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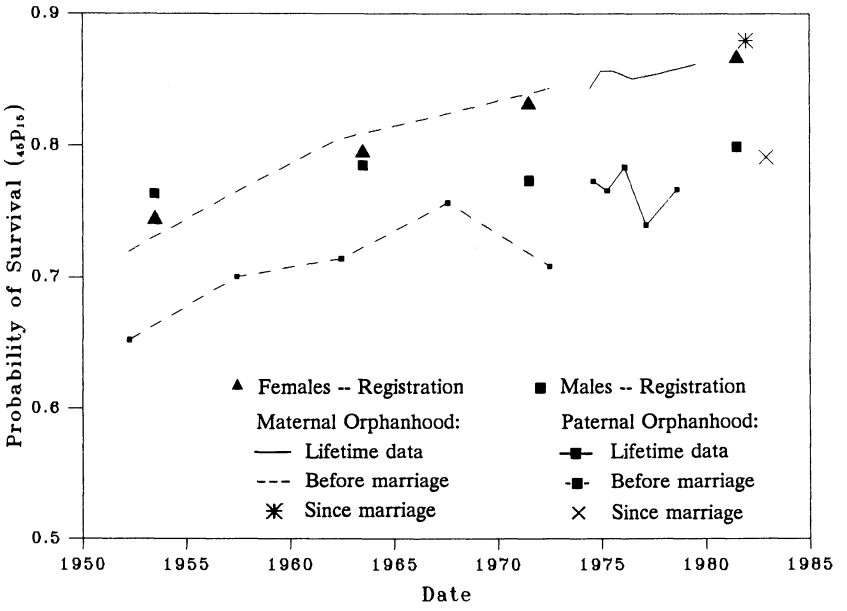
TRENDS IN ADULT MORTALITY IN SRI LANKA ACCORDING TO ORPHANHOOD AND REGISTRATION DATA



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MEASUREMENT OF ADULT MORTALITY IN LESS DEVELOPED COUNTRIES: A COMPARATIVE REVIEW

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Abstract: This paper compares the direct and indirect methods used to measure adult mortality in the developing world. No other approach can substitute fully for accurate and complete vital registration, but in many countries it is unrealistic to expect the registration system to cover the majority of the population in the foreseeable future. In these countries attempts to use the system as a source of statistical data should probably be abandoned. The difficulties involved in measuring adult mortality using surveys and other ad hoc inquiries are discussed. Even though the problems are greater than those encountered in measuring child mortality, information can be collected that is of value for planning and forecasting. While the choice of methods must depend on each country's situation, direct questions require very large samples and are unreliable in single-round inquiries. On the other hand, although indirect methods provide less detailed and up-to-date information than is ideal, they are adequate for many practical purposes. In particular, the experience of the 1980s suggests that questions about orphanhood perform better than earlier assessments indicated, and recent methodological developments have circumvented some of the limitations of the indirect approach.

Introduction

This paper reviews experience of the measurement of adult mortality in countries with limited or defective demographic data. It assesses the performance of established approaches and describes methods that have recently been developed or proposed. The death of adults is a neglected health issue about which little is known. It has been estimated that about eight million avoidable deaths occur in those between ages 15 and 60 each year. This represents more than a fifth of avoidable years of life lost before age 85 in developing countries (Murray and Feachem, 1990). While a great deal has now been discovered about child mortality in developing countries, about its causes and underlying determinants, and about ways to intervene to prevent death in childhood, in large parts of Africa even the overall level of adult mortality is unknown. In much of the rest of the world, we are almost completely ignorant about old-age mortality, the main causes of death in early adulthood and middle age, and the distribution of adult deaths within national populations.

More plentiful and accurate population-based measures of adult mortality would be of value in many ways. Synthetic measures of the level of mortality, such as life expectancy at birth or at age 15, are used as indicators of health status and social development. They also quantify the extent of the public health problem represented by adult mortality, making it possible to assess its priority in the allocation of resources. Information on mortality trends is required to project the population and to monitor and evaluate programs intended to

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reduce adult mortality. For research into determinants and for the design and targeting of interventions, data on differentials in mortality and causes of death are needed.

