used was truncated at 55 instead of 65, the value of b for males would be 0.54 instead of 1.21. Thus, no use is made of the estimates of completeness of death registration, but the estimates of relative enumeration completeness, which are much more robust, are adopted throughout this report when consistent population denominators are required.

Estimates of Female Adult Mortality from Information Concerning Survival of Mother

The 1973 census included the question "Is your mother still alive?" The proportion of respondents in each age group with a surviving mother is an indicator of the general level of female adult mortality, but more refined analytical procedures are possible. Brass (Brass and Hill, 1973) has developed a technique using additional information on age at time of childbearing that makes it possible to transform the proportion with surviving mother in a particular age group into a probability of female survival from age 25 to a subsequent age 25+x where the value of x depends on the age of the respondents providing the basic information. Hill and Trussell (1977) have further developed the original form of the estimation procedure and have proposed the following estimation equation:

$$\frac{l(25+i)}{l(25)} = a(i) + b(i)\,\bar{M} + c(i)\,{}_5PSM_{i-5}\,, \qquad (3)$$

where

$\bar{M}$ is the average age at which mothers have their children given the population age structure;

${}_5PSM_{i-5}$ is the proportion of respondents with surviving mother in the age group i-5, i; and

a(i), b(i), and c(i) are regression coefficients obtained by Hill and Trussell from an analysis of a large number of model cases.

All respondents have been exposed to the risk of being maternally orphaned since birth, so the period of exposure at the time of the survey is equal to respondents' ages. The incidence of maternal orphanhood amongst respondents of a given age will also depend on the age distribution of the mothers at the time the respondents were born; if all the mothers were young, fewer of them would die (other things being equal) during a given exposure period than if they were all old. The age pattern of the mothers at the time when the respondents were born is, after age, the most important non-mortality factor influencing the proportion not maternally orphaned.

The mortality estimates obtained by applying the Hill-Trussell procedure to the proportions by age with surviving mother are shown in Table 8 in terms of the actual estimates of l(25+i)/l(25) and in terms of the implied mortality level in the Coale-Demeny (1966) West model life tables. Table 8 also shows comparable survival ratios for 1964 and 1973 based on registered deaths after the adjustments described in the section "Evaluation of Death Registration Relative to Enumeration Completeness" and smoothing using the West model life tables. (The use of the West pattern rather than one of the other families is discussed in the section "Summary and Conclusions Regarding Adult Mortality.") The mortality estimates derived from orphanhood do not refer to the time of the survey, since the mothers have been exposed to the risk of dying throughout the life of the respondent; the estimates represent averages of the mortality experience of the women throughout the exposure to risk period. If mortality has been changing in a regular way, each estimate will represent mortality conditions at some point during the exposure to risk period, and the older the respondents the longer ago will be the time period referred to by the mortality estimate.

Brass and Bamgboye (1981) have recently proposed a procedure to estimate the time reference of indirect estimates of adult mortality, and this procedure can be applied to the mortality estimates obtained from maternal orphanhood data for Guatemala. This procedure assumes that the trend in mortality has been more or less regular for a considerable time before the census or survey and estimates the time t in years before the census or survey when the period life table would have had the estimated l(25+i)/l(25) survival probability. Values of t for each age group on the basis of the 1973 data are shown in Table 8. Figure 3 shows the West mortality levels implied by each survival ratio by reference date, together with the average female mortality levels implied by registered deaths in 1949, 1964, and 1973 after adjustment for coverage.

The West mortality estimates derived from data on survival of mother show a very rapid improvement in female adult survival, indicating on average an improvement of two-thirds of a mortality level per year, equivalent to an increase in expectation of life at age 25 of about two-thirds of a year per year. This implied decline in adult female mortality is implausibly rapid, and the mortality estimates based on information from respondents under age 30, for whom the trend is even more rapid (three levels in three and one-half years), appear to be distorted downward (upward in terms of levels) by some data error that declines with age. One error that would result in such a pattern is the misreporting of survival of mother by respondents who were adopted as a result of being maternally orphaned at an early age; the proportion of such respondents would only change slowly over time as female adult mortality declined, but the proportion of all maternally orphaned respondents would decline fairly rapidly with age as the probability of mothers dying increases. The comparison in Figure 3 of mortality estimates based on maternal survival with mortality estimates based on adjusted registered deaths also suggests that the former are much too low for respondents under age 30. For mid-1964, for example, the maternal survival data indicate a mortality level of 17.2, whereas adjusted registered deaths imply a mortality level of 13.5; for the maternal survival estimate to be correct, female deaths in 1964 would have had to have been registered with a completeness relative to the 1964 census enumeration of around 160 percent, which cannot be entertained as a possibility. The maternal survival estimates for respondents over age 30 are closer to the estimates from adjusted registered deaths, the difference being only a level or so, but in view of the likelihood that the error below age 30 comes through in an attenuated form to respondents above age 30, it seems probable that it is the maternal survival estimates that are underestimates, rather than that the adjusted registration estimates represent overestimates.

Summary and Conclusions Regarding Adult Mortality

Two of the procedures described in the above discussion cannot be regarded as serious contenders to provide final estimates of adult mortality. Intercensal survival probabilities are too distorted by changes in enumeration completeness to provide a reliable picture of mortality levels, and the estimates of relative death registration completeness derived from the combined death registration and intercensal survival procedure are far too sensitive to the choice of the upper truncation age to provide a sound basis for the adjustment of registered deaths. Of the two remaining procedures, the estimates of adult female mortality based on information regarding survival of mother indicate an implausibly rapid decline in female adult mortality and cannot, therefore, be accepted at face value; some reporting error has biased upward the proportions of younger respondents with surviving mother, and the reports of older respondents over age 30 cannot be assumed to be free of a continuation of the same bias at a lower level proportionate to the total number of reported mothers dead. The estimates developed in the section "Evaluation of Death Registration Relative to Enumeration Completeness" of the completeness of death registration and population growth rate seem, however, to be acceptably consistent both internally and externally with other information available. The estimates of completeness of registration show little variation with age, indicate a high degree of completeness, show only moderate differentials by sex, and, in general, fit in quite well with independent estimates of changes in enumeration completeness. Similarly, the estimated growth rates obtained as a by-product of the procedure show reasonable consistency by sex and a plausible trend toward faster growth over the period considered. Registered deaths adjusted to consistency with the available enumerations seem, therefore, to provide the most secure basis for adult mortality estimates.

The mortality rates calculated from such adjusted deaths, however, cannot be accepted as they stand. The evaluation in the section "Evaluation of Death Registration Relative to Enumeration Completeness" grouped all deaths above age 55 and disregarded the population above age 55; thus the mortality rates above age 55 may be substantially distorted by age misreporting, and the completeness estimates should be regarded as being relative to the enumerated population aged 10 to 55. Even between ages 10 and 55, the mortality rates are likely to fluctuate as a result of random annual variations in small numbers of deaths and age reporting errors. It is therefore necessary to smooth the mortality rates between age 10 and age 50 and extrapolate from this relatively reliable age range to higher ages. A convenient way to achieve both goals is to fit a Coale-Demeny model life table from each of the four regional families to the calculated mortality rates between ages 10 and 50 and to accept for all ages 10 and over both the level and pattern of mortality of the fitted regional model giving the smallest average absolute deviation from the observations. Appendix 1 shows by sex the calculated age-specific mortality rates, the implied mortality levels in each of the Coale-Demeny families, and the average absolute deviations from the mean levels for 1949, 1964, and 1972. With the single exception of males in 1949, the West mortality pattern gives the lowest average absolute deviation from the mean level for the age range 10 to 50, and for males in 1949 the West average deviation is second only to that for the North pattern. On the basis of this evidence, the West pattern is indicated as the adult mortality pattern to be preferred for smoothing and extrapolating the calculated rates.

Final estimates of mortality above age 10 are therefore taken from West model life tables of the average levels indicated by the mortality rates between 10 and 50. Table 9 summarizes the parameters of these life tables, which are also incorporated into the life tables from birth presented in the section "Life Tables for the Years 1949, 1964, and 1972," combining estimates of both child and adult mortality.

CHILD MORTALITY

Deaths for children by sex aged 0 to 1, 1 to 4, and 5 to 9 are available for 1949 and for the period 1954-72. Age-specific central mortality rates can be calculated from these numbers of deaths by dividing by estimates of the mid-year population of each age and sex group. Such estimates can, in theory, be obtained very simply for census years by minor adjustments to the enumerated populations, but in practice the results will be distorted by omission from the censuses and by age misreporting. There is clear evidence that the population under age 1 was substantially underreported by each of the three available censuses (see the section "Summary and Conclusions Concerning Fertility, 1950-73"), whether by omission of infants or age exaggeration or both, and that overall coverage of the censuses changed substantially, improving somewhat from 1950 to 1964, and then worsening sharply in 1973 (see the section "Intercensal Changes in Population Size"). Direct calculation of central mortality rates in childhood is thus likely to give rise to misleading results. In an attempt to avoid the effects of changes in census coverage, central mortality rates for the age groups 1 to 4 and 5 to 9 have been calculated using population totals adjusted for the average levels of completeness of the 1950 and 1973 censuses relative to the completeness of the 1964 census as estimated in the section "Intercensal Changes in Population Size." Further small adjustments were made for dates, moving the 1950 population back to mid-1949 using an annual growth rate of 2.4 percent, moving the 1964 population to mid-1964 using a growth rate of 2.7 percent, and moving the 1973 population to mid-1972 using a growth rate of 2.9 percent. The resulting central mortality rates, and their implied mortality levels in each of the Coale-Demeny (1966) regional families of model life table, are shown in Table 10. Rather than attempt to adjust the population under age 1 for underreporting, deaths under 1 in 1949, 1964, 1969, and 1972 were used in conjunction with registered births in order to compute infant mortality rates rather than central mortality rates under age 1. Infant deaths in a calendar year occur to births that occurred both in that year and in the preceding year, but because most infant deaths occur fairly shortly after birth, most of the deaths occur to births in the same year. The denominator used was thus a weighted average of the births registered in the same year and in the preceding year, the weights being two-thirds and one-third, respectively (representing a rough separation factor for high-mortality populations). The infant mortality rates obtained and their implied mortality levels in each of the Coale-Demeny regional families are shown in Table 10.

The mortality levels of the estimates in Table 10 are distinctly erratic, the variability suggesting that the estimates cannot be accepted as reliable. Two independent sources of estimates of child mortality are available from the 1973 census, one being the number of children dead among those ever borne by women classified by age and the other being the proportion dead among children born in the 12 months before the census, again by age group of mother.

Information on children ever born and children dead is used to calculate the proportion of children ever borne by women by five-year age groups who had died by the time of the survey. This proportion is, by itself, an indicator of childhood mortality, though it is affected by factors other than mortality, such as the age pattern of fertility, and cannot, therefore, be used directly as a mortality measure.

Brass (1964) first proposed a way of transforming such proportions into probabilities of dying between birth and exact ages, and a number of developments of his original procedure have been put forward. A variation developed by Trussell (United Nations, 1983) has been applied in this report.

Trussell's method allows the estimation of the probability of dying between birth and exact ages of childhood using the relation $q(x) = K(i)D(i)$ where $q(x)$ is the probability of dying between birth and exact age x, $D(i)$ is the proportion dead among children ever borne by women in age group i (i=1 for women 15-19, i=2 for women 20-24, and so on); and $K(i)$ is a multiplying factor that converts the proportions of children dead $D(i)$ into probabilities of dying, $q(x)$, by allowing for the age distribution of children ever born. Using a number of combinations of model fertility and mortality schedules, Trussell calculated the proportions dead among children ever borne by women in each age group and used regression analysis to relate the value of $k(i)$ to indicators of the age pattern of fertility. The relationship he developed is

$$K(i) = a(i) + b(i)P(1)/P(2) + c(i)P(2)/P(3) \ , \qquad (4)$$

where P(1), P(2), and P(3) are the average number of children ever borne per woman for the age groups 15-19, 20-24, 25-29, respectively, and a(i), b(i), and c(i) are regression coefficients whose values are tabulated for each i from 1 to 7 and for each one of the four families of Coale-Demeny model life tables. The value of the multiplying factor K(i) depends on both the mortality pattern and the age pattern of fertility, but the latter is the more important factor.

The recent age pattern of adult mortality in Guatemala resembles most closely that of the West family of model life tables (see the section "Life Tables for the Years 1949, 1964, and 1972"), but it does not follow that the West model necessarily provides the closest representation of the true age pattern of child mortality; thus, the Trussell method has been applied using all four of the regional variants. Details of the calculations are shown in Appendix 1, and are summarized in Table 11, which shows the estimated q(x) values and implied mortality levels. The method has been applied to information from a sample of the 1973 census rather than to the full results: the full census tabulations imputed children ever born in cases of nonresponse, but did not impute children surviving, thus inflating the apparent proportions dead, particularly for younger women for whom nonresponse was substantial; the sample, on the other hand, used no imputation, and the data suggest (see the section "1973 Census") that most of the cases of nonresponse were actually women with no children. For this analysis, it has been assumed that all the cases of nonresponse were childless women, an assumption that will give the same results as a alternative assumption that the time level of nonresponse was constant at all ages.

Estimates of child mortality obtained from proportions dead among children ever born do not reflect mortality only at the time of the census. The deaths of children have occurred throughout the child-bearing lives of the reporting women and therefore reflect the mortality rates in operation throughout the period; the final proportion dead reflects a weighted average of the mortality rates over the period, the weights depending on the "age" distribution of children ever born. If child mortality rates have been changing in a regular way, it is possible to identify the time period to which each estimate of child mortality refers; in general, the older the reporting women, the longer ago the time referred to, since the children of those women were exposed to child mortality rates further in the past.

Trussell (United Nations, 1983) has developed a companion procedure to that described above to estimate the reference date of each mortality estimate (the length of time before the survey when the period life table had the estimated value of q(x)) on the assumption that the trend in mortality over time has been regular. The reference dates of the child mortality estimates obtained from the 1973 census are shown in Table 11; the date based on reports by women aged 45 to 49 refers to 15 years before the census, or 1958, while that based on reports by women aged 20 to 24 refers to only 2.5 years before the census, or 1971. (The estimate based on reports by women aged 15 to 19 is the most recent, but is generally discounted in any evaluation because it is distorted by selection or other bias.)

Once put in their proper time perspective, the child mortality estimates (except those based on the North mortality pattern) indicate a steady trend over time toward lower mortality (higher Coale-Demeny levels) with an improvement of nearly two levels over 10 years using the South or East patterns, and nearly one and one-half levels using the West pattern; use of the North pattern suggests only a moderate improvement over time. The estimated trend is sensitive to the family of model life tables chosen for the analysis: use of the North family would imply virtually no trend in child mortality, whereas use of either the South or East family would imply a rather faster rate of decline than West. Figure 4 shows the mortality levels for each family by reference date. The selection of the West mortality pattern for the childhood mortality analysis is essentially a compromise; West seems to fit adult mortality rates best and gives an intermediate trend for recent levels of child mortality, but there are no conclusive grounds for chosing one model family rather than another to represent the pattern of child mortality. The North pattern should be regarded as the least satisfactory, however, since the trend in child mortality suggested by the child survival data does not agree with the trend indicated by registration data; for the other three families, the trends indicated by the two sources are very similar.

It is now possible to compare the child mortality measures derived from registered deaths with those obtained from children ever born and children dead. The former measures, which are specific by sex, have been combined into measures for both sexes together using a sex ratio at birth of 105 males per 100 females and converted into mortality levels in each of the four Coale-Demeny regional families for ease of comparison. Child mortality levels for 1969 and 1972 from the 1973 child survival data were obtained by extrapolating forward the trend of the levels and reference dates estimated for women aged 20 to 49 and 45 to 49. Results are shown in Table 12. A clear age pattern can be seen for each of the three years 1964, 1969, and 1972 using the South, East, and West mortality patterns; the infant mortality rate calculated from registered deaths under age 1 indicates a Coale-Demeny mortality level clearly above (i.e., lower mortality) the average level implied by the 1973 child survival data, whereas the central death rates for age groups 1 to 4 and 5 to 9 indicate lower mortality levels (i.e., higher mortality). With the North pattern the mortality measures calculated from registered deaths imply higher levels (lower mortality) in infancy and at ages 5 to 9 than the 1973 child survival data, but similar levels at ages 1 to 4, except in 1969, when the child death rate at ages 5 to 9 also implies a lower mortality level than the 1973 data. These patterns suggest two possibilities: that child deaths were underregistered, particularly in infancy and at ages 5 to 9, but that the North pattern best reflects the true age pattern of child mortality; or that age at death was exaggerated, reducing infant deaths but inflating deaths at ages 1 to 4 and 5 to 9. The first possibility seems unlikely since there is no obvious reason why deaths should be registered less completely at ages 5 to 9 than at ages 1 to 4, and since the North pattern seems unsuitable given that its use to analyse the 1973 child survival data produces a trend in child mortality over time that is not consistent with the trend indicated by registered deaths between 1964 and 1972. The second possibility can be examined by calculating central mortality rates under age 10 and finding the implied mortality level of each rate. Since mortality rates around age 10 are very low, the effect of exaggeration of age at death should be small, since few deaths would be transferred upward. However, when using a 10-year age interval, some allowance must be made for the effects of the age distribution within the interval, so central mortality rates under 10 were calculated for each family and mortality level for stable populations with growth rates of 2.5 percent. The mortality levels implied by the observed rates were then obtained by interpolating within the calculated stable population values. Results for 1964, 1969, and 1972 are shown in Table 13 by sex for each regional family, together with the corresponding estimates of mortality level for both sexes obtained from the 1973 child survival data. The registration-based levels are somewhat higher (that is, showing lower child mortality) than the child survival levels for 1964 and 1972, but for 1969 the relationship is reversed (1969 seems to have been either a year of unusually high mortality or a year of unusually high registration).

For 1969, the central mortality rates under age 10 calculated from registered deaths imply levels of child mortality higher than those estimated for the same year on the basis of the 1973 child survival data for all four of the Coale-Demeny regional mortality patterns. For 1964 and 1972, on the other hand, the directly-calculated rates imply somewhat lower mortality (higher levels) than the estimates based on child survival, the differences being about half a level in 1964 for each of the mortality patterns, and ranging from a third of a level for the West and East patterns to over one level for the North pattern in 1972. Thus, even after allowing for the probable exaggeration of reported age of child deaths, it seems that there is still some underregistration of child deaths (assuming that the child survival data do not overestimate child mortality) at least in 1964 and 1972, the omission relative to the adjusted population figures being of the order of 5 to 10 percent. Regardless of the assumption, the death rates under age 10 can be regarded as upper bounds for the true levels of child mortality.

In general, in cases where comparisons with reliable values have been possible, estimates based on child survival data have been found to underestimate rather than overestimate child mortality (Somoza 1981; Hill 1981), so it is unlikely that the Coale-Demeny levels derived from the 1973 child survival data are too low. In the absence of further reliable information, it seems likely that the sequence of mortality estimates for 1958 to 1968 based on child survival data from women aged 20 to 49 should be preferred to the directly-calculated rates. The question of which mortality pattern to use is harder to resolve; there is little basis in the available informaton for choosing between the West, South and East patterns, though, as noted earlier, the North pattern seems the least appropriate. Since the West pattern appeared most appropriate for adult mortality, it has also been adopted for child mortality; the use of a different pattern would have little overall impact on the complete life tables for 1964 and 1972 presented in the next section.

One additional piece of information concerning child mortality is available from the 1973 census, which collected data on the births in the year before the survey by age of mother and recorded whether children born were still alive. The proportion alive of such children should approximate the life table function, ${}_1L_0$, person-years lived under age 1, and can therefore be used directly as a measure of mortality in infancy. Table 14 shows the proportions surviving by five-year age group of mother and the mortality levels implied in each of the four Coale-Demeny mortality families, assuming a sex ratio at birth of 105 males per 100 females. Despite a plausible pattern of differentials by age of mother (lowest child mortality for mothers in the age range 20 to 34), the overall Coale-Demeny levels of mortality are substantially higher than those calculated from registered infant deaths in 1972 (see Table 10), which must themselves be regarded as implausibly high. It is thus concluded that deaths to children born in the year before the 1973 census were greatly underreported and that the information is of no practical value.

On the basis of the results and discussion in this section, it is concluded that for the period 1958-71 child mortality estimates derived from the 1973 child survival data assuming a West pattern of mortality are to be preferred to the alternatives. For the period 1971-73, estimates are obtained by extrapolating forward the trend line of the estimated levels for 1958-71. For 1949, rather than extrapolate the trend line backward, the implied completeness of registration of deaths under 10 in 1964 (96 percent) was applied to adjust registered deaths under 10 in 1949, the West mortality level of the implied death rate under 10 for a stable population with a growth rate of 2.5 percent being accepted as the final estimate, which indicates slightly heavier child mortality than would the extrapolation of the 1958-71 trend.

The 1973 child survival data provide no information about child mortality differentials by sex, since the children ever born and surviving were reported for both sexes together. The registered deaths, however, imply a relative male advantage prior to 1972 in terms of Coale-Demeny levels, the advantage being about one level in 1949 and about half a level in 1964; by 1972, the difference is negligible. There is no reason to suppose that either the differential or its gradual disappearance over time are the results of systematic errors or changes in errors, so both the differential and its disappearance have been incorporated into the final estimates.

The accepted estimates of childhood mortality for 1949, 1964, and 1972 are summarized in Table 15, which shows for each year and sex the mortality level in the West model life tables, the implied infant mortality rates and mortality rates at ages 1 to 4 and 5 to 9, and the probabilities of surviving to age 10. The infant mortality rate for females is in all cases lower than that for males, whereas the child mortality rates are in all cases, except in 1972 at ages 1 to 4, higher for females than for males; the probability of surviving to age 10 is slightly lower for females than males in 1949, but somewhat higher in both 1964 and 1973. The pace of child mortality decline thus seems to have been somewhat more rapid for females than males over the period.

LIFE TABLES, 1949, 1964, AND 1972

The childhood mortality estimates developed in the section "Child Mortality" and for adulthood developed in the section "Adult Mortality" have been combined to obtain life tables from both for 1949, 1964, and 1972 in Table 16. The differences between child and adult mortality levels are small for 1964, but are substantial for 1949 and 1972, with relatively higher levels (lower mortality) in childhood in 1949, changing to relatively higher levels in adulthood in 1972. Local smoothing of the ${}_5q_a$ function was carried out around age 10, the age at which the child and adult life table segments were joined, leading to slight differences between Table 16, the final estimates, and Tables 9 and 15. Expectation of life at birth for females is estimated to have increased from 40.6 years in 1949 to 49.9 years in 1964 and to 54.3 years in 1972. For males, comparable figures are 40.4 years for 1949, 47.9 years for 1964, and 51.6 years for 1972. The crude death rates implied for smoothed population age distributions are shown in Table 3.

CHAPTER 3

FERTILITY

As in the case of mortality, fertility rates can be calculated directly, from registered births and enumerated populations, or estimated indirectly through a variety of techniques. Among the indirect techniques available, the most important are those based on information collected by retrospective questions concerning lifetime fertility, and those based on recorded age distributions, such as the "own-children" method of reverse survival. This chapter presents results of both direct and indirect procedures, with a view to estimating levels and trends of fertility, in terms of age-specific rates and total fertility for the period 1950-73.

DIRECT ESTIMATION

Using information on registered births by age of mother for census years and the enumerated female population by age group moved to mid-year, age-specific fertility rates can be calculated directly without correction and total fertility rates can be obtained. Such direct estimates of fertility for 1950, 1964, and 1973 are shown in Table 17.

The fertility rates shown in Table 17 show no marked trend in fertility for the period 1950-73, but an evaluation of the basic data is required before firm conclusions concerning levels and trends of fertility can be shown. Not only is it possible that the completeness of registration of births may have changed over the period, but there is also evidence (see the section "Intercensal Changes in Population Size") that the completeness of coverage of the female population by the successive population censuses changed, and it is also possible that age-reporting errors may have changed as well. For example, the appearance of virtually constant total fertility between 1964 and 1973 would conceal a small reduction in fertility if the 1973 census suffered a higher degree of omission of females than the previous censuses, or if the completeness of birth registration had improved over the period. Indirect estimation procedures can be applied to evaluate the quality of the data, and to make possible the selection of final estimates on the basis of all the information available.

ESTIMATES BASED ON RETROSPECTIVE QUESTIONS

Brass (1964) has suggested a procedure, known as the P/F ratio method, to check the consistency of reports on lifetime fertility, in the form of information on children ever born, with information on current fertility, in the form of births reported in the year before the survey or registered in the year of the survey. Age-specific fertility rates calculated from the latter can be cumulated and an interpolation procedure used to estimate average parity equivalents that can be compared with reported average parities. Brass also suggested that if fertility were constant, the P/F ratio comparison could provide a technique for adjustment in view of the errors likely to characterize the two different types of information. If the most important error in the recent fertility information is a tendency to report births occurring during a period somewhat longer or shorter than 12 months, or to underregister births, and the tendency to error is roughly constant for women of different ages, then the age pattern of recent fertility will be correct, but not its level. If the most important error in information on children ever born is a tendency among older women to fail to report some of their children, then average parities for younger women may be more or less correct, but not those for older women. If fertility is constant, so that recent and lifetime fertility are more or less the same, the age pattern of fertility calculated from the data on recent births can be adjusted to match the level of fertility indicated by the average parities of younger women, thus combining the most reliable features of the two types of information to obtain a refined final estimate of fertility.

The Brass P/F ratio method has been applied using parity information from the 1964 and 1973 censuses and the age-specific fertility rates calculated from registered births shown in Table 17. It is not possible to apply the method to 1950 since no information concerning lifetime fertility was collected by the 1950 census. For 1973, it is also possible to apply the method using age-specific fertility rates calculated from births reported as occurring in the year before the census; using information of both types obtained from the same source has the methodological advantage that the age errors that may affect the data will be consistent.

1964 Census

The only fertility question in the 1964 census schedule concerned the number of children ever born alive, and it was put only to women who had had at least one child. No information was available from the census concerning births in the previous year, so the variant of the Brass method designed to use current fertility information from registered age-specific fertility rates was used.

Table 18 shows the application of the method and the results obtained, using the age-specific fertility rates shown in Table 17 calculated by using estimated mid-year populations by age group.

The P/F ratios in column 5 of Table 18 are all less than unity, indicating that the age-specific fertility rates derived from registered births imply a higher level of fertility than do the numbers of children ever born reported by women at the census. The method of collection of the information concerning children ever born provides a reason for supposing that the downward correction implied by the P/F ratios should not be accepted; it is probable that the average parities reported by the census were underestimated at all ages, thus reducing the values of the P/F ratios. The average parities were calculated by dividing the total number of children ever born reported by women in each age group by the total number of women enumerated in the relevant age group, regardless of whether the women provided information concerning children ever born or not. Since the information concerning children ever born was collected only from women who reported having had at least one child, it is impossible to distinguish between those women who had no children and those who simply did not reply to the question concerning children ever born. The method by which average parity was calculated assumes that the women from whom no information was available did not have any children; if any of the women for whom no information was provided had in fact had children, the calculated level of average parity would be too low. The use of the P/F ratios as a correction factor would therefore tend to underestimate the true level of fertility. The age pattern of the P/F ratios, showing a steady decline with age, is also consistent with a commonly-observed tendency for omission of children ever born to increase with age of mother. The 1964 census information on children ever born is therefore concluded to be of no value in the evaluation of birth registration.

1973 Census

More information concerning fertility is available from the 1973 census, although the information from this census has to be interpreted with caution given its low level of coverage (see discussion in the section "Intercensal Changes in Population Size").

The P/F ratio method has been applied using age-specific fertility rates calculated from both registered births in 1973, using the reported census population moved to mid-year, and from births reported as having occurred in the year before the census. The registration-based rates may be inflated because of the underenumeration of the 1973 census, but if the coverage error was approximately constant within the age range 15 to 49, the age pattern of fertility should not be distorted, and the error in level should appear in the P/F ratios. The census-based rates may be distorted by reference-period error, but once again if this error is approximately constant by age, the age pattern of fertility should not be distorted, and the effects of the error should appear in the general level of the P/F ratios. Thus the age patterns of fertility from the two sources should be similar, and the overall levels of fertility after adjustment by the P/F ratios for younger women should also be similar.

Major discrepancies in the fertility patterns might arise either from differential underregistration of births by age of mother or from systematic differences in the reporting of age when registering a birth and at the time of enumeration; in the case of either error, the age pattern of the census-based rates is likely to be preferable to that of the registration-based rates. In this application to Guatemala, once allowance is made for the different ways in which age is recorded (age of mother at birth for registered births, age of mother on average half a year after birth for births in the 12 months preceding the census), the two age patterns of fertility are virtually idential (see Table 20).

The average parities for 1973 have been calculated making an allowance for nonresponse. The allowance made was not the simple subtraction of women classified as being of not-stated parity; the numbers of such women are often inflated by the misclassification of women with no children as being of not-stated parity. El-Badry (1961) has proposed a simple procedure for estimating the true level of nonresponse, assumed to be a constant proportion by age, by plotting the proportions of women with no children against the proportions classified as being of not-stated parity by age group. The intercept of the straight line fitted to the points on the nonresponse axis then provides an estimate of the "true" level of nonresponse, and the estimate can be accepted if the fitted line fits the points fairly closely and the intecept is positive. This correction procedure has been applied to the 1973 census data (with results shown in Appendix 2), indicating a low level of true nonresponse of less than one half of 1 percent. The average parities used in the application of the P/F ratio procedure have been calculated by subtracting the proportion of women presumed to have been true cases of nonresponse, taken as 0.28 percent, from the number of women reported in each age group.

The application of the method using age-specific fertility rates based on both registered births and births in the year before the census is shown in Table 19.

The total fertility rate of 6.81 derived from births in the year before the census is substantially higher than the 6.34 rate derived from births registered in 1973. The female population was substantially underenumerated in 1973, so if births were completely registered, the registration-based fertility rates (and total fertility) would be too high since the denominators would be too small. Thus the census-based fertility rates, if correct, would imply substantial underregistration of births. The comparisons of cumulated fertility rates with the average parities in 1973, the P/F ratios, suggest that at least part of the discrepancy arises from an overreporting of births in the 12 months before the census. The age patterns of both sets of P/F ratios are very similar, but not their levels. For both the registered births and the census births, the P/F ratios are virtually constant for women aged 25 and over, but are considerably higher for women aged 15 to 19 and, though to a lesser extent, for women aged 20 to 24. The average levels of the P/F ratios for women aged 25 and over are preferred as indicators of recording completeness for two reasons; the first reason is that the P/F ratios for younger women are very sensitive to recent changes in fertility at young ages, such as those that might arise from changing age at marriage, and the second reason is that the average parities for younger women may be distorted by a residual nonresponse problem not adjusted for adequately by the El-Badry procedure, or by age misreporting related to parity, or, in the face of serious underenumeration, by a selection bias. The average P/F ratios for women aged 25 and over are 1.023 for registered births, implying some slight underregistration of births relative to the census enumeration in 1973, and 0.952 for census births, implying some overreporting of births in the 12 months before the census. The two total fertility rates, after adjusting by these average ratios, are 6.48 from both registered births and census births.

This consistency in the adjusted fertility levels should not be the basis for great confidence in the result. The same average parities were used for both companions, so the use of two similar age patterns of fertility was bound to result in similar adjusted levels. The assumption made by the P/F ratio method of constant fertility will also affect both sets of ratios in similar ways, again resulting in a consistency that should not be interpreted as evidence of reliability; the pattern of the P/F ratios for younger women does suggest some recent change in fertility below age 25. However, the high degree of consistency between the age patterns of current fertility indicated by the two sources can be taken as powerful evidence that the age patterns are approximately correct. This consistency is illustrated in Table 20, which shows the reported and adjusted age-specific fertility rates obtained from the two sources, the 1973 census-based rates having been further adjusted to refer to standard five-year age groups rather than age groups half a year younger than those usually used.

In order to probe somewhat more deeply into the possible errors in the 1973 census data, a variant of the original Brass P/F ratio method has been applied to first-order births alone (Brass 1975). For this variant, age-specific first-birth rates are cumulated and interpolation between the cumulated values is used to obtain measures comparable to the proportions of women in each age group having had at least one child, that is, the proportion of women in each age group who are mothers.

The first-birth variant is less affected by possible changes in marital fertility in the recent past, though it may be severely affected by changes in age at marriage and does not directly provide an adjustment factor for recent fertility, since recording of first births may not be the same as recording of all births. Because of this last reservation, the method has been applied here as a consistency check and as a device for exploring the possibility of errors rather than as a technique for adjusting recent fertility data. The application of the method to both registered and census births is shown in Table 21.

The cumulative proportion of women becoming mothers calculated from first births registered in 1973 is 1.18, clearly an impossibility for a cohort, though not necessarily for period rates. In conjunction with the P/F ratios for all registered births, however, it has to be concluded that births of higher orders have been registered as first births, rendering the first birth rates useless for the purposes of checking consistency; the age pattern of the P(1+)/F(1) ratios, declining steadily with age, also suggests that the misclassification of birth order gets progressively worse as age increases.

The cumulative proportion of women becoming mothers calculated from census-based first births also exceeds unity, reaching 106 percent. In this case, however, the data are still of some value for checking on consistency, since the overall level of the P(1+)/F(1) ratios is not very different from that of the P/F ratios, the two sets of ratios show rather similar age patterns (effectively constant from age 25 and over) and since there is a necessary connection between the parity data and first-birth rates. This last point deserves further elaboration. The births used to calculate the first-birth rates are those reported as having occurred in the year before the census by women who also report having one and only one child. The P(1+)/F(1) ratios will be biased downward if women with more than one child report having exactly one, since the P(1+) will be unaffected, but F(1) will be too large; in such a case, the P/F ratios will also be biased downward, since the P's will be too small, whereas the F's will be unaffected. Thus the difference in the two sets of ratios cannot readily be explained in terms of differences in reporting of single children. It is generally argued (United Nations, 1983) that when fertility has been approximately constant, or only changing at older ages, the P(1+)/F(1) ratios represent corrections for all births that should be regarded as a lower bound for overall fertility. Applying the average P(1+)/F(1) ratio for women aged 25 to 49, 0.891, to the reported census total fertility rate gives a value of 6.06.

The reliability of the P/F ratio-adjusted fertility estimates for 1973, which indicate a level of total fertility between 6.06 and 6.48, depend critically on whether the assumption is justified that fertility at younger ages has been constant. Given the apparent level of fertility in 1973, the use of contraception cannot be very extensive at any age, and so it is very unlikely that early fertility has been significantly reduced by the use of contraception. More serious is the possibility of changes in age of marriage. Table 22 shows the proportions of women by age group reported by the 1964 and 1973 censuses as being never married. For the first two age groups, the proportions single are higher in 1973 than 1964, suggesting some small increase in age at marriage, but from age 30 and over the proportions single in 1973 are lower than in 1964 for corresponding age groups. Marital status information in Latin America is often hard to interpret because of the difficulties involved in the classification of consensual unions, and the changes in the proportions single between 1964 and 1973 for approximate cohorts (for example, women aged 45 to 49 in 1973 are approximately the same cohort as women aged 35 to 39 in 1964), in comparison with the changes in proportions single for the two years separately that show little first marriage after age 30, strongly suggest that reporting of marital status changed between 1964 and 1973. One obvious change is that more unions were classified as marriages in 1973 than in 1964, but it also seems likely that some women who would have reported themselves as ever-married in 1973 reported themselves as single in 1964. If marital status had been reported equivalently in 1964 and 1973, the changes in the proportion ever-married would have been larger than they appear to have been, perhaps by about 2 precent of all women. The changes would then be large enough to inflate P/F and P(1+)/F(1) ratios, particularly for younger women.

Fortunately it is possible, when sufficient information on fertility by age exists, to apply a modification of the P/F ratio method which is unaffected by changing fertility. Hill (1980) has proposed a method to examine the consistency of births registered as having occurred over the whole reproductive life of a cohort of women with the average parity of the cohort obtained from a census or a survey. In addition to being able to examine the consistency of the information from the two sources, it is also possible, if the completeness of registration has remained approximately constant, to correct the age-specific fertility rates calculated from registered births without making the assumption of constant fertility required by the original P/F ratio method, since the method compares two measures of lifetime fertility. If the method is used to obtain adjustment factors, it has to be assumed that there is no fertility differential between mothers who provide information on children ever born at the time of the census and those who contribute to registered births but are not covered by the census.

The first step in the application of the method is to calculate age-specific fertility rates for each calendar year for a period of 20 years prior to the 1973 census. These age-specific fertility rates are then cumulated by cohort in order to obtain estimates of the average parity of cohorts of the same age as those for which census data on parity are available. In order to carry out such a cumulation it is necessary to split the age-specific fertility rates for five-year age groups and calendar years in order to be able to follow individual cohorts through individual calendar years. In order to carry out the splitting of age-specific rates, weights have been calculated on the basis of model age-specific fertility distributions.