Strategies for improving our knowledge of adult mortality should be oriented to these uses of the data. Estimates are of limited value for any purpose unless they are moderately accurate. On the other hand, there are few countries in which resource allocation and planning are sufficiently sophisticated processes that refined and precise measures are of appreciably greater practical value than broad indications of mortality patterns.

Many countries have collected data on child, but not adult, mortality. Faced with this situation, international organizations and national statistical offices often use model life tables to infer the level of adult mortality from estimates for children. Such guesses can be worse than useless. In Africa, for example, age patterns of mortality have been found to differ greatly between populations (Blacker et al., 1985). This research suggests that the relationship between child and adult mortality in Africa often differs from that in any of the families of Princeton or U.N. model life tables, yet is seldom as extreme as in the Senegalese data that have been treated tentatively as representative of West Africa (United Nations, 1982). One cannot rely on data about children, but must collect information on adults to provide a sound basis for population forecasts and for planning in the health and other sectors.

At the outset, it is worth emphasizing some general issues that make the study of adult mortality inherently more challenging than that of children. Firstly, in broad terms, adult mortality rates are an order of magnitude lower than those of children. Adult deaths are relatively rare events. Obtaining precise measures of adult mortality requires data either on a large sample of people or on events occurring during a long reference period. Secondly, it is difficult to identify an appropriate informant who can provide reliable information about deceased adults. Data on child mortality can usually be collected from mothers. In addition, the characteristics of parents are among the more important determinants of the risk of dying in childhood. Since there is no single universally suitable informant to provide data about adult deaths, problems of undercounting and multiple reporting are common. Moreover, it is often unreasonable to use the social and economic characteristics of the respondent as a proxy for those of the dead person in order to investigate mortality differentials.

In developing countries, age misreporting is another serious problem that affects all sources of adult mortality estimates. There are several reasons why it is difficult to obtain usable information on adult ages and ages at death. Older people are less likely to have birth certificates or health cards than are the young. Levels of education decline rapidly with age in most developing countries. Moreover, even if dead persons knew their own age, the informant who reports their death may not. Ages tend to be exaggerated and ages at death are exaggerated even more. This obstructs the study of age patterns of mortality within adulthood. Nearly all developing country data on adult mortality require smoothing by fitting a model life table, and those on the elderly population usually have to be discarded.

The development, assessment, and refinement of methods for collecting and analyzing information on mortality in developing countries is an active and ongoing field of research that has generated a large literature (e.g., United Nations, 1984; Vallin et al., 1984; Vallin et al., 1990). Although much of this literature is avowedly general in scope, in practice it tends to concentrate on child mortality. The present review has the opposite emphasis: it focuses on the approaches that can be used to measure adult mortality in developing countries. They are grouped under three major headings. The first group of methods yields direct measures of adult mortality. It comprises all approaches in which the information collected and analyzed refers to the deceased individual. These include vital registration systems, health service statistics, and several types of surveys. The other two sets of methods yield indirect measures of adult mortality. The first involves the analysis of census age distributions. In the other, the unit of analysis is not the deceased person but a clearly defined category of his or her relatives.

This discussion considers the basis and rationale of these approaches, without reiterating technical details explained in the primary research literature, and summarizes the experience that has been gained in their use. On this basis, an assessment is offered of the

accuracy, detail, and timeliness of the mortality measures obtained from each approach, judged against its cost gauged broadly from the scale, intensity, and duration of the field operations involved. The ground covered by the paper is outlined in Table 1.

Direct Measures

Vital and Sample Registration

Direct methods and measures of mortality represent the conventional or classical approach to demographic estimation and form the basis of the statistical systems of developed countries. In combination with census-based measures of the population at risk, accurate and complete vital registration represents a permanent source of comparable, annual, age-specific statistics for both the entire population and subpopulations (see Table 1). In addition, vital registration systems provide the means for compiling cause-specific mortality statistics about deaths certified by physicians. This information is of crucial importance for health planning and cannot be obtained readily in other ways.