Age-specific fertility rates calculated from registered births and female populations are shown for the years 1953 to 1972 in Appendix 2. These age-specific rates were calculated from the births registered by age group of mother for each year and estimates of female population of each five-year age group obtained by interpolating between the census populations of 1950, 1964, and 1973. Given the considerable evidence that the coverage of the censuses was not equal, the 1964 census was taken as the most complete, and the other two censuses were adjusted to be consistent with the 1964 enumeration, using correction factors obtained in the section "Intercensal Changes in Population Size;" the adjustment factors were 1.02 for the 1950 census and 1.07 for the 1973 census.

Table 23 shows the comparison of the average parity reported by women up to age 35 in 1973 after adjustment for nonresponse with comparable measures obtained by cumulating the registered fertility rates for the same cohorts. The ratios in the last column are analogous to the P/F ratios presented above, except that they are unaffected by changing fertility, and estimate adjustment factors for registered births relative to the coverage of the 1964 census, on the assumption that the reporting of children ever borne by younger women at the time of the 1973 census, was approximately complete.

The estimates of completeness of cohort birth registration (the reciprocals of the ratios in column 4 of Table 23) are not very consistent; the completeness estimates based on the reports by younger women under 25 average around 90 percent while those calculated for women aged 25 to 34 average around 96 percent. It is possible that completeness varies with age of mother, being lower for births to younger women unfamiliar with registration procedures, though the low estimate for women aged 20 to 24 is surprising. The age pattern of the cohort P/F ratios is similar to the age patterns of the period sets based on both registered and census births, with high values for the first two age groups. It is therefore unlikely that either the age pattern of the period ratios arises from declining fertility at young ages, since the cohort ratios would be unaffected by such a change, or that the age patterns of the ratios for registered births arise from higher underregistration of births by young mothers, since the factors that might cause such higher underregistration would be unlikely to affect births reported in the year before the census. Thus, it seems most likely that the age pattern of all the sets of ratios arises from errors in the average parities, which are either too high for young women or too low for women 25 and over. The period ratios for women aged 25 and over are virtually constant, showing no signs of increasing omission of children ever born as age rises, and the proportions dead of children ever born analysed in the section on child mortality also show no sign of increasing omission of dead children as age rises, so on balance it is concluded that the average parities of women under 25 have been somewhat overreported and that those for women aged 25 and over represent a more reliable basis for adjustment.

Two points need to be made about the application of the cohort P/F ratio method. The first is that the age-specific fertility rates from registered births were cumulated only up to the end of 1972, since the census parities refer to early 1973, so the adjustment factors can only be applied to births registered in 1973 if it is assumed that no change occurred in completeness of registration in 1973. The second point is that the use of the cohort ratios to provide adjustment factors assumes that registration completeness has been effectively constant for 10 or 15 years. If completeness had been improving, the ratios would be expected to rise with age, so the age pattern of the observed ratios gives no indication of improving registration in the recent past.

In the light of this discussion, it is concluded that the cohort P/F ratio of 1.028 for women aged 30 to 34 represents a sound average adjustment factor for registered births relative to the completeness of the 1964 census enumeration for the period from the late 1950s to the early 1970s. Table 24 shows the adjusted total fertility rates for the years 1958 to 1973. The estimates suggest that total fertility was virtually constant in the range 6.6 to 6.9 between 1958 and 1966 and then took a step downward to fluctuate in the range 6.0 to 6.3 between 1967 and 1973. It is possible, given the age pattern of the cohort P/F ratios, that registration completeness fell between 1966 and 1967, in which case the estimates for 1966 and earlier would be rather too high, and those for 1967 on rather too low. In this context, it should be noted that the estimate of 6.3 for the 12 months before the 1973 census falls in the middle of the range of values (6.1 from first-birth P/F ratios to 6.5 from all-birth P/F ratios) suggested by the 1973 census data on fertility. Given the data being used, there is no firm basis for deciding whether it was fertility or registration completeness that declined in the late 1960s, though there can be little doubt that total fertility was in the range of 6.1 to 6.5 in the year before the 1973 census. Fortunately, population age distributions in combination with mortality estimates can provide information about recent levels and trends of fertility which are independent of information on births or children ever born, and an analysis of the fertility implications of the 1964 and 1973 age distributions, presented in the next section, may provide a basis for choosing between the two possible interpretations of the birth registration and census parity data.

ESTIMATION OF FERTILITY FROM AGE DISTRIBUTIONS USING THE OWN-CHILDREN METHOD

The reverse survival method, whereby young children enumerated by a census or survey are back-projected allowing for the effects of mortality in order to estimate numbers of births in years prior to the census or survey, has long been used as a technique for estimating fertility. This method, however, provides no information about the age pattern of fertility, and it is therefore not possible to use the method to obtain estimates of age-specific fertility rates.

The own-children method, developed primarily by Lee-Jay Cho (Cho and Feeney, 1978) provides a solution to this problem by relating children to mothers within households and thus obtaining an age distribution of surviving children by age of mother. In some cases, the link between mother and child within the same household is established by the use of an additional survey question, but in other cases the link is established by a computer matching routine on the basis of certain selected characteristics of the women and children within a particular household. Children found in households which include no woman fulfilling the matching criteria are designated as non-own children and are subsequently distributed by age of mother following the distribution of the assigned or own-children.

The method has been applied to children under age 15 recorded by the 1964 and 1973 censuses, providing estimates of age-specific fertility rates for a period of more than 20 years from 1949 to 1972. The percentage of children assigned to mothers was satisfactory, 88 percent being assigned in 1964 and 92 percent being assigned in 1973 (the basic data are shown in Appendix 2). The basis of the method is a tabulation of children aged 0 to 14 by single years of age against mothers by single years of age. In the absence of age-reporting errors and migration, the children of any particular age represent the survivors of the births that number of years ago, so by allowing for the effects of child mortality, the number of births can be estimated, not only in total, but by age of mother at the time of the birth. The effects of mortality on women can also be allowed for in order to estimate the number of women of each age in each preceding year, allowing the calculation of age-specific fertility rates for each calendar year. Children not allocated to mothers, non-own children, of each age can then be introduced by rating up the age-specific rates by the ratio of all children of that age to allocated children of that age. It should be remembered when interpreting the results that the own-children method is essentially a reverse survival technique and that the estimates of aggregate fertility obtained will be no better than the age distribution to which the method is applied.

The method has been applied to samples of both the 1964 and 1973 censuses. The reverse survival method of children was carried out using the mortality rates obtained in the section "Child Mortality;" mortality rates for women were taken from the section "Adult Mortality."

Table 25 shows the estimates of total fertility by year obtained by applying the own-children method to the 1964 and 1973 censuses. The age-specific fertility rates obtained for the 15 years prior to each census are shown in Appendix 2. The sequences of total fertility estimates are plotted by time period in Figure 5, together with comparable estimates from Table 24 based on adjusted registered births.

The sequences of total fertility from both the 1964 and the 1973 censuses exhibit certain similar features. The most dramatic common feature is the sawtooth pattern of alternate high and low estimates based on children aged 8 and over; this feature arises from heaping on attractive ages, even numbers in this case, and avoidance of odd numbers. The second common feature is a downward trend in the estimates based on young children, the decline running from ages 4 to 1 in 1964, and from ages 6 to 1 in 1973, with an upturn for the estimate based on infants in both cases. Such a pattern is very common in own-children applications and is generally interpreted as evidence of underrecording of young children, either because of omission or age exaggeration; in this application, the downward trend for the period 1959-60 to 1962-63 indicated by the 1- to 4-year olds in 1964 is certainly not borne out by the estimates based on 10- to 13-year olds in 1973.

It is clear from Figure 5 that the proportionate errors at each single year of age are similar in 1964 and 1973. If these errors were exactly the same, and there were no other errors, then the ratios of the total fertility estimates based on each age from 1973 to the corresponding estimates from 1964 would provide accurate indicators of the change in total fertility over nine-year periods from the 1964 reference dates to the 1973 reference dates. These ratios, shown in Table 26, are above 1.0 for children ages 11 to 14, suggesting slightly higher fertility for the period 1958-61 than for the period 1949-52, then average about 1.0 for ages 7 to 10, suggesting similar fertility for the periods 1953-56 and 1962-65, and are then considerably below unity for ages 1 to 6, indicating lower fertility for the period 1966-71 than for the period 1957-62. The ratio for children under 1 year is above 1.0, but should be interpreted with caution since the population under 1 year is particularly sensitive to data collection procedures.

The availability of a sequence of estimates of total fertility from adjusted registered births in Table 24 makes it possible to calculate comparable ratios of fertility change for similar nine-year periods from an independent source for part of the period. The estimates in Table 24 start in 1958, but additional estimates for the years 1953 to 1957 can be made from the rates given in Appendix 2 by assuming a constant correction factor prior to 1958 of 1.028, and ratios of total fertility for periods nine years apart can be calculated starting with 1953 to 1962 and finishing with 1963 to 1972. These ratios based on adjusted registered births, also shown in Table 26, imply changes that are very similar in pattern, though of somewhat smaller magnitude, to the ratios based on own-children estimates. This similarity of pattern strongly suggests that there was a fall in fertility in the late 1960s and early 1970s, rather than a change in the completeness of birth registration.

Despite the similarity of the fertility trends implied by the own-children analysis to those indicated by registered births, the levels do not seem to agree closely. The average level of total fertility for the period 1958-68 estimated from own-children in 1973 is 6.91, nearly a third of a child higher than the corresponding average from registered births of 6.65; with the 1964 census and the period 1953-59, the comparable averages are 7.23 from own-children and 6.69 from registered births. (In these comparisons, the own-children estimates based on children under age 4 are excluded, and for the 1964 data, the comparison period is limited by the availability of adjusted registered births.) Thus, either registered births have not been adjusted enough, or the own-children applications are overestimating the level of fertility. The own-children method will overestimate fertility if the child mortality rates used in its application are too high, if the female adult mortality rates are too low, or if children are more completely enumerated than women. All these errors may possibly have occurred, but the data simply do not exist to examine the mortality rates more thoroughly. Somoza (1981) has indicated another mechanism by which the own-children procedure might lead to exaggerated estimates of total fertility. Children are assigned to women as own-children on the basis of a computer matching procedure that uses relevant attributes of both woman and child to make the match; false matches are more likely to inflate the number of children of older women than of younger, distorting the age pattern of fertility and also increasing total fertility since the transfer of a given number of children from young women to older women inflates the age-specific rates at older ages by more than it reduces the rates at younger ages.

Fortunately, since the true age pattern of fertility is thought to be reliably given by birth registration, it is possible to see whether this bias may have affected the own-children data, and if so, to what extent. Table 27 compares the means and standard deviations of the age-specific fertility distributions for three-year periods obtained from registered births with those of the distributions obtained from the own-children analyses. Within each set, the means and standard deviations are highly consistent and indicate no systematic changes in the age pattern of childbearing over the period. However, the means and standard deviations of the fertility distributions obtained from the own-children applications are consistently higher than those of the fertility distributions obtained from registered births, the differences in the means being about half a year for the 1973 own-children rates and about 1 year for the 1964 own-children rates. These differences strongly suggest that mismatches between children and women in the own-children applications have distorted the resulting age patterns of fertility, increasing the means and the spreads. It is possible to assess the impact of this distortion on the estimates of total fertility by comparing the number of births implied by the own-children and registration rates, given a common age distribution of the female population; if the differences in total fertility arise largely from the misallocation of children to women, the numbers of births should be similar. Table 28 shows the numbers of births implied and the ratios of own-children births to registered births for the periods 1958-68, using the 1973 data, and 1953-59, using the 1964 data. For the period 1958-68, the ratio of own-children births to registered births is 1.026, compared with the total fertility ratio of 1.039; for the period 1953-59, the ratios are 1.043 and 1.081, respectively. Thus, even after allowing for the effects of misallocation of children to mothers, the own-children estimates of fertility are still some 3 or 4 percent higher than the registration estimates.

It has already been noted that the own-children fertility estimates based on children aged 0 to 3 are too low because of a deficit of children at these ages. If this deficit arises from the omission of young children, the own-children estimates based on children aged 4 and over will not be affected, but if the deficit arises from the systematic exaggeration of age, young children will be pushed into the 4 and over category. The own-children estimates based on these ages will then be exaggerated for two reasons, first because there will be too many births, and second because the adjustment for mortality would be slightly too high. If it is assumed that the entire deficit under age 4 is accounted for by age exaggeration, the 1973 own-children estimates become almost consistent with the registration estimates, whereas the 1964 own-children estimates are still some 2 percent higher than the registration estimates.

The 1964 own-children estimates thus imply a level of fertility between 2 and 4 percent higher than adjusted registered births, depending on how much of the deficit under age 4 is accounted for by age exaggeration and how much by omission; for 1973, the range is between less than 1 percent and 3 percent. Given the evidence that enumeration completeness was low in 1973, the effects of underenumeration need to be considered; constant proportional omission at all ages will have no effect on own-children estimates, but higher omission of women than children will inflate them. However, there is no evidence that adult females were relatively less completely enumerated by the 1973 census than children; indeed, the recorded annual growth rate between 1964 and 1973 is 2.4 percent for females aged 15 to 49, but only 2.0 percent for children under 15.

In summary, the own-children estimates of fertility indicate very similar trends to the estimates derived from adjusted registered births, but indicate a general level some 2 or 3 percent higher, if it is assumed that the deficit of children under age 4 arises partly from age exaggeration and partly from omission. The estimates of the age pattern of childbearing derived from the own-children technique indicate both a higher mean and a wider spread of the distribution than the estimates based on registered births, with higher rates under 20 and over 30, but lower rates in the 20s.

SUMMARY AND CONCLUSIONS CONCERNING FERTILITY, 1950-73

There are two sources of information about fertility levels in Guatemala from the early 1950s to the early 1970s. The first, registered births by age of mother, has been adjusted for registration completeness and changes in enumeration completeness and yields a fairly smooth time trend in fertility as well as plausible and virtually constant age patterns of fertility. The second, age distributions from the 1964 and 1973 censuses, give erratic estimates by calendar year, though once smoothed, they support the trend shown by registered births; they also suggest a broader and later age pattern of fertility, and indicate a general level of fertility some 2 or 3 percent higher than the registered births. The consistency with respect to everything except age pattern is impressive, but a choice of level needs to be made.

The 1973 census provides a basis for estimates that are independent of both registered births and the age distribution of children. These estimates, based on births reported as occurring in the year before the census, support the age pattern of fertility from registered births and indicate a level of total fertility in the range 6.1 to 6.5 for the period early 1972 to early 1973; the comparable level from adjusted registered births is 6.3 and from the age distribution somewhat over 6.4. Under conditions of gently declining fertility, the upper limit of 6.5 from the census would be somewhat too high.

There are no compelling reasons for preferring the fertility levels from adjusted registered births to those from the census age distributions or vice versa. The former could be slightly too low if lifetime fertility had been underreported by women aged 25 to 34 at the 1973 census, and the latter could be slightly too high if child mortality had been somewhat overestimated. Since the two levels are not very different, a final estimate of level has been arrived at by assuming that adjusted registered births underestimate the level of fertility by 2 percent. However, both the time trend and the age pattern of fertility indicated by adjusted registered births are accepted. Table 29 shows the age-specific fertility rates and total fertility rates for 1950, 1964, and 1973, the values for 1950 having been obtained by using the same adjustment factors as those used for 1964 and 1973.

Fertility was effectively stable during the period 1950-66 (period total fertility fluctuating within the range 6.6 to 7.0) and then began a modest decline, though with some fluctuations, to a level of 6.2 in 1973. This decline in overall fertility of about 10 percent seems to have occurred at all ages rather than as a result of changing age at marriage or the use of contraception limited to older women.

CHAPTER 4

AGE STRUCTURE AND NATURAL INCREASE OF THE POPULATION

The age and sex structure of a population at a given time represents a record of the cumulative effects of fertility, mortality, and migration rates prior to that time and is characteristic of the rates to which it has been subject. The estimates of fertility and mortality obtained in the previous two sections can therefore be used to calculate model age structures, assuming no net migration, which can be compared with the observed age structures for 1950, 1964, and 1973. If the estimated vital rates are approximately correct, the observed and calculated age structures should be similar to one another, apart from deviations introduced by age misreporting, so the comparison can provide further support for the estimates arrived at, though it should be noted that different combinations of fertility and mortality rates can give rise to virtually identical age structures and that the age distributions have already been used in estimating the vital rates. The model age distributions also provide a base for the calculation of crude birth rates, crude death rates, and rates of natural increase, which represent useful summary measures but are sensitive to distortions of the recorded age distributions.

The simplest procedure is to compare the reported age distributions with ready-tabulated stable populations from the Coale-Demeny set. However, the population of Guatemala has clearly not been stable, that is, exposed to constant fertility and mortality rates, over the period under study. Mortality is estimated to have declined sharply between 1950 and 1964, and to have continued to decline, though more slowly, between 1964 and 1973; it is also overwhelmingly probable that mortality had been declining for some time prior to 1950, though such a decline has not been documented in this report. Fertility has changed less dramatically, though there seems to have been a very slight rise to around 1960 and then a gradual decline from around 1965 to 1973.

In order to take these changes into account, model age distributions have been obtained by projecting an initially stable population using fertility and mortality assumptions based on the estimates in this report. The initial stable population, of mortality level 3 and a growth rate of 1 percent, was assumed to represent the population in 1909, and was then projected forward to 1949 assuming constant fertility (total fertility of 6.67) and mortality declining linearly from level 3 to the levels estimated for 1949; the 1949 population was then projected forward to 1964 and 1974, assuming that fertiliity and mortality followed the trends estimated in this report. The 1949 and 1974 projected populations are taken to represent adequately the populations for early 1950 and early 1973, respectively.

The observed and projected proportions in broad age groups are compared in Table 30. The agreement is by and large satisfactory, though the projected female population over age 45 is always larger than the observed population. A more sensitive comparison is provided by the ratios of the observed proportion to the projected proportion in each age group. Such ratios may be expected to fluctuate from age group to age group as a result of age misreporting, but if the underlying assumptions of the projection are correct they should fluctuate around a central value of 1.0. Figure 6 shows the ratios by age group, sex, and census year. For males, the ratios seem to fluctuate rather satisfactorily around 1.0 for all three years, though it might be contended that in 1964 and 1973 the central value above age 60 is somewhat above 1.0. For females, the ratios up to age 50 behave broadly in a satisfactory way for all three years, but above age 50 they seem to fluctuate around a level somewhat below 10. The evolution of the age distribution is thus quite consistent with the vital rate estimates, though suggesting that female mortality over age 50 may have been somewhat underestimated whereas male mortality over age 60 from 1950 onward may have been somewhat overestimated. However, the distortions could arise from systematic age misreporting, and no adjustment has been deemed justified on this basis alone to the mortality estimates in Chapter 2.