Although national civil registration is very expensive, death certificates are important legal documents and much of the expenditure involved should be ascribed to the system's administrative functions. In countries where most deaths are medically certified, the extra costs involved in obtaining statistical data from the system can certainly be justified.

Unfortunately, in much of the world, vital statistics data are nonexistent or cover only part of the population. Apart from small island states, there are only about a dozen developing countries in which the registration of adult deaths is effectively complete.[1] Most of them are middle-income countries with fairly low mortality. Elsewhere, deaths occur outside the official health care system and administrative exigencies, such as the requirement that a death certificate be produced before a corpse is disposed of, often fail to operate. On the one hand, the population lacks incentives to register deaths, while on the other, registrars are often badly paid and poorly trained, affecting both the accuracy and the completeness of their returns (Moriyama, 1984). In addition, the processing of those certificates that are issued is often in disarray, introducing further errors into the statistics and delaying their publication (Gonzales Diaz, 1988). Even if these obstacles could be overcome, a civil registration system can only yield reasonably representative data on mortality by cause once the health services have developed sufficiently to cover the bulk of the population.

In some countries, particularly in much of Latin America and East Asia, the registration system has developed enough for the majority of adult deaths to be registered. Since Brass (1975) proposed the Growth Balance Technique, a wide range of analytic methods have been developed that can be used to assess and correct such data. These have been reviewed by Hill (1984) and Preston (1984). All such methods assume that the scale of underreporting is constant by age and most are based on the fact that everyone who reaches any given age must die at an older age. Therefore, it is possible to compare the age distribution of deaths with information on the age structure of the population and obtain a measure of the completeness of reporting that can be used to correct the data. Some of the techniques require denominator data from only one census of the population, but assume a stable age structure (Brass, 1975; Preston et al., 1980) or make heavy use of model life tables (Courbage and Fargues, 1979). Others make use of data from two censuses to relax these assumptions (Bennett and Horiuchi, 1981; Palloni and Kominski, 1984; Preston and Hill, 1980; Preston and Lahiri, 1991) but may be affected adversely by differences in the accuracy and completeness of the enumerations.

The existence of these methods implies that even deficient registration data can often be used to estimate adult mortality. However, various factors, including migration and differential underreporting by age, can distort the results and tend to preclude application of the techniques to data on subnational populations. Thus, adjusted registration data can

Table 1: Summary of the Features of Different Methods for Measuring Adult Mortality.

Method	Level		Trends			Age Patterns		Differentials		Cause of Death		Cost
	Accuracy	Recency	Yes/No	Detail	Time Range	Estimated/ Assumed	Detail	Socioeconomic	Geographical	Certification	Verbal Autopsy	
Vital registration	E-A	C-B	Y	A	A[1]	Est	A	B	E-A	Y	N	E
Adjusted vital registration	D-B	C-B	Y	A	A[1]	Est[2]	A	D	D	Y	N	E
(Adjusted) household deaths	E-B	A	N	N/A	N/A	Est[2]	C	D	D	N	Y	C
Multiround surveys	C-A	B	N	N/A	N/A	Est	B[3]	D-B[3]	D-B[3]	N	Y	D
Surveillance systems	C-A	A	Y/N[3]	B[3]	A[1]	Est	B[3]	E-A[3]	E	Y	Y	E
Intercensal methods	E-B	C	N	N/A	N/A	Ass[2]	D	E	D	N	N	A
Basic orphanhood method	D-B	D-C	Y	Sm	16-4	Ass	N/A	C	C	N	N	B
Synthetic orphanhood estimates	C-B	C	N	N/A	N/A	Ass[2]	D	E	C	N	N	B
Orphanhood relative to marriage	C-B	C	Y	Sm	37-17, 6	Ass	N/A	C	C	N	?	B
Widowhood	D-B	C	Y	Sm	15-3	Ass	N/A	C	C	N	?	B
Adult siblings[4]	?	?	Y	Sm	?	Ass	N/A	C	C	N	Y[5]	B

Key: A = most satisfactory; E = least satisfactory; Sm = smoothing of short-term fluctuations inherent in the method.

[1] Capability depends on the length of time for which the system is maintained.
[2] Capability depends largely on the quality of the data.
[3] Capability depends largely on sample size.
[4] Methodology not yet fully developed.
[5] Maternal mortality only.

be valuable for studying the level, trend, and age pattern of adult mortality but are of less value for the investigation of mortality differentials or causes of death (see Table 1). Moreover, throughout mainland Sub-Saharan Africa, much of Asia, and parts of Latin America, the registration of deaths falls short of the 60 percent limit below which adjustment of the data becomes infeasible (Preston, 1984).

Sample registration, with more active registrars, appears to offer the possibility of overcoming some of the limitations of national civil registration. Some such inquiries have been organized within the framework of the national system, others as parallel activities. Although registration of an appropriate sample of deaths is adequate for most statistical purposes, is of limited value administratively. The expense of sample registration is therefore difficult to justify, unless the system can be organized to provide useful data on causes of death or can be seen realistically as an interim step toward the development of a national system.

A major operational problem with active registration is that registration areas that are large enough (i.e., sufficient deaths occur) to occupy a registrar full-time are often too large for him or her to be well enough acquainted with the population to detect all deaths. Some systems use part-time informants to try to circumvent this problem. Dual-record systems such as the Indian Sample Registration Scheme, in which continuous recording of vital events is supplemented by biannual surveys, do appear to be successful in reducing the omission of deaths (Padmanabha, 1984); however, they are very expensive. Maintaining the independence of the two systems in the field is difficult (and is no longer attempted in India), and the matching of events during analysis is a formidable task.

A large number of countries are making efforts to improve the coverage of their civil registration systems (e.g., Gil, 1989). Some have begun to develop alternative routine reporting systems based on primary health care workers and traditional birth attendants (e.g., Hill and Graham, 1988). Progress is likely to be slow (Moriyama, 1984), and many promising initiatives have collapsed once international assistance was withdrawn. There are large parts of the world in which it is unlikely that routine reporting systems will produce adequate data on adult mortality in the foreseeable future.

Retrospective Survey Questions on Household Deaths

In the absence of effective systems for routinely collecting data on deaths, most information on adult mortality in developing countries has been collected in surveys and other ad hoc inquiries. An obvious and conceptually simple way of trying to measure mortality levels directly in a census or household survey is to ask questions about deaths of household members during a fixed period before the enumeration. Most inquiries ask about deaths in the preceding year; the World Fertility Survey (WFS), however, has experimented with a two-year reference period, asking about the exact date when each death occurred. Information is usually collected on the age at death and sex of the deceased, and sometimes on their relationship to the household head. After making minor adjustments for population growth, the enumeration of the living population in the same inquiry provides appropriate denominators for the calculation of mortality rates.

The most important limitation of this approach is that questions on recent deaths can only be used in large-scale surveys or censuses. Even in high-mortality countries, the sampling variability of mortality rates is relatively large compared with their absolute size. To calculate reasonably precise five-year age-specific mortality rates by sex, one needs data on several hundred thousand households. Only a few of the world's most populous countries are able to consider sample inquiries on this scale. If the individual rates are smoothed by fitting a model life table, estimates can be obtained from much smaller studies. Blacker and Scott (1974) suggest that a survey of about 100,000 individuals or 20,000 households is the minimum size that might yield reasonably precise results.[2] Unfortunately, this remains several times the number of households enumerated in most fertility surveys such as those conducted under the auspices of the WFS and Demographic and Health Surveys (DHS) programs.