The model age distributions for 1949, 1964, and 1973 have been used as the basis for calculating the crude rates of birth, death, and natural increase shown in Table 31. The crude birth rate declined slightly from 1949 to 1964 as a result of changes in the age distribution and then declined more sharply to 1974 as a result of a fall in fertility. The crude death rate fell steadily through the period. The rate of natural increase rose to nearly 3 percent in 1964, the decline in the death rate outweighing the slight fall in the birth rate, and then rose slightly between 1964 and 1974 as the fall in the birth rate almost cancelled out the continued fall in the death rate. Unless the pace of mortality decline slows, there is no reason to expect that the growth rate of the population of Guatemala will change much in the medium term.

TABLE 1 Enumerated Population by Sex and Average Annual Intercensal Growth Rates, 1950, 1964, and 1973: Guatemala

	Male	Female	Total
Enumerated population, 18 April 1950	1,410,775	1,380,093	2,790,868
Average annual intercensal growth rate	3.08	3.05	3.07
Enumerated population, 18 April 1965	2,172,456	2,115,541	4,287,997
Average annual intercensal growth rate	1.97	2.18	2.07
Enumerated population, 26 March 1973	2,589,264	2,570,957	5,160,221
Average annual intercensal growth rate	1.90	2.05	1.98
Provisional population, 23 March 1981	3,014,255	3,029,304	6,043,559

TABLE 2 Socioeconomic Indicators, 1973: Guatemala

Population living in rural areas	64%
Population illiterate among those aged 7 and over	55%
Population with less than 3 years of schooling in the population aged 30 and over	85%
Population aged 7-14 attending school	48%
Male employees involved in agriculture	65%
Own-account workers and unpaid family workers	53%
Houses with an earth floor	70%
Households without water supply	78%
Households without electricity	75%
GNP produced by the agricultural sector, 1970	29%
GNP per capita (1970)	$482
Population per square kilometer	53

Sources: Guatemala (1975); United Nations (1978).

TABLE 3 Demographic Indicators for Census Years: Guatemala

Indicator	1949	1964	1972
Expectation of life at birth, e_0			
Males	40.4	47.9	51.6
Females	40.6	49.9	54.3
Expectation of life at age 10, e_0			
Males	45.2	50.5	53.7
Females	45.8	52.6	55.5
Infant mortality rate (per 1,000)			
Males	175	138	126
Females	165	124	107
Total fertility rate	6.7	6.7	6.2
Gross reproduction rate	3.3	3.3	3.0
Crude birth rate (per 1,000)	48	47	43
Crude death rate (per 1,000)	23	17	13
Annual rate of natural increase (per 1,000)	25	30	30

TABLE 4 Demographic Data by Source: Guatemala

Demographic Information	1950 Census	1964 Census	1973 Census	Vital Registration
	Data Source			
Population by age and sex	x	x	x	
Children ever born		x	x	
Children surviving			x	
Births by age of mother			x	1954-73
Survival of most recent birth			x	
Deaths by age and sex				1949, 1964, 1973
Survival of mother			x	

TABLE 5 Initial Estimates of Completeness of Death Registration Relative to Census Enumeration from Preston-Coale Procedure, 1949, 1964, and 1972 (iterated growth rates): Guatemala

	Male		Female	
Year	Average Completeness	Growth Rate	Average Completeness	Growth Rate
1949	0.900	2.4	0.916	2.2
1964	0.984	2.8	1.044	3.0
1972	1.102	3.0	1.144	3.3

TABLE 6 Final Estimates of Completeness of Death Registration Relative to Census Enumeration from Preston-Coale Procedure, 1949, 1964, and 1972 (fixed growth rates): Guatemala

Year	Male Average Completeness	Male Growth Rate	Female Average Completeness	Female Growth Rate
1949	0.904	2.4	0.960	2.4
1964	0.986	2.8	0.986	2.8
1972	1.082	3.0	1.015	3.0

TABLE 7 The Estimation of Relative Completeness of Coverage of Two Successive Censuses and of the First Census Relative to the Completeness of Death Registration During the Period; Preston-Hill Method: Guatemala

Indicator of Completeness of Coverage	1950-64		1964-73	
	Male	Female	Male	Female
(a) First census relative to second census	0.94	0.98	1.08	1.07
(b) Enumeration of the first census relative to the completeness of registration of intercensal deaths	1.19	1.14	1.21	1.32

TABLE 8 Adult Female Mortality Estimates from Survival of Mother, Estimates of Their Time Reference, and Comparable Mortality Measures, 1973: Guatemala

Age Group of Respondents	i	Estimated l(25+i)/l(25) Females	Estimated Time Reference (years before survey)	Implied West Mortality Level	Comparable Estimates of l(25+i)/l(25) from Deaths after Adjustment	
					1964	1973
15-19	20	.909	8.8	17.2	.858	.889
20-24	25	.852	10.6	15.8	.814	.851
25-29	30	.773	12.3	14.3	.757	.801
30-34	35	.676	13.8	13.0	.687	.737
35-39	40	.558	15.2	12.1	.594	.649
40-44	45	.428	16.3	11.6	.479	.535
45-49	50	.316	n.a.	12.4	.342	.394

TABLE 9 Summary Indicators of Final Mortality Estimates Above Age 10 by Sex, 1949, 1964, and 1972: Guatemala

Indicator	1949		1964		1972	
	Male	Female	Male	Female	Male	Female
West mortality level	9.5	8.5	13.6	13.5	16.3	15.7
Expectation of life at age x, e(x):						
x = 10	45.1	45.7	50.5	52.6	53.7	55.5
x = 50	17.7	19.0	19.9	21.8	21.1	22.9
Probability of survival from age 10 to age 50, l(50)/l(10)	0.633	0.639	0.737	0.762	0.798	0.811
Probability of survival from age 25 to age 60, l(60)/l(25)	0.517	0.559	0.629	0.687	0.693	0.737

TABLE 10 Infant Mortality and Child Death Rates by Sex, 1949, 1964, 1969, and 1972, with Implied Mortality Levels: Guatemala

			Implied Mortality Level by Coale-Demeny Family			
Year and Sex	Measure	Value	North	South	East	West
1949						
Males[a]	$_1q_0$	.10938	14.2	16.6	16.9	15.2
	$_4m_1$	.03744	9.4	10.7	7.4	7.7
	$_5m_5$	.00863	12.3	7.7	6.5	6.1
	$_{10}m_0$	.03722	11.6	12.2	12.5	11.2
Females[b]	$_1q_0$	.09550	14.0	16.9	16.5	14.8
	$_4m_1$	.04051	8.3	10.1	6.5	6.9
	$_5m_5$	.00977	11.0	7.3	5.6	5.5
	$_{10}m_0$	.03750	10.5	11.6	11.3	10.2
1964						
Males	$_1q_0$	.09358	15.6	18.3	18.0	16.4
	$_4m_1$	.02633	12.3	13.2	10.3	10.7
	$_5m_5$	.00666	14.2	10.0	9.1	8.8
	$_{10}m_0$	.02728	13.9	14.9	14.7	13.4
Females	$_1q_0$	.08144	15.4	18.5	17.6	16.0
	$_4m_1$	.02797	11.5	12.7	9.8	10.1
	$_5m_5$	.00694	13.5	10.1	8.9	8.9
	$_{10}m_0$	.02622	13.2	14.5	13.8	12.9

TABLE 10 (continued)

Year and Sex	Measure	Value	Implied Mortality Level by Coale-Demeny Family: North	South	East	West
1969						
Males	$_1q_0$	.09736	15.3	17.9	17.7	16.1
	$_4m_1$	.03068	11.1	12.1	9.1	9.4
	$_5m_5$	.00825	12.6	8.1	7.0	6.6
	$_{10}m_0$	.02963	13.3	14.2	14.1	12.9
Females	$_1q_0$	.08596	14.9	18.0	17.3	15.6
	$_4m_1$	.03157	10.5	11.9	8.7	9.1
	$_5m_5$	.00861	12.0	8.4	6.9	6.8
	$_{10}m_0$	.02851	12.7	13.9	13.3	12.3
1972						
Males[c]	$_1q_0$	.08540	16.4	19.1	18.5	17.1
	$_4q_1$	.02072	13.9	14.7	12.0	12.4
	$_5m_5$	.00460	16.6	12.8	12.2	12.3
	$_{10}m_0$	.02213	15.3	16.5	16.0	14.1
Females[d]	$_1q_0$	.07494	16.0	19.2	18.1	16.6
	$_4m_1$	.02169	13.2	14.3	11.6	12.1
	$_5m_5$	.00477	15.8	12.6	12.0	12.2
	$_{10}m_0$	.02112	14.7	16.1	15.2	14.3

Notes: The infant mortality rates ($_1q_0$) were calculated using unadjusted registered births and infant deaths.

The child death rates ($_4m_1$, $_5m_5$, and $_{10}m_0$) were calculated using unadjusted registered deaths and populations adjusted to consistency with the 1964 census enumeration, the adjustments being:

[a] 1.06.
[b] 1.02.
[c] 1.08.
[d] 1.07.

TABLE 11 Probabilities of Dying by Exact Ages, Implied Mortality Levels, and Reference Dates of Estimates by Model Life Table Family Derived from Child Survival Data from 1973 Census: Guatemala

	Age Group of Women and x Value						
	15-19 1	20-24 2	25-29 3	30-34 5	35-39 10	40-44 15	45-49 20
North Family							
$_xq_0$	.1014	.1383	.1610	.1831	.2212	.2447	.2648
Implied mortality level	14.2	13.6	13.3	13.4	13.1	12.8	12.7
Reference date (years)	1972.1	1970.8	1969.0	1966.8	1964.4	1961.8	1958.9
South Family							
$_xq_0$	.0979	.1446	.1720	.1900	.2195	.2413	.2624
Implied mortality level	17.3	15.6	14.9	14.7	14.0	13.4	13.1
Reference date (years)	1972.1	1970.8	1968.9	1966.5	1964.0	1961.2	1958.1
East Family							
$_xq_0$	.1063	.1464	.1708	.1877	.2174	.2399	.2620
Implied mortality level	16.5	15.3	14.5	14.3	13.6	13.1	12.8
Reference date (years)	1972.1	1970.7	1968.7	1966.4	1963.8	1960.9	1957.7
West Family							
$_xq_0$	.1044	.1455	.1695	.1875	.2166	.2399	.2623
Implied mortality level	14.9	13.8	13.3	13.2	12.7	12.3	12.1
Reference date (years)	1972.1	1970.7	1968.8	1966.5	1964.0	1961.3	1958.4

TABLE 12 A Comparison of Child Mortality Levels Calculated from Registered Deaths with Those Estimated from 1973 Child Survival Data by Model Life Table Family: Guatemala

Year and Measure (both sexes)	Implied Mortality Level by Coale-Demeny Family			
	North	South	East	West
<u>1964</u>				
$_1q_0$	15.5	18.4	17.8	16.2
$_4m_1$	11.9	13.0	10.1	10.4
$_5m_5$	13.9	10.1	9.0	8.9
Child survival	13.1	14.2	13.9	12.8
<u>1969</u>				
$_1q_0$	15.1	18.0	17.5	15.9
$_4m_1$	10.8	12.0	8.9	9.3
$_5m_5$	12.3	8.3	7.0	6.7
Child survival	13.5	15.2	14.8	13.5
<u>1972</u>				
$_1q_0$	16.2	19.2	18.3	16.9
$_4m_1$	13.6	14.5	11.8	12.3
$_5m_5$	16.2	12.7	12.1	12.3
Child survival	13.7	15.8	15.4	13.9

TABLE 13 A Comparison of Mortality Levels Implied by Mortality Rates Under Age 10 Calculated from Registered Deaths with Those Implied by Child Survival Data from 1973 Census: Guatemala

Year and Measure	Sex	Implied Mortality Level by Coale-Demeny Family			
		North	South	East	West
1964					
$_{10}m_0$	Male	13.9	14.9	14.7	13.4
$_{10}m_0$	Female	13.2	14.5	13.8	12.9
Child survival	Both	13.1	14.2	13.9	12.8
1969					
$_{10}m_0$	Male	13.3	14.2	14.1	12.9
$_{10}m_0$	Female	12.7	13.9	13.3	12.3
Child survival	Both	13.5	15.2	14.8	13.5
1972					
$_{10}m_0$	Male	15.3	16.5	16.0	14.1
$_{10}m_0$	Female	14.7	16.1	15.2	14.3
Child survival	Both	13.7	15.8	15.4	13.9

TABLE 14 Estimates of Child Mortality Level Based on Survival of Children Born in Year Before 1973 Census: Guatemala

Age Group of Mother	Proportion Surviving Among Births Reported for 12 Months Before Census	Implied Mortality Level by Coale-Demeny Family			
		North	South	East	West
15-19	.9440	16.5	19.5	19.0	17.1
20-24	.9537	18.3	21.3	20.2	18.7
25-29	.9565	18.8	21.8	20.6	19.1
30-34	.9528	18.2	21.2	20.1	18.6
35-39	.9431	16.4	19.3	18.9	17.0
40-44	.9264	13.4	15.8	16.7	14.3
45-49	.9155	12.0	14.0	15.6	13.1
All	.9499	17.6	20.6	19.8	18.1

TABLE 15 Summary Indicators of Accepted Child Mortality Estimates by Sex, 1949, 1964, and 1972: Guatemala

Year and Sex	Mortality Measure: West Level	Infant Mortality Rate $_1q_0$	Child Mortality Rates: 1-4	Child Mortality Rates: 5-9	Probability of Surviving to Age 10, $p(10)$
1949					
Males	10.8	.17511	.02583	.00543	.72519
Females	9.8	.16469	.02905	.00631	.72205
1964					
Males	13.1	.13793	.01829	.00411	.78564
Females	12.6	.12367	.02003	.00455	.79152
1972					
Males	13.9	.12602	.01593	.00370	.80552
Females	13.9	.10676	.01588	.00377	.82313

TABLE 16 Abridged Life Tables, 1949, 1964, and 1972: Guatemala

Age	Q(X)	l(X)	L(X)	D(X)	M(X)	P(X)	E(X)
1949							
Males							
0	0.17511	1.00000	0.88268	0.17511	0.19839	0.79421	40.37
1	0.09668	0.82489	3.08839	0.07975	0.02582	0.92506	47.87
5	0.02805	0.74514	3.67346	0.02090	0.00569	0.97530	48.85
10	0.02127	0.72424	3.58271	0.01540	0.00430	0.97396	45.19
15	0.03091	0.70884	3.48943	0.02191	0.00628	0.96275	41.12
20	0.04379	0.68693	3.35946	0.03008	0.00895	0.95392	37.35
25	0.04847	0.65685	3.20466	0.03184	0.00994	0.94798	33.94
30	0.05576	0.62501	3.03794	0.03485	0.01147	0.93946	30.55
35	0.06562	0.59016	2.85401	0.03872	0.01357	0.92744	27.20
40	0.07999	0.55144	2.64691	0.04411	0.01667	0.91260	23.94
45	0.09545	0.50733	2.41558	0.04842	0.02005	0.89148	20.80
50	0.12297	0.45890	2.15344	0.05643	0.02621	0.86198	17.73
55	0.15518	0.40247	1.85622	0.06246	0.03365	0.81900	14.87
60	0.21156	0.34002	1.52024	0.07193	0.04732	0.75732	12.14
65	0.28214	0.26808	1.15131	0.07564	0.06570	0.67632	9.73
70	0.38154	0.19244	0.77866	0.07343	0.09430	0.56758	7.57
75	0.51469	0.11902	0.44195	0.06126	0.13861	0.34812	5.70
80	1.00000	0.05776	0.23601	0.05776	0.24474	0.0	4.08
Females							
0	0.16469	1.00000	0.89295	0.16469	0.18444	0.79928	40.64
1	0.10788	0.83531	3.10343	0.09011	0.02904	0.91716	47.59
5	0.03256	0.74520	3.66532	0.02426	0.00662	0.97036	49.18
10	0.02663	0.72093	3.55666	0.01920	0.00540	0.96838	45.75
15	0.03673	0.70173	3.44422	0.02578	0.00748	0.95863	41.93
20	0.04618	0.67596	3.30174	0.03122	0.00945	0.95103	38.44
25	0.05189	0.64474	3.14007	0.03345	0.01065	0.94484	35.17
30	0.05862	0.61129	2.96684	0.03583	0.01208	0.93845	31.96
35	0.06467	0.57545	2.78422	0.03722	0.01337	0.93260	28.80
40	0.07031	0.53824	2.59658	0.03784	0.01457	0.92617	25.62
45	0.07763	0.50040	2.40487	0.03884	0.01615	0.91113	22.36
50	0.10107	0.46155	2.19114	0.04665	0.02129	0.88524	19.04
55	0.12999	0.41490	1.93968	0.05393	0.02781	0.84322	15.90
60	0.18758	0.36097	1.63557	0.06771	0.04140	0.78341	12.90
65	0.25230	0.29326	1.28132	0.07399	0.05775	0.70310	10.30
70	0.35654	0.21927	0.90090	0.07818	0.08678	0.59302	7.93
75	0.48538	0.14109	0.53425	0.06848	0.12819	0.36222	5.94
80	1.00000	0.07261	0.30341	0.07261	0.23930	0.0	4.18

TABLE 16 (continued)

Age	Q(X)	l(X)	L(X)	D(X)	M(X)	P(X)	E(X)
1964							
Males							
0	0.13793	1.00000	0.90759	0.13793	0.15198	0.83933	47.85
1	0.06975	0.86207	3.28904	0.06013	0.01828	0.94594	54.46
5	0.01991	0.80194	3.96976	0.01597	0.00402	0.98294	54.44
10	0.01416	0.78597	3.90204	0.01113	0.00285	0.98267	50.49
15	0.02054	0.77484	3.83443	0.01592	0.00415	0.97519	46.18
20	0.02917	0.75893	3.73929	0.02214	0.00592	0.96949	42.10
25	0.03189	0.73679	3.62519	0.02350	0.00648	0.96584	38.29
30	0.03650	0.71329	3.50136	0.02604	0.00744	0.96006	34.47
35	0.04350	0.68725	3.36153	0.02990	0.00889	0.95129	30.68
40	0.05415	0.65736	3.19780	0.03560	0.01113	0.93925	26.96
45	0.06774	0.62176	3.00352	0.04212	0.01402	0.92128	23.36
50	0.09051	0.57965	2.76708	0.05246	0.01896	0.89514	19.88
55	0.12064	0.52719	2.47693	0.06360	0.02568	0.85632	16.61
60	0.16988	0.46359	2.12104	0.07876	0.03713	0.80044	13.54
65	0.23531	0.38483	1.69777	0.09055	0.05334	0.72379	10.80
70	0.32971	0.29428	1.22882	0.09702	0.07896	0.61886	8.36
75	0.45786	0.19725	0.76047	0.09031	0.11876	0.38187	6.24
80	1.00000	0.10694	0.46981	0.10694	0.22762	0.0	4.39
Females							
0	0.12367	1.00000	0.91961	0.12367	0.13448	0.84982	49.93
1	0.07603	0.87633	3.32949	0.06663	0.02001	0.94250	55.92
5	0.02160	0.80970	4.00479	0.01749	0.00437	0.98113	56.41
10	0.01607	0.79221	3.92923	0.01273	0.00324	0.98131	52.60
15	0.02135	0.77948	3.85580	0.01664	0.00432	0.97563	48.42
20	0.02746	0.76284	3.76184	0.02095	0.00557	0.97073	44.42
25	0.03113	0.74189	3.65172	0.02310	0.00633	0.96685	40.61
30	0.03522	0.71879	3.53068	0.02532	0.00717	0.96268	36.83
35	0.03949	0.69348	3.39892	0.02739	0.00806	0.95814	33.09
40	0.04432	0.66609	3.25664	0.02952	0.00907	0.95208	29.34
45	0.05169	0.63657	3.10057	0.03291	0.01061	0.93983	25.59
50	0.06911	0.60366	2.91401	0.04172	0.01432	0.91970	21.85
55	0.09232	0.56194	2.68002	0.05188	0.01936	0.88693	18.28
60	0.13593	0.51007	2.37699	0.06933	0.02917	0.83739	14.89
65	0.19348	0.44073	1.99047	0.08527	0.04284	0.76502	11.84
70	0.28644	0.35546	1.52275	0.10182	0.06686	0.66190	9.08
75	0.41050	0.25364	1.00791	0.10412	0.10330	0.40872	6.72
80	1.00000	0.14952	0.69670	0.14952	0.21461	0.0	4.66

TABLE 16 (continued)

Age	Q(X)	l(X)	L(X)	D(X)	M(X)	P(X)	E(X)
1972							
Males							
0	0.12602	1.00000	0.91557	0.12602	0.13764	0.85400	51.64
1	0.06114	0.87398	3.35442	0.05344	0.01593	0.95284	58.04
5	0.01662	0.82054	4.06862	0.01364	0.00335	0.98618	57.74
10	0.01096	0.80691	4.01241	0.00885	0.00221	0.98697	53.67
15	0.01511	0.79806	3.96015	0.01206	0.00304	0.98178	49.24
20	0.02139	0.78600	3.88798	0.01681	0.00432	0.97781	44.95
25	0.02301	0.76919	3.80170	0.01770	0.00466	0.97540	40.88
30	0.02623	0.75149	3.70817	0.01971	0.00532	0.97105	36.79
35	0.03175	0.73178	3.60082	0.02323	0.00645	0.96382	32.71
40	0.04075	0.70855	3.47055	0.02887	0.00832	0.95293	28.70
45	0.05366	0.67967	3.30719	0.03647	0.01103	0.93621	24.81
50	0.07449	0.64320	3.09623	0.04791	0.01547	0.91145	21.08
55	0.10373	0.59529	2.82207	0.06175	0.02188	0.87464	17.57
60	0.14949	0.53354	2.46830	0.07976	0.03231	0.82154	14.32
65	0.21253	0.45378	2.02780	0.09644	0.04756	0.74699	11.39
70	0.30442	0.35734	1.51474	0.10878	0.07182	0.64393	8.79
75	0.43032	0.24856	0.97539	0.10696	0.10966	0.40092	6.55
80	1.00000	0.14160	0.65276	0.14160	0.21692	0.0	4.61
Females							
0	0.10676	1.00000	0.93060	0.10676	0.11472	0.87198	54.26
1	0.06094	0.89324	3.42929	0.05444	0.01587	0.95371	59.70
5	0.01713	0.83880	4.15808	0.01437	0.00346	0.98540	59.48
10	0.01203	0.82443	4.09736	0.00992	0.00242	0.98620	55.48
15	0.01560	0.81451	4.04080	0.01271	0.00314	0.98200	51.12
20	0.02044	0.80181	3.96807	0.01639	0.00413	0.97809	46.89
25	0.02341	0.78542	3.88115	0.01838	0.00474	0.97497	42.82
30	0.02668	0.76704	3.78402	0.02047	0.00541	0.97143	38.79
35	0.03051	0.74657	3.67591	0.02278	0.00620	0.96712	34.78
40	0.03533	0.72379	3.55504	0.02557	0.00719	0.96093	30.80
45	0.04295	0.69822	3.41613	0.02999	0.00878	0.94945	26.83
50	0.05850	0.66823	3.24344	0.03909	0.01205	0.93110	22.92
55	0.07996	0.62914	3.01995	0.05030	0.01666	0.90125	19.19
60	0.11917	0.57884	2.72174	0.06898	0.02534	0.85487	15.64
65	0.17461	0.50986	2.32672	0.08903	0.03826	0.78487	12.42
70	0.26423	0.42083	1.82616	0.11120	0.06089	0.68372	9.52
75	0.38703	0.30963	1.24858	0.11984	0.09598	0.42745	7.04
80	1.00000	0.18980	0.93214	0.18980	0.20361	0.0	4.91

TABLE 17 Age-Specific Fertility Rates and Total Fertility Calculated from Registered Births and Mid-Year Female Population, 1950, 1964, and 1973: Guatemala

Age Group	1950	1964	1973
15-19	.1609	.1456	.1387
20-24	.2820	.2991	.3005
25-29	.2939	.2988	.2963
30-34	.2540	.2470	.2527
35-39	.1939	.1906	.1803
40-44	.0855	.0836	.0827
45-49	.0279	.0185	.0171
Total Fertility	6.49	6.42	6.34

TABLE 18 Comparison of Current Fertility with Lifetime Fertility Using P/F Ratio Method, 1964: Guatemala

		Registered Births, 1964		
Age Group of Women	Average Parity, 1964	Age-Specific Fertility	Parity Equivalent	P/F Ratio
15-19	0.255	.1456	0.261	.974
20-24	1.442	.2991	1.454	.992
25-29	2.825	.2988	2.987	.946
30-34	4.007	.2470	4.354	.920
35-39	4.936	.1906	5.465	.903
40-44	5.309	.0836	6.136	.865
45-49	5.422	.0185	6.387	.849

TABLE 19 Comparison of Current Fertility with Lifetime Fertility Using P/F Ratio Method, 1973: Guatemala

		Current Fertility from Registration			Current Fertility from Census		
Age Group of Women	Average Parity, 1973	Age-Specific Fertility[a]	Parity Equivalent	P/F Ratio	Age-Specific Fertility[b]	Parity Equivalent	P/F Ratio
15-19	0.283	.1387	0.246	1.151	.131	0.289	0.981
20-24	1.517	.3005	1.424	1.065	.315	1.573	0.965
25-29	3.044	.2963	2.948	1.033	.316	3.190	0.954
30-34	4.438	.2527	4.337	1.023	.272	4.650	0.955
35-39	5.497	.1803	5.423	1.014	.207	5.830	0.943
40-44	6.226	.0827	6.074	1.025	.095	6.502	0.958
45-49	6.438	.0171	6.315	1.020	.028	6.787	0.949
Total Fertility		6.34			6.81		

[a]Births from registration are classified by age of mother at time of birth.
[b]Births from census are classified by age of mother at time of census.

TABLE 20 Reported and Adjusted Age-Specific Fertility Rates for Standard Five-Year Age Groups for Registered and Census-Based Births, 1973: Guatemala

Age Group	Reported Age-Specific Fertility Rates		Adjusted Age-Specific Fertility Rates	
	Registration	Census	Registration	Census
Adjustment Factor	1.0	1.0[a]	1.016	0.952[a]
15-19	.139	.156	.142	.149
20-24	.301	.322	.308	.307
25-29	.296	.314	.303	.299
30-34	.253	.266	.257	.254
35-39	.180	.198	.184	.189
40-44	.083	.086	.085	.082
45-49	.017	.022	.018	.021
Total Fertility	6.34	6.82	6.48	6.48

[a]The census-based rates have in both cases been converted to refer to standard five-year age groups by interpolation (United Nations, 1983).

TABLE 21 Comparison of Age-Specific First Birth Rates with Proportions of Women with at Least One Child, 1973: Guatemala

Age Group of Women	Proportion Mothers, 1973	First Births from Registration			First Births from Census		
		First Birth Rates	Lifetime Equivalent	P(H)/F(1) Ratio	First Birth Rates	Lifetime Equivalent	P(H)/F(1) Ratio
15-19	.207	.1021	0.203	1.020	.0900	0.215	.965
20-24	.666	.0813	0.738	0.902	.0836	0.725	.919
25-29	.855	.0296	1.006	0.850	.0267	0.967	.884
30-34	.919	.0130	1.103	0.833	.0064	1.025	.897
35-39	.933	.0064	1.148	0.813	.0032	1.044	.894
40-44	.938	.0025	1.168	0.803	.0015	1.054	.890
45-49	.939	.0009	1.177	0.798	.0004	1.058	.888
Ultimate Proportion Becoming Mothers		1.18			1.06		

TABLE 22 Distribution of Female Population by Age Group and Marital Status, 1964 and 1973: Guatemala

Age Group	1964 Proportions				1973 Proportions			
	Single	Married	Consen-sually Married	Widowed/ Divorced	Single	Married	Consen-sually Married	Widowed/ Divorced
15-19	.698	.094	.205	.003	.713	.103	.178	.006
20-24	.307	.262	.418	.013	.337	.285	.363	.016
25-29	.172	.326	.482	.020	.174	.372	.429	.025
30-34	.133	.351	.482	.034	.119	.412	.428	.041
35-39	.126	.349	.475	.050	.111	.401	.432	.056
40-44	.135	.346	.432	.087	.108	.404	.387	.101
45-49	.146	.343	.389	.122	.105	.415	.351	.129
50-54	.159	.322	.321	.198	.124	.362	.303	.211

TABLE 23 Comparison of Lifetime Fertility with Cumulated Cohort Fertility from Registered Births, 1973: Guatemala

Cohort Age, 1973	Reported Average Parity, 1973	Cumulated Cohort Fertility	Ratio of Reported Fertility to Registered Fertility
15-19	0.283	0.255	1.110
20-24	1.517	1.389	1.092
25-29	3.044	2.878	1.058
30-34	4.438	4.316	1.028

TABLE 24 Estimates of Total Fertility by Calendar Year 1958-63 Using Adjustment Factor Implied by Cohort P/F Ratios: Guatemala

Year	Total Fertility	Year	Total Fertility	Year	Total Fertility
1958	6.67	1964	6.59	1969	6.20
1959	6.84	1965	6.55	1970	5.92
1960	6.87	1966	6.56	1971	6.21
1961	6.96	1967	6.31	1972	6.34
1962	6.72	1968	6.28	1973	6.08
1963	6.78				

TABLE 25 Estimates of Total Fertility by Single Years Obtained from Application of the Own-Children Procedure to the 1964 and 1973 Censuses: Guatemala

Year	Total Fertility Estimated 1964 Census	Total Fertility Estimated 1973 Census	Year	Total Fertility Estimated 1964 Census	Total Fertility Estimated 1973 Census
1949-50	6.51	n.a.	1961-62	6.74	6.03
1950-51	6.71	n.a.	1962-63	5.87	7.27
1951-52	7.71	n.a.	1963-64	6.09	6.35
1952-53	5.74	n.a.	1964-65	n.a.	7.25
1953-54	7.55	n.a.	1965-66	n.a.	7.02
1954-55	6.41	n.a.	1966-67	n.a.	7.06
1955-56	7.52	n.a.	1967-68	n.a.	6.62
1956-57	6.62	n.a.	1968-69	n.a.	6.44
1957-58	7.72	n.a.	1969-70	n.a.	6.23
1958-59	7.32	6.90	1970-71	n.a.	5.61
1959-60	7.47	6.94	1971-72	n.a.	5.49
1960-61	7.13	8.19	1972-73	n.a.	6.24

TABLE 26 Ratios of Estimated Total Fertility for Periods Nine Years Apart from the Two Own-Children Applications and from Adjusted Registered Births: Guatemala

	Calendar Year of Reference		Ratios of Estimated Total Fertility, Year b/Year a	
Age of Children	a	b	Own-Children	Adjusted Registered Births
14	1949	1958	1.060	n.a.
13	1950	1959	1.034	n.a.
12	1951	1960	1.062	n.a.
11	1952	1961	1.051	n.a.
10	1953	1962	0.963	1.000
9	1954	1963	0.991	0.994
8	1955	1964	0.964	1.013
7	1956	1965	1.060	0.998
6	1957	1966	0.915	0.976
5	1958	1967	0.904	0.946
4	1959	1968	0.862	0.919
3	1960	1969	0.874	0.903
2	1961	1970	0.832	0.851
1	1962	1971	0.935	0.924
0	1963	1972	1.025	0.935

TABLE 27 Means and Standard Deviations of Age-Specific Fertility Distributions for Three-Year Periods from Own-Children Applications and Registered Births: Guatemala

	Own-Children, 1964 Census		Own-Children, 1973 Census		Registered Births	
Period	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
1952-54	29.8	8.22	n.a.	n.a.	28.8[a]	7.48[a]
1955-57	29.9	8.20	n.a.	n.a.	28.8	7.38
1958-60	29.9	8.19	29.5	8.14	28.8	7.34
1961-63	30.4	8.23	29.4	8.11	28.9	7.41
1964-66	n.a.	n.a.	29.5	8.05	28.9	7.46
1967-69	n.a.	n.a.	29.4	8.04	28.9	7.49
1970-72	n.a.	n.a.	29.5	8.04	28.9	7.47

[a]1953-54 only.

TABLE 28 Estimates of Total Fertility and Numbers of Births Implied by Age-Specific Fertility Rates Derived from Own-Children Applications and from Adjusted Registered Births: Guatemala

	Total Fertility			Births to Sample Age Distribution		
Period	Own-Children (i)	Registered Births (ii)	Ratio (i)/(ii) (iii)	Own-Children (iv)	Registered Births (v)	Ratio (iv)/(v) (vi)
1953-59	7.23	6.69	1.081	8502	8154	1.043
1958-68	6.91	6.65	1.039	9525	9282	1.026

TABLE 29 Final Estimates of Age-Specific Fertility, Total Fertility, and Crude Birth Rate, 1950, 1964, and 1973: Guatemala

	Age-Specific Fertility Rates		
Age Group	1950	1964	1973
15-19	.1654	.1525	.1357
20-24	.2900	.3131	.2938
25-29	.3022	.3128	.2898
30-34	.2612	.2586	.2471
35-39	.1994	.1995	.1763
40-44	.0879	.0876	.0808
45-49	.0287	.0194	.0168
Total Fertility	6.67	6.72	6.20

TABLE 30 Comparison of Observed and Projected Age Structure by Broad Age Categories, 1950, 1964, and 1973: Guatemala

	1950		1964		1973	
Age Group	Observed	Projected	Observed	Projected	Observed	Projected
Males						
Under 15	.4306	.4435	.4580	.4595	.4570	.4519
15-44	.4360	.4257	.4126	.4185	.4106	.4254
45 and Over	.1334	.1308	.1295	.1220	.1325	.1227
Females						
Under 15	.4146	.4356	.4512	.4544	.4446	.4499
15-44	.4529	.4217	.4209	.4123	.4261	.4177
45 and Over	.1326	.1427	.1279	.1333	.1292	.1324

TABLE 31 Crude Birth Rates, Death Rates, and Rates of Natural Increase, 1949, 1964, and 1974: Guatemala

	Year		
Measures (per 1,000)	1949	1964	1974
Crude birth rate	47.9	46.5	43.4
Crude death rate	23.1	16.7	13.0
Rate of natural increase	24.8	29.8	30.4

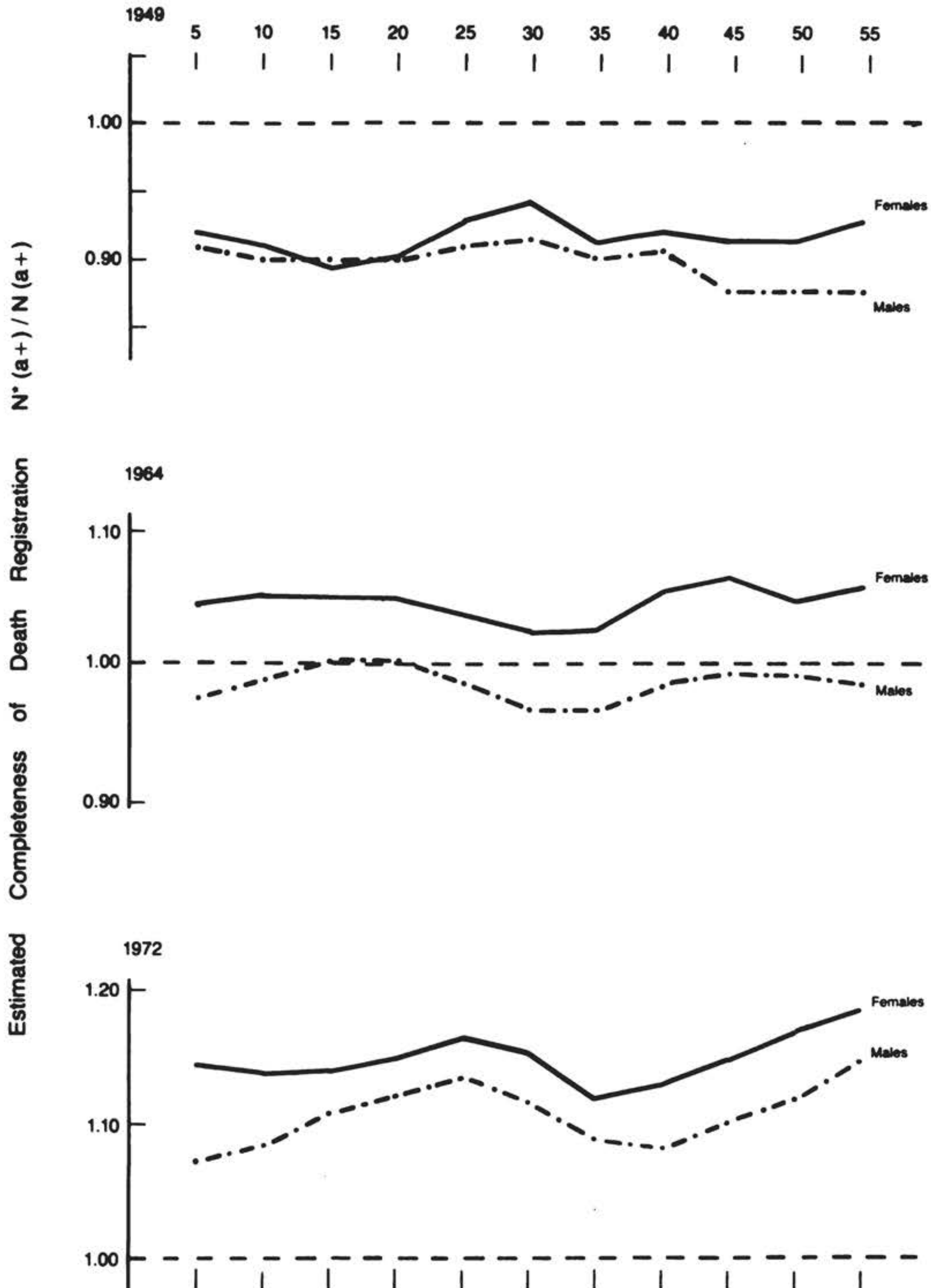

FIGURE 1 Ratios of Estimated to Enumerated Population N+(a)/N(a) (relative completeness of death registration) Using Iterated Growth Rates, 1949, 1964, and 1972: Guatemala