There has been considerable experience with this approach to measuring adult mortality. It shows that it is common for a substantial proportion of recent deaths to remain unreported. It is sometimes possible to evaluate and adjust these data in the same way as registration data, but often only about a third to one half of the expected number of adult deaths are reported and occasionally far fewer. There seem to be several reasons for this. One major problem is that deaths only occur in a small minority of households, and interviewers simply give up asking about them and leave that section of the schedule blank. In addition, reference-period errors may be important, as are omissions, perhaps because of an unwillingness on the part of respondents to talk about the dead. In several WFS surveys the number of deaths reported each month declined rapidly as the interval between their occurrence and the survey increased (Timæus, 1987). Coverage errors are also a problem. Not everyone is clearly attached to a single household and some people live alone. Such individuals may be among those most likely to die but are unlikely to have their deaths reported. Moreover, the death of an adult can precipitate household fission, so that households in which deaths occur dissolve before the survey is conducted.

There were ten WFS studies that incorporated a large household survey asking about recent deaths (Timæus, 1987). The WFS experience illustrates how difficult it is to collect such data. Despite the high quality of the fieldwork in this program of surveys, too few deaths were reported in Mexico, Sudan and North Yemen to allow worthwhile evaluation of the data. In Cameroon, Mauritania, and Morocco, the Growth Balance Technique and related methods suggest that a substantial proportion of deaths was omitted. However, age misreporting and the distorting impact of migration on the age structure mean that it is impossible to determine the scale of the omissions. In Jordan and Syria, the data on adult men (but not women) and, in Korea, the data on both sexes appear to be complete. Finally, in Lesotho, while the results are consistent with complete reporting, the data are again too erratic to conclude that this is in fact the case.[3]

Questions about recent deaths have also been included on many census schedules. Some countries have asked about the topic repeatedly. Partly because of the limited training that can be provided to census enumerators, little has been gained from this effort. For example, in Africa, the only census known to the author in which reporting was more or less complete is that of Botswana in 1981. In a few other African censuses, evaluations suggest that about 50-60 percent of adult deaths were identified. Otherwise the data have been useless (see also Waltisperger and Rabetsitonta, 1988).

Asking about recent deaths in single-round inquiries has proved an unreliable way of collecting data on adult mortality. While better questionnaire design, field procedures, and training of interviewers would probably yield more complete data than has usually been obtained in the past, such efforts would not avoid all the limitations of this approach (see Table 1). Firstly, as the WFS experience reveals, one cannot rely on being able to assess the completeness of reporting from internal evidence with any degree of precision. Secondly, the approach can only be used to study mortality trends if it is adopted in a series of surveys. Thirdly, information on recent deaths is of limited value for the study of mortality differentials. Even if the sample size does not prohibit disaggregation, it is seldom possible to adjust data on subpopulations, and it is difficult to collect information retrospectively on the characteristics of the deceased. Finally, to reduce the impact of sampling, age misreporting, and other errors, the data should usually be smoothed by discarding statistics on the elderly and fitting a model life table. Thus, the apparent advantages of direct questions over indirect methods for the study of age patterns of mortality and old-age mortality are illusory.

Multiround Surveys and Surveillance Systems

Multiround surveys and the surveillance of geographically localized populations reduce the problems experienced when asking about deaths in the household in a single-round survey by enumerating and then re-enumerating the same population and inquiring about deaths in the intervening period. Since inquiries can be made about each individual

present in the first enumeration but not in the second, such investigations eliminate most of the omissions and reference-period errors that vitiate the single-round approach. Everyone enumerated in the first round, including those who subsequently die, can be asked about their age and other personal characteristics. Thus, longitudinal studies yield more reliable data than do single-round surveys for the study of age patterns of mortality, mortality in old age, and mortality differentials. Moreover, because households in which adult deaths have occurred can readily be revisited, both designs provide a suitable framework for the investigation of causes of death by verbal autopsy methods.

As with the single-round approach to measuring adult mortality, longitudinal inquiries need to cover some 100,000 person-years of exposure to yield sufficiently precise data for the study of adult mortality. To take advantage of the potential that this design offers for the study of differentials in adult mortality and causes of death, the sample size would need to be considerably larger. This sample needs to be interviewed