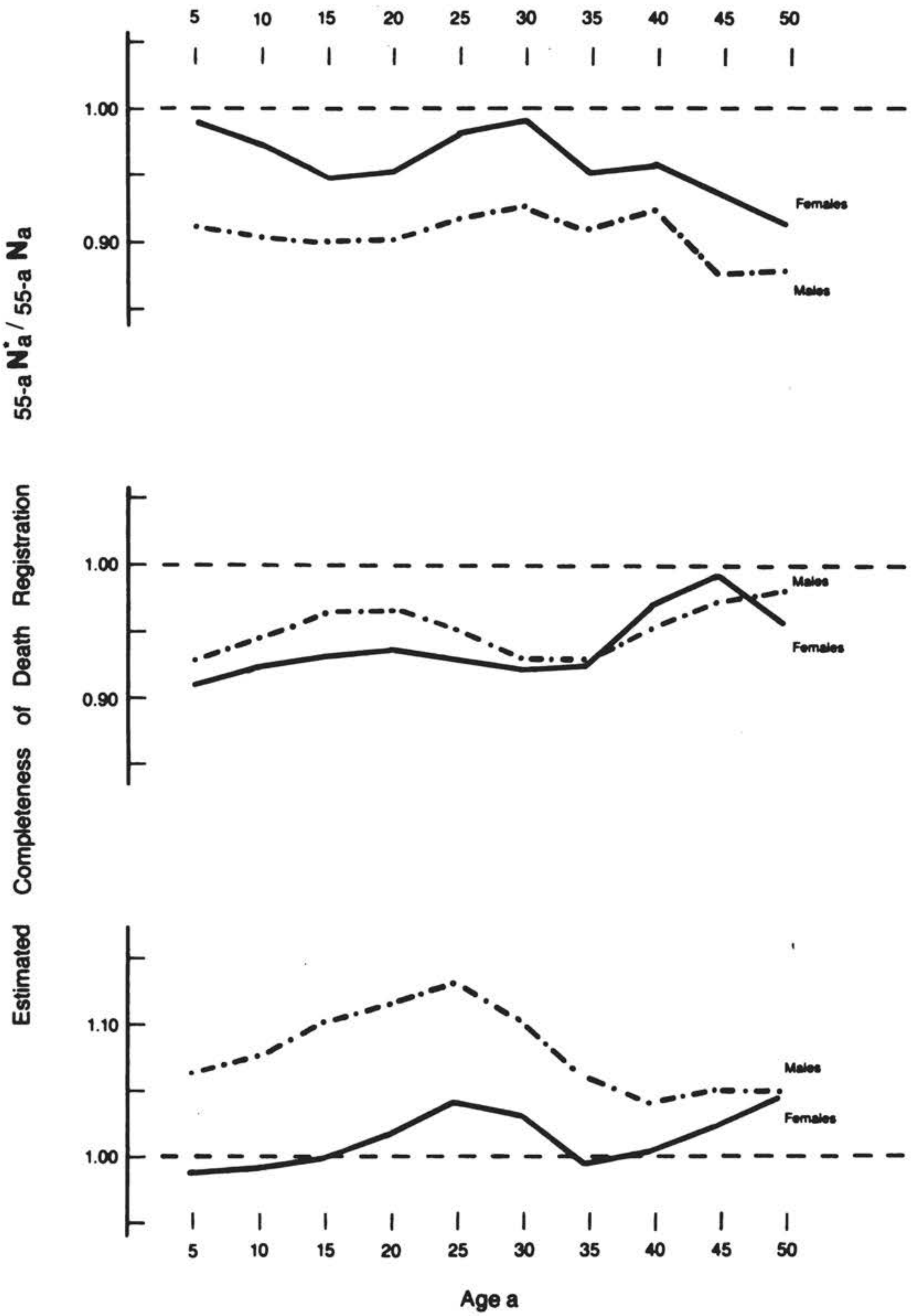

FIGURE 2 Ratios of Estimated to Enumerated Population N+(a)/N(a) (relative completeness of death registration) Using Assumed Growth Rates, 1949, 1964, and 1972: Guatemala

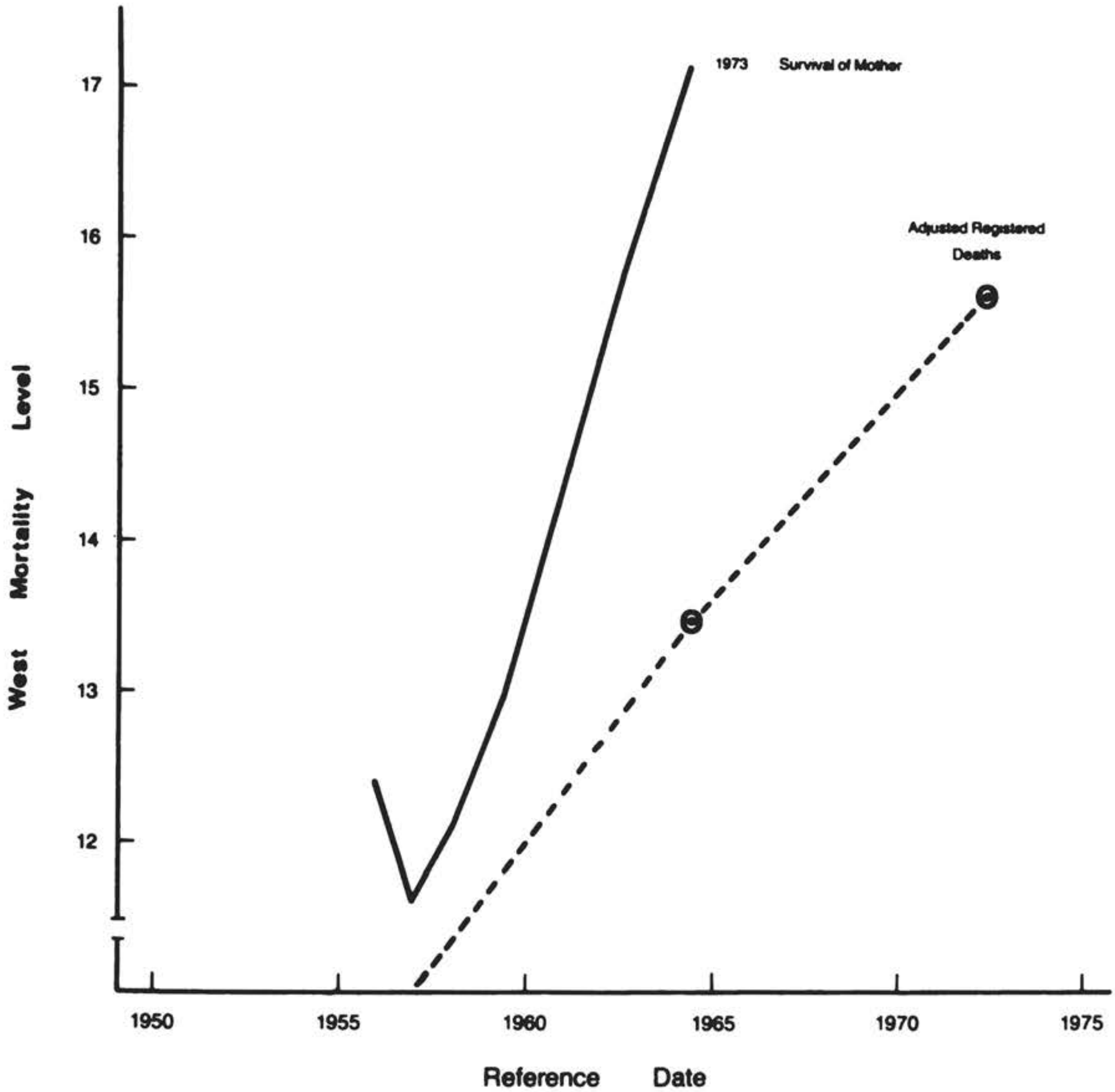

FIGURE 3 West Female Mortality Levels Estimated from 1973 Maternal Survival Data by Reference Date, with Comparable Estimated Levels from Adjusted Registered Deaths: Guatemala

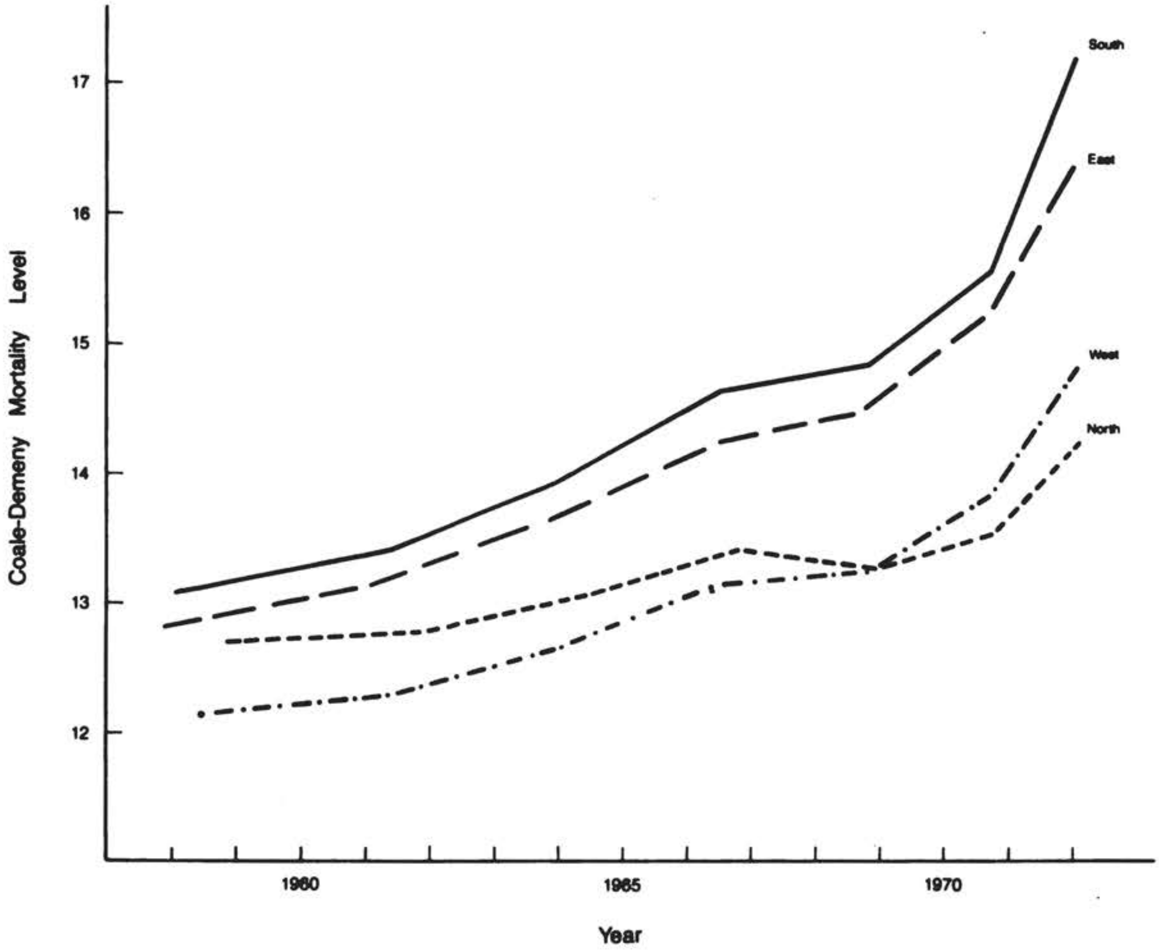

FIGURE 4 Time Trends of Child Mortality Level from 1973 Child Survival Data (census sample) by Assumed Mortality Pattern: Guatemala

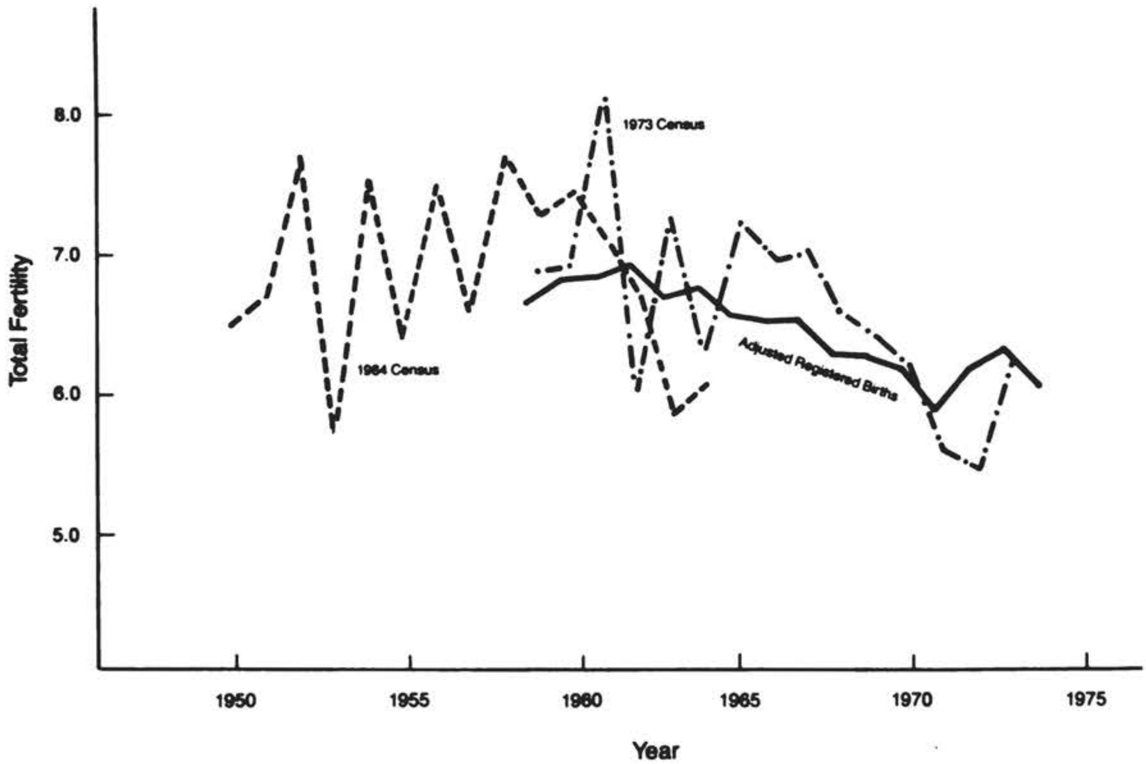

FIGURE 5 Own-Children Estimates of Total Fertility from 1964 and 1973 Censuses, with Comparable Estimates from Adjusted Registered Births

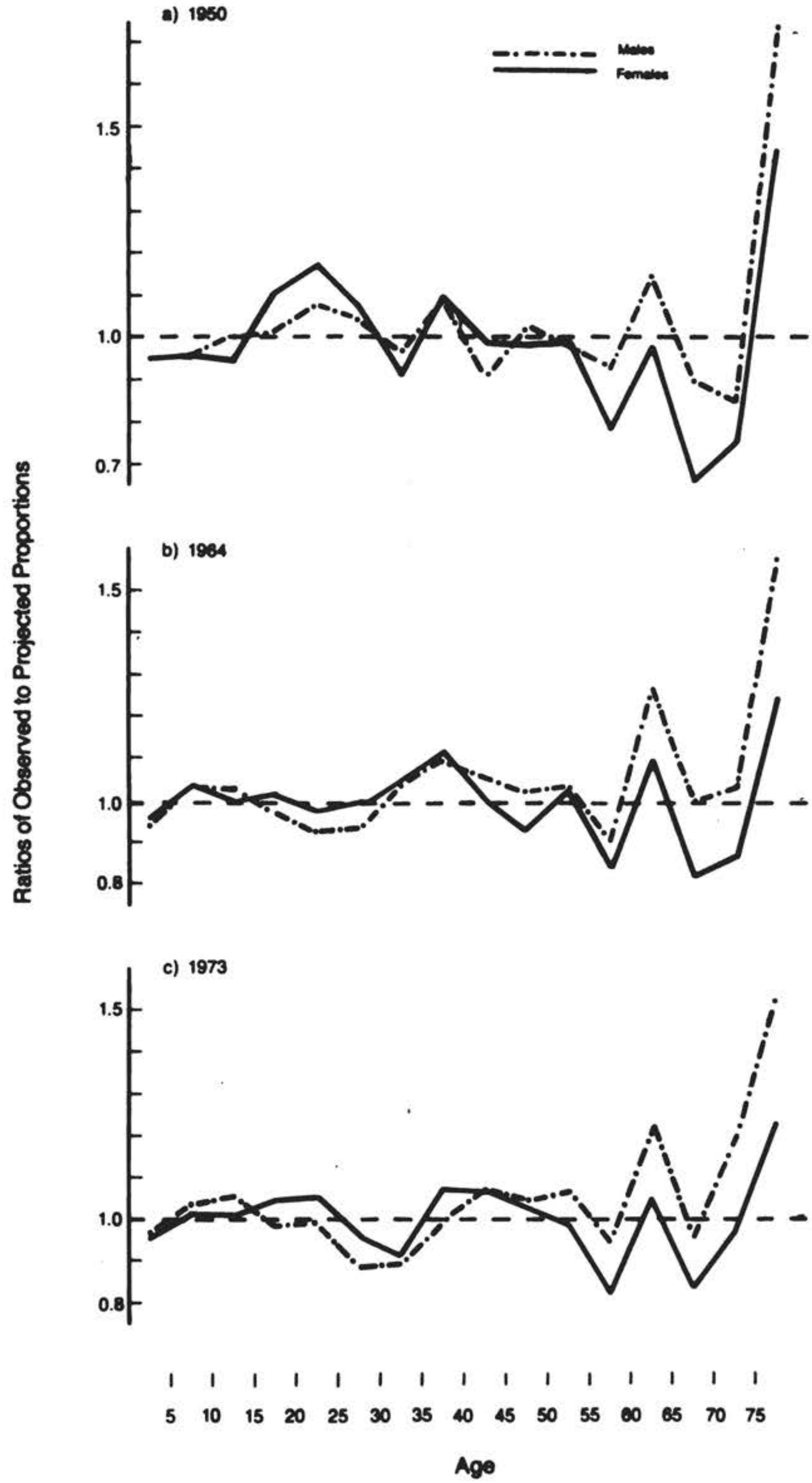

FIGURE 6 Ratios of Observed to Projected Proportions by Age Group and Sex, 1950, 1964, and 1973: Guatemala

APPENDIX 1

Detailed Results from Mortality Estimations Procedures

TABLE A-1.1 Ratios of Expected to Observed Population Above Age x, N*(x+)/N(x+), for Different Open Intervals Z+, by Sex, 1950, 1964, and 1973: Guatemala

Age	75+	70+	65+	60+	55+	50+	45+
1950							
i) Males, r = 2.4 percent							
0+	0.9517	0.9428	0.9347	0.9367	0.9304	0.9376	0.9488
5+	0.9280	0.9186	0.9099	0.9121	0.9056	0.9135	0.9257
10+	0.9220	0.9120	0.9028	0.9053	0.8985	0.9071	0.9206
15+	0.9214	0.9106	0.9008	0.9036	0.8964	0.9061	0.9211
20+	0.9236	0.9119	0.9012	0.9044	0.8968	0.9078	0.9247
25+	0.9385	0.9255	0.9136	0.9173	0.9092	0.9220	0.9416
30+	0.9470	0.9324	0.9192	0.9235	0.9148	0.9298	0.9528
35+	0.9350	0.9186	0.9040	0.9091	0.8998	0.9174	0.9444
40+	0.9457	0.9266	0.9097	0.9160	0.9058	0.9275	0.9606
45+	0.9200	0.8981	0.8788	0.8866	0.8756	0.9021	0.9424
50+	0.9287	0.9017	0.8781	0.8884	0.8760	0.9107	
55+	0.9387	0.9042	0.8744	0.8885	0.8744		
60+	0.9299	0.8844	0.8456	0.8657			
65+	1.0370	0.9644	0.9035				
70+	1.0105	0.8995					
75+	0.8020						
Mean	0.9352	0.9149	0.8955	0.9017	0.8957	0.9144	0.9371
ii) Females, r = 2.4 percent							
0+	1.0678	1.0501	1.0331	1.0247	1.0134	1.0097	1.0119
5+	1.0445	1.0257	1.0076	0.9988	0.9869	0.9832	0.9859
10+	1.0327	1.0129	0.9939	0.9845	0.9722	0.9686	0.9718
15+	1.0151	0.9941	0.9740	0.9643	0.9514	0.9479	0.9519
20+	1.0265	1.0036	0.9815	0.9709	0.9571	0.9536	0.9586
25+	1.0597	1.0337	1.0088	0.9970	0.9816	0.9782	0.9846
30+	1.0785	1.0492	1.0212	1.0080	0.9911	0.9879	0.9961
35+	1.0558	1.0235	0.9928	0.9785	0.9604	0.9577	0.9679
40+	1.0768	1.0392	1.0035	0.9872	0.9667	0.9646	0.9782
45+	1.0871	1.0427	1.0008	0.9821	0.9588	0.9578	0.9759
50+	1.1147	1.0602	1.0089	0.9865	0.9591	0.9599	
55+	1.1816	1.1099	1.0429	1.0143	0.9801		
60+	1.1644	1.0724	0.9870	0.9516			
65+	1.3049	1.1615	1.0293				
70+	1.1813	0.9820					
75+	0.9365						
Mean	1.0907	1.0436	1.0040	0.9853	0.9696	0.9659	0.9745

TABLE A-1.1 (continued)

Age	85+	80+	75+	70+	65+	60+	55+	50+	45+
1964									
i) Males, r = 2.7 percent									
0+	0.9532	0.9481	0.9416	0.9396	0.9388	0.9521	0.9469	0.9504	0.9584
5+	0.9392	0.9338	0.9270	0.9248	0.9241	0.9382	0.9329	0.9369	0.9458
10+	0.9553	0.9495	0.9421	0.9399	0.9391	0.9544	0.9490	0.9535	0.9636
15+	0.9735	0.9672	0.9592	0.9568	0.9561	0.9728	0.9672	0.9725	0.9840
20+	0.9755	0.9687	0.9602	0.9576	0.9570	0.9751	0.9694	0.9757	0.9887
25+	0.9631	0.9559	0.9467	0.9440	0.9435	0.9631	0.9575	0.9648	0.9795
30+	0.9462	0.9383	0.9285	0.9257	0.9252	0.9467	0.9411	0.9497	0.9667
35+	0.9471	0.9384	0.9274	0.9244	0.9241	0.9483	0.9428	0.9534	0.9737
40+	0.9642	0.9541	0.9415	0.9380	0.9380	0.9665	0.9609	0.9744	0.9997
45+	0.9736	0.9618	0.9470	0.9431	0.9434	0.9774	0.9721	0.9897	1.0217
50+	0.9713	0.9572	0.9396	0.9351	0.9359	0.9774	0.9727	0.9959	
55+	0.9605	0.9432	0.9216	0.9163	0.9180	0.9702	0.9666		
60+	0.9018	0.8804	0.8538	0.8477	0.8507	0.9168			
65+	0.9863	0.9534	0.9127	0.9039	0.9103				
70+	0.9796	0.9303	0.8692	0.8571					
75+	0.9365	0.8569	0.7589						
80+	0.8324	0.6909							
85+	0.5584								
Mean	0.9273	0.9237	0.9157	0.9225	0.9281	0.9589	0.9575	0.9667	0.9804
ii) Females, r = 2.7 percent									
0+	0.9664	0.9595	0.9460	0.9390	0.9319	0.9387	0.9292	0.9260	0.9200
5+	0.9567	0.9494	0.9351	0.9277	0.9203	0.9275	0.9177	0.9145	0.9085
10+	0.9737	0.9658	0.9505	0.9426	0.9347	0.9426	0.9323	0.9292	0.9232
15+	0.9853	0.9769	0.9605	0.9520	0.9437	0.9523	0.9415	0.9386	0.9327
20+	0.9946	0.9855	0.9679	0.9588	0.9499	0.9594	0.9481	0.9455	0.9397
25+	0.9936	0.9839	0.9649	0.9552	0.9458	0.9562	0.9445	0.9423	0.9369
30+	0.9938	0.9832	0.9626	0.9520	0.9420	0.9536	0.9414	0.9397	0.9348
35+	1.0069	0.9950	0.9720	0.9603	0.9493	0.9627	0.9497	0.9488	0.9445
40+	1.0473	1.0335	1.0068	0.9933	0.9808	0.9969	0.9826	0.9828	0.9795
45+	1.0700	1.0539	1.0227	1.0072	0.9930	1.0124	0.9970	0.9988	0.9972
50+	1.0680	1.0491	1.0127	0.9947	0.9786	1.0022	0.9857	0.9901	
55+	1.0941	1.0705	1.0253	1.0032	0.9839	1.0145	0.9963		
60+	1.0566	1.0275	0.9718	0.9450	0.9222	0.9618			
65+	1.1726	1.1290	1.0454	1.0059	0.9734				
70+	1.1652	1.1022	0.9821	0.9264					
75+	1.1620	1.0610	0.8689						
80+	0.9917	0.8252							
85+	0.7038								
Mean	1.0256	1.0120	0.9766	0.9660	0.9552	0.9702	0.9579	0.9530	0.9441

TABLE A-1.1 (continued)

Age	85+	80+	75+	70+	65+	60+	55+	50+	45+
1973									
i) Males, r = 3.0 percent									
0+	1.0828	1.0775	1.0730	1.0760	1.0773	1.0873	1.0911	1.1020	1.1141
5+	1.0631	1.0576	1.0529	1.0560	1.0574	1.0678	1.0720	1.0834	1.0962
10+	1.0739	1.0681	1.0632	1.0665	1.0680	1.0791	1.0836	1.0959	1.1097
15+	1.0986	1.0923	1.0871	1.0906	1.0923	1.1043	1.1094	1.1229	1.1381
20+	1.1103	1.1035	1.0979	1.1017	1.1036	1.1166	1.1223	1.1371	1.1539
25+	1.1238	1.1165	1.1103	1.1145	1.1167	1.1309	1.1374	1.1539	1.1726
30+	1.1019	1.0941	1.0876	1.0921	1.0945	1.1098	1.1171	1.1352	1.1557
35+	1.0725	1.0642	1.0573	1.0621	1.0648	1.0814	1.0897	1.1097	1.1324
40+	1.0640	1.0548	1.0472	1.0526	1.0558	1.0744	1.0843	1.1073	1.1336
45+	1.0766	1.0660	1.0571	1.0634	1.0674	1.0893	1.1016	1.1293	1.1612
50+	1.0877	1.0751	1.0646	1.0722	1.0774	1.1038	1.1195	1.1540	
55+	1.1057	1.0901	1.0771	1.0867	1.0936	1.1271	1.1482		
60+	1.0618	1.0427	1.0267	1.0386	1.0479	1.0901			
65+	1.1153	1.0879	1.0651	1.0824	1.0970				
70+	1.0465	1.0083	0.9764	1.0011					
75+	1.0482	0.9840	0.9303						
80+	0.9121	0.8000							
85+	0.6391								
Mean	1.0471	1.0503	1.0534	1.0700	1.0797	1.0979	1.1077	1.1229	1.1393
ii) Females, r = 3.0 percent									
0+	1.0526	1.0421	1.0319	1.0302	1.0222	1.0273	1.0185	1.0176	1.0165
5+	1.0341	1.0233	1.0127	1.0109	1.0027	1.0081	0.9991	0.9983	0.9975
10+	1.0408	1.0295	1.0184	1.0165	1.0080	1.0137	1.0044	1.0039	1.0032
15+	1.0536	1.0416	1.0298	1.0279	1.0189	1.0250	1.0155	1.0151	1.0147
20+	1.0752	1.0622	1.0496	1.0475	1.0380	1.0447	1.0347	1.0346	1.0346
25+	1.1012	1.0871	1.0734	1.0711	1.0609	1.0684	1.0577	1.0581	1.0586
30+	1.1022	1.0851	1.0703	1.0679	1.0571	1.0653	1.0543	1.0552	1.0565
35+	1.0826	1.0664	1.0506	1.0481	1.0367	1.0458	1.0345	1.0361	1.0383
40+	1.1052	1.0869	1.0691	1.0664	1.0538	1.0643	1.0522	1.0550	1.0584
45+	1.1359	1.1148	1.0942	1.0913	1.0770	1.0896	1.0765	1.0808	1.0862
50+	1.1704	1.1454	1.1209	1.1176	1.1010	1.1166	1.1023	1.1090	
55+	1.2053	1.1746	1.1447	1.1407	1.1211	1.1410	1.1252		
60+	1.1638	1.1268	1.0908	1.0863	1.0636	1.0887			
65+	1.2271	1.1755	1.1253	1.1195	1.0892				
70+	1.1796	1.1085	1.0394	1.0323					
75+	1.1877	1.0731	0.9618						
80+	1.0226	0.8362							
85+	0.7457								
Mean	1.0959	1.0773	1.0634	1.0674	1.0560	1.0643	1.0506	1.0446	1.0387

TABLE A-1.2 Application of Preston-Hill Intercensal Accounting Procedure to 1950-64 and 1964-73 Periods, by Sex: Guatemala

	1950-64				1964-73			
	Males		Females		Males		Females	
Age x	$\frac{N_x^t}{N_{x+n}^{t+n}}$	$\frac{D_{cx}^{t,t+n}}{N_{x+n}^{t+n}}$	$\frac{N_x^t}{N_{x+n}^{t+n}}$	$\frac{D_{cx}^{t,t+n}}{N_{x+n}^{t+n}}$	$\frac{N_x^t}{N_{x+n}^{t+n}}$	$\frac{D_{cx}^{t,t+n}}{N_{x+n}^{t+n}}$	$\frac{N_x^t}{N_{x+n}^{t+n}}$	$\frac{D_{cx}^{t,t+n}}{N_{x+n}^{t+n}}$
5	1.1597	0.1650	1.1563	0.1663	1.2011	0.0865	1.1526	0.0754
10	1.1664	0.1812	1.1821	0.1845	1.2148	0.0970	1.1726	0.0838
15	1.1883	0.2066	1.2424	0.2112	1.2209	0.1124	1.2011	0.0971
20	1.2094	0.2360	1.2578	0.2381	1.2322	0.1291	1.2269	0.1117
25	1.2586	0.2793	1.3027	0.2804	1.2366	0.1461	1.2254	0.1255
30	1.3006	0.3282	1.3427	0.3268	1.2738	0.1695	1.2739	0.1467
35	1.3937	0.3947	1.4354	0.3879	1.3144	0.2002	1.3200	0.1712
40	1.4344	0.4723	1.5004	0.4756	1.3409	0.2389	1.3430	0.2084
45	1.5306	0.5652	1.5733	0.5781	1.3950	0.2910	1.3982	0.2567
50	1.7550	0.7499	1.8189	0.7784	1,4060	0.3416	1.4335	0.3165
55	2.1703	1.0270	2.0277	1.0145	1.6191	0.4615	1.5721	0.4316
60	2.5577	1.1692	2.6097	1.2325	1.9302	0.5567	1.8604	0.5260

TABLE A-1.3 Age-Specific Mortality Rates from Adjusted Registered Deaths, and Implied Mortality Levels in Each Coale-Demeny Family of Model Life Tables, by Sex, 1949-50, 1964, and 1972-73: Guatemala

Age Group	Age-Specific Mortality Rate	Implied Mortality Level by Family			
		North	South	East	West
<u>1949-50</u>					
Males, Adjustment Factor 1.111					
5-9	.00993	11.05	6.30	5.00	4.65
10-14	.00609	9.37	3.75	1.89	6.31
15-19	.00712	8.86	6.58	5.10	8.14
20-24	.00800	11.61	9.88	8.43	10.68
25-29	.00885	11.04	8.73	7.46	10.69
30-34	.01068	9.65	6.92	6.59	10.23
35-39	.01194	9.85	6.79	7.72	10.81
40-44	.01617	8.53	5.34	6.72	9.84
45-49	.02046	7.96	4.50	6.50	9.28
50-54	.02529	7.99	5.05	6.92	9.97
55-59	.02623	10.95	9.25	11.80	13.25
60-64	.03932	10.01	9.19	10.66	12.58
65-69	.05437	10.73	10.74	12.82	13.16
70-74	.08895	9.78	10.12	10.68	10.79
Mean Level, 10-54		9.43	6.39	6.37	9.55
Mean Absolute Deviation 10-54		0.98	1.54	1.28	1.09
Females, Adjustment Factor 1.042					
5-9	.01018	10.62	6.92	5.16	5.11
10-14	.00532	10.80	7.27	5.91	9.06
15-19	.00790	7.32	6.62	4.89	7.96
20-24	.00850	8.02	8.17	7.07	9.57
25-29	.00987	8.06	7.50	7.25	9.29
30-34	.01221	7.44	5.75	6.08	8.40
35-39	.01383	7.60	5.05	5.74	8.15
40-44	.01557	7.17	4.02	4.98	7.78
45-49	.01831	6.17	2.87	4.14	6.98
50-54	.02037	7.25	4.92	6.37	9.08
55-59	.02886	6.77	4.60	6.84	8.01
60-64	.03587	8.79	8.23	9.84	10.53
65-69	.05887	7.72	7.68	9.16	8.22
70-74	.07964	9.56	10.56	11.76	10.07
Mean Level, 10-54		7.76	5.80	5.83	8.47
Mean Absolute Deviation, 10-54		0.80	1.42	0.79	0.69

TABLE A-1.3 (continued)

Age Group	Age-Specific Mortality Rate	Implied Mortality Level by Family North	South	East	West
1964					
Males, Adjustment Factor 1.010					
5-9	.00679	14.05	9.81	8.90	8.63
10-14	.00339	14.68	10.06	8.77	12.13
15-19	.00451	14.14	11.33	10.72	12.83
20-24	.00518	16.37	13.77	13.49	14.81
25-29	.00648	14.61	11.85	11.15	13.61
30-34	.00763	13.55	10.93	10.53	13.40
35-39	.00887	13.24	10.43	11.17	13.63
40-44	.01059	13.33	10.86	11.93	14.08
45-49	.01439	12.00	9.36	11.33	13.32
50-54	.01777	12.52	10.53	12.92	14.52
55-59	.02249	12.96	12.11	15.14	15.88
60-64	.03477	11.72	11.55	13.82	14.94
65-69	.04745	12.91	13.45	16.30	16.37
70-74	.06980	13.91	15.46	17.90	17.07
75-79	.08208	19.28	21.90	23.56	22.95
Mean Level, 10-54		13.83	11.01	11.33	13.59
Mean Absolute Deviation 10-54		1.00	0.87	0.96	0.60
Females, Adjustment Factor 1.010					
5-9	.00707	13.39	9.93	8.78	8.75
10-14	.00314	14.96	11.77	11.17	13.43
15-19	.00388	14.31	12.81	12.17	14.33
20-24	.00569	12.36	11.76	11.28	13.28
25-29	.00652	12.49	11.45	11.50	13.20
30-34	.00720	12.96	10.99	11.59	13.47
35-39	.00815	13.06	10.58	11.48	13.40
40-44	.00920	13.11	10.01	11.13	13.36
45-49	.01067	12.52	9.47	11.19	13.45
50-54	.01454	11.58	9.21	11.03	13.31
55-59	.02058	11.02	8.97	11.63	12.62
60-64	.03307	9.86	9.26	11.06	11.68
65-69	.04596	11.14	11.15	13.39	12.25
70-74	.06642	12.30	13.60	15.48	13.68
75-79	.08070	17.24	19.33	21.31	20.21
Mean Level, 10-54		13.04	10.90	11.39	13.47
Mean Absolute Deviation, 10-54		0.73	0.96	0.26	0.19

TABLE A-1.3 (continued)

Age Group	Age-Specific Mortality Rate	Implied Mortality Level by Family			
		North	South	East	West
<u>1972-73</u>					
Males, Adjustment Factor 0.926					
5-9	.00390	17.52	13.93	13.51	13.51
10-14	.00202	18.14	14.66	14.18	16.10
15-19	.00266	18.85	15.65	16.28	17.28
20-24	.00391	18.74	15.86	16.20	17.05
25-29	.00510	16.88	13.89	13.84	15.62
30-34	.00610	15.88	13.18	13.08	15.26
35-39	.00676	16.06	13.37	14.17	15.94
40-44	.00862	15.58	13.30	14.35	16.01
45-49	.01111	15.08	13.07	14.94	16.23
50-54	.01449	15.41	13.79	16.29	17.09
55-59	.02076	14.19	13.53	16.68	17.11
60-64	.02728	15.70	15.87	19.10	19.12
65-69	.04399	14.39	14.88	18.04	17.96
70-74	.06030	16.66	18.33	21.23	20.54
75-79	.08675	18.26	21.17	22.92	22.19
Mean Level, 10-54		16.74	14.09	14.81	16.29
Mean Absolute Deviation 10-54		1.26	0.87	0.99	0.57
Females, Adjustment Factor 0.980					
5-9	.00434	16.27	13.23	12.66	12.97
10-14	.00205	17.53	14.64	14.41	16.06
15-19	.00278	16.77	15.02	14.75	16.44
20-24	.00375	16.12	14.76	14.65	16.31
25-29	.00463	15.63	14.10	14.29	15.85
30-34	.00583	14.86	12.79	13.44	15.18
35-39	.00674	14.80	12.33	13.30	15.05
40-44	.00755	15.17	12.14	13.33	15.28
45-49	.00874	14.92	11.91	13.82	15.76
50-54	.01229	13.93	11.41	13.52	15.48
55-59	.01757	13.07	11.12	13.97	14.97
60-64	.02804	12.02	11.49	13.72	14.14
65-69	.03987	13.35	13.21	15.68	14.95
70-74	.06357	13.10	14.29	16.30	14.73
75-79	.09000	14.98	17.60	19.48	17.49
Mean Level, 10-54		15.53	13.23	13.95	15.71
Mean Absolute Deviation, 10-54		0.88	1.24	0.51	0.41

TABLE A-1.4 Number of Women by Age Group, Children Ever Born, and Children Surviving from Sample of 1973 Census: Guatemala

Age Group	Number of Women	Children Ever Born	Children Surviving
15-19	14,826	4,183	3,754
20-24	12,458	18,848	16,172
25-29	9,209	27,957	23,166
30-34	7,165	31,712	25,782
35-39	7,148	39,183	30,880
40-44	5,843	36,271	27,660
45-49	4,643	29,808	22,007

APPENDIX 2

Detailed Results from Fertility Estimation Procedures

TABLE A-2.1 Application of El-Badry Correction Procedure for Nonresponse to 1973 Census Sample: Guatemala

Age Group	Proportion of Women: Reported as Childless	Reported as Nonresponse
15-19	0.5829	0.2107
20-24	0.2404	0.0954
25-29	0.1064	0.0415
30-34	0.0592	0.0246
35-39	0.0473	0.0222
40-44	0.0447	0.0199
45-49	0.0401	0.0232

Note: Straight line fitted by group means to first four age groups: proportion nonresponse = 0.00284 + 0.3649 (proportion childless).

TABLE A-2.2 Age-Specific Fertility Rates Calculated from Registered Births and Numbers of Women Adjusted to Consistency with Coverage of 1964 Census, 1953-73: Guatemala

Year	Age-Specific Fertility Rate 15-19	20-24	25-29	30-34	35-39	40-44	45-49	Total Fertility
1953	0.1545	0.3012	0.3056	0.2630	0.1729	0.0856	0.0245	6.54
1954	0.1579	0.3058	0.3173	0.2649	0.1726	0.0854	0.0233	6.64
1955	0.1519	0.2878	0.3071	0.2479	0.1693	0.0820	0.0208	6.33
1956	0.1466	0.2869	0.3176	0.2527	0.1721	0.0778	0.0204	6.38
1957	0.1497	0.2981	0.3238	0.2579	0.1813	0.0754	0.0214	6.54
1958	0.1464	0.2935	0.3203	0.2585	0.1833	0.0753	0.0211	6.49
1959	0.1508	0.3078	0.3206	0.2682	0.1877	0.0748	0.0208	6.65
1960	0.1503	0.3109	0.3154	0.2678	0.1880	0.0816	0.0210	6.68
1961	0.1552	0.3162	0.3169	0.2725	0.1893	0.0829	0.0212	6.77
1962	0.1498	0.3048	0.3014	0.2609	0.1875	0.0840	0.0204	6.54
1963	0.1520	0.3107	0.3053	0.2561	0.1921	0.0846	0.0183	6.60
1964	0.1454	0.2986	0.2983	0.2466	0.1903	0.0835	0.0185	6.41
1965	0.1448	0.2956	0.2979	0.2409	0.1942	0.0810	0.0200	6.37
1966	0.1488	0.2948	0.2942	0.2409	0.1969	0.0814	0.0196	6.38
1967	0.1451	0.2865	0.2785	0.2317	0.1889	0.0795	0.0184	6.14
1968	0.1433	0.2861	0.2756	0.2332	0.1851	0.0802	0.0177	6.11
1969	0.1393	0.2850	0.2720	0.2314	0.1813	0.0794	0.0169	6.03
1970	0.1331	0.2710	0.2618	0.2247	0.1687	0.0750	0.0181	5.76
1971	0.1417	0.2845	0.2733	0.2369	0.1724	0.0810	0.0174	6.04
1972	0.1422	0.2888	0.2820	0.2430	0.1767	0.0828	0.0175	6.17
1973	0.1294	0.2802	0.2764	0.2357	0.1681	0.0771	0.0160	5.91

TABLE A-2.3 Basic Own-Children Tabulations of Women by Single Years of Age and Their Own-Children by Single Years of Age, 1964 and 1973: Guatemala

Age of Mother	Age of Children														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1964															
15	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	68	33	0	0	0	0	0	0	0	0	0	0	0	0	0
17	149	71	38	0	0	0	0	0	0	0	0	0	0	0	0
18	251	186	145	74	0	0	0	0	0	0	0	0	0	0	0
19	258	176	162	92	63	0	0	0	0	0	0	0	0	0	0
20	408	319	322	270	205	120	0	0	0	0	0	0	0	0	0
21	236	158	187	156	125	62	55	0	0	0	0	0	0	0	0
22	357	292	317	282	258	178	114	81	0	0	0	0	0	0	0
23	335	297	289	310	250	238	144	101	72	0	0	0	0	0	0
24	356	321	319	326	279	272	213	153	117	51	0	0	0	0	0
25	479	429	500	490	479	470	414	296	275	151	179	0	0	0	0
26	320	257	304	304	329	305	272	221	177	129	105	61	0	0	0
27	299	239	288	288	320	308	254	217	227	167	151	84	69	0	0
28	352	315	369	350	340	366	359	279	304	211	213	143	126	76	0
29	184	173	198	205	201	218	195	184	171	170	139	100	102	55	34
30	475	361	481	505	554	530	547	429	521	386	475	276	339	240	188
31	143	158	156	173	183	170	172	161	181	140	150	121	102	99	86
32	250	230	242	282	258	269	300	255	293	253	251	193	225	173	136
33	213	215	219	233	262	257	295	215	261	234	243	194	216	191	144
34	207	194	197	244	242	272	244	232	237	217	233	213	215	183	172

35	348	303	382	437	437	460	500	407	449	390	485	330	465	375	330
36	173	174	188	225	211	210	254	205	229	207	222	198	222	205	168
37	146	140	157	184	198	193	199	201	197	174	195	160	205	190	151
38	166	179	212	203	244	239	260	243	272	247	311	213	290	243	231
39	117	107	132	138	163	144	179	171	151	162	183	143	174	173	154
40	177	198	215	243	305	283	333	281	374	271	406	236	410	305	332
41	51	58	72	80	75	93	104	89	104	91	112	79	108	108	101
42	73	87	87	102	140	115	142	124	149	154	154	153	183	162	156
43	57	70	57	86	89	116	111	120	126	124	138	124	135	143	130
44	41	40	65	65	77	96	111	91	127	94	138	98	139	128	133
45	74	80	102	103	159	136	203	163	196	192	230	165	256	226	213
46	35	30	45	45	60	59	76	65	75	67	99	72	104	91	76
47	23	20	24	27	57	39	64	57	70	59	76	68	82	87	90
48	39	40	43	37	53	57	62	73	96	92	110	96	126	111	105
49	18	20	14	18	18	21	37	42	46	47	68	55	74	78	71
50	65	78	71	71	66	89	123	79	114	122	154	96	217	145	179
51	22	10	20	18	17	21	22	25	22	37	42	30	48	41	53
52	0	25	22	41	29	16	31	24	42	28	57	53	80	66	69
53	0	0	9	16	19	17	14	16	28	20	32	34	41	40	54
54	0	0	0	20	19	22	19	23	25	28	34	35	42	40	54
55	0	0	0	0	28	32	38	32	44	36	59	34	69	69	84
56	0	0	0	0	0	22	17	16	23	14	21	15	29	36	31
57	0	0	0	0	0	0	11	8	13	11	17	16	22	19	19
58	0	0	0	0	0	0	0	18	20	17	28	13	25	22	21
59	0	0	0	0	0	0	0	0	9	13	4	13	11	15	12
60	0	0	0	0	0	0	0	0	0	39	49	27	61	48	45
61	0	0	0	0	0	0	0	0	0	0	4	6	5	5	6
62	0	0	0	0	0	0	0	0	0	0	0	7	16	16	11
63	0	0	0	0	0	0	0	0	0	0	0	0	12	16	15
64	0	0	0	0	0	0	0	0	0	0	0	0	0	13	14
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
Unallocated Children	850	653	771	797	768	800	828	723	861	705	814	646	907	840	879

TABLE A-2.3 (continued)

Age of Mother	Age of Children 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1973															
15	132	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	166	102	0	0	0	0	0	0	0	0	0	0	0	0	0
17	279	186	107	0	0	0	0	0	0	0	0	0	0	0	0
18	495	288	194	153	0	0	0	0	0	0	0	0	0	0	0
19	416	300	235	173	112	0	0	0	0	0	0	0	0	0	0
20	706	494	416	396	294	202	0	0	0	0	0	0	0	0	0
21	359	271	240	196	165	114	97	0	0	0	0	0	0	0	0
22	609	496	428	464	350	271	212	151	0	0	0	0	0	0	0
23	572	430	420	435	355	302	263	199	117	0	0	0	0	0	0
24	549	404	381	434	403	361	316	224	157	97	0	0	0	0	0
25	695	572	570	601	596	509	480	422	344	239	224	0	0	0	0
26	418	346	355	364	379	351	343	287	255	192	148	75	0	0	0
27	396	334	338	330	335	366	331	308	294	221	165	142	114	0	0
28	430	365	359	448	397	391	439	363	369	269	287	179	188	109	0
29	246	247	206	236	276	255	246	249	257	223	189	132	128	71	63
30	558	487	459	491	569	568	594	550	557	462	554	324	390	303	228
31	187	158	132	160	186	179	185	179	182	151	161	143	136	112	56
32	277	243	253	306	285	324	364	319	313	307	327	267	313	217	177
33	264	215	261	283	301	297	339	306	348	295	309	249	313	265	233
34	198	161	176	223	224	233	229	264	251	234	235	242	268	237	212

35	431	361	381	438	483	489	558	505	590	456	589	399	596	476	460
36	195	161	176	202	231	227	270	255	307	230	287	219	278	234	251
37	187	151	185	199	187	237	221	269	224	238	259	242	289	272	259
38	211	189	215	250	255	269	322	327	319	292	332	288	415	307	326
39	119	107	126	141	143	175	170	185	192	167	195	165	202	208	180
40	232	206	260	268	322	359	396	404	479	394	510	378	565	455	446
41	61	47	73	64	66	93	101	99	116	119	134	100	143	121	127
42	93	96	109	129	154	163	188	215	209	241	255	216	287	259	247
43	79	66	72	86	131	129	158	173	169	179	191	152	241	193	191
44	44	52	55	61	78	116	112	139	147	114	152	158	173	176	159
45	97	117	119	143	145	181	232	237	257	220	308	250	348	305	297
46	39	28	43	49	58	67	98	114	136	105	159	105	168	136	160
47	23	21	21	33	39	60	72	92	90	77	114	117	140	119	107
48	36	40	31	53	61	80	88	99	122	111	138	125	198	187	173
49	22	20	23	24	28	29	49	61	58	55	69	70	92	80	88
50	61	46	54	59	67	88	86	108	132	124	142	135	228	208	207
51	16	15	8	13	13	14	17	25	25	31	34	30	53	51	67
52	0	21	21	19	21	27	26	47	48	47	73	77	106	79	79
53	0	0	19	20	23	21	14	23	26	37	39	38	70	69	72
54	0	0	0	14	14	16	17	27	26	18	30	29	61	44	62
55	0	0	0	0	28	29	31	34	44	38	49	52	71	67	89
56	0	0	0	0	0	11	9	9	12	16	23	18	40	36	43
57	0	0	0	0	0	0	10	13	9	14	21	15	18	23	29
58	0	0	0	0	0	0	0	25	20	20	22	15	22	33	41
59	0	0	0	0	0	0	0	0	10	14	15	11	18	18	20
60	0	0	0	0	0	0	0	0	0	40	51	35	59	43	58
61	0	0	0	0	0	0	0	0	0	0	10	5	6	4	7
62	0	0	0	0	0	0	0	0	0	0	0	5	16	14	13
63	0	0	0	0	0	0	0	0	0	0	0	0	13	16	17
64	0	0	0	0	0	0	0	0	0	0	0	0	0	8	10
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
NST	445	393	372	453	501	511	621	605	712	605	710	670	1002	869	899

TABLE A-2.4 Age-Specific Fertility Estimates for Single Year Periods from Own-Children Analysis, 1964 and 1973 Census: Guatemala

Age Group	Age-Specific Fertility Rates by Year							
	1963-64	1962-63	1961-62	1960-61	1959-60	1958-59	1957-58	1956-57
1964 Census								
15-19	0.1085	0.1091	0.1452	0.1548	0.1642	0.1673	0.1660	0.1574
20-24	0.2478	0.2345	0.2780	0.2947	0.3041	0.3174	0.3057	0.2657
25-29	0.2707	0.2378	0.2896	0.3042	0.3166	0.3208	0.3416	0.2868
30-34	0.2405	0.2337	0.2552	0.2888	0.2896	0.2732	0.2924	0.2523
35-39	0.1827	0.1793	0.1949	0.1957	0.2132	0.2079	0.2335	0.1958
40-44	0.1023	0.1113	0.1158	0.1120	0.1403	0.1141	0.1386	0.1080
45-49	0.0661	0.0678	0.0689	0.0767	0.0668	0.0637	0.0666	0.0572
TFR	6.0928	5.8676	6.7384	7.1341	7.4741	7.3222	7.7218	6.6162
	1955-56	1954-55	1953-54	1952-53	1951-52	1950-51	1949-50	
15-19	0.1777	0.1488	0.1790	0.1368	0.1781	0.1616	0.1622	
20-24	0.3141	0.2718	0.3001	0.2456	0.3089	0.2797	0.2585	
25-29	0.3160	0.2795	0.3250	0.2327	0.3273	0.2823	0.2820	
30-34	0.2776	0.2389	0.2836	0.2255	0.2924	0.2613	0.2402	
35-39	0.2219	0.1844	0.2183	0.1575	0.2309	0.1806	0.1950	
40-44	0.1225	0.1018	0.1313	0.1022	0.1339	0.1126	0.1080	
45-49	0.0740	0.0569	0.0718	0.0470	0.0711	0.0637	0.0563	
TFR	7.5187	6.4106	7.5450	5.7365	7.7136	6.7095	6.5108	
	1972-73	1971-72	1970-71	1969-70	1968-69	1967-68	1966-67	1965-66
1973 Census								
15-19	0.1415	0.1292	0.1325	0.1574	0.1565	0.1574	0.1722	0.1710
20-24	0.2756	0.2385	0.2456	0.2746	0.2823	0.2820	0.2995	0.2850
25-29	0.2755	0.2520	0.2364	0.2729	0.2917	0.2935	0.3204	0.3015
30-34	0.2366	0.2009	0.2156	0.2405	0.2405	0.2490	0.2595	0.2604
35-39	0.1736	0.1442	0.1620	0.1603	0.1734	0.1855	0.2044	0.2177
40-44	0.0942	0.0901	0.0886	0.0934	0.0947	0.1059	0.1122	0.1135
45-49	0.0502	0.0434	0.0408	0.0478	0.0482	0.0508	0.0437	0.0545
TFR	6.2358	5.4911	5.6072	6.2346	6.4371	6.6202	7.0596	7.0179
	1964-65	1963-64	1962-63	1961-62	1960-61	1959-60	1958-59	
15-19	0.1789	0.1629	0.1835	0.1472	0.1980	0.1752	0.1767	
20-24	0.3050	0.2790	0.3099	0.2603	0.3412	0.2992	0.3000	
25-29	0.3198	0.2668	0.3106	0.2558	0.3513	0.2963	0.2896	
30-34	0.2677	0.2502	0.2734	0.2349	0.3197	0.2698	0.2546	
35-39	0.2165	0.1666	0.2078	0.1668	0.2278	0.1854	0.1814	
40-44	0.1088	0.0929	0.1056	0.0986	0.1407	0.1092	0.1221	
45-59	0.0531	0.0514	0.0633	0.0428	0.0585	0.0529	0.0561	
TFR	7.2484	6.3487	7.2698	6.0321	8.1862	6.9403	6.9027	

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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.

DUAL RECORD SYSTEM See Chandrasekaran-Deming Technique

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 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 ($_xq_o$) is related linearly to the logit of a standard probability of dying by age x ($_xq_o^s$) so that

$$\text{logit } ({}_xq_o) = a + \ddot{O} \; [\text{logit } ({}_xq_o^s)],$$

where a is a measure of mortality level relative to the standard and Ö 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.

MIGRATION RATE Number of migrants during a specified period divided by the person-years-lived of the population exposed to migration. Also see population change due to migration.

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.

POPULATION CHANGE DUE TO MIGRATION The sum of in-migrants minus out-migrants during a specified period of time. The change may also be expressed as a rate by dividing the change by person-years-lived in the population during the same period.

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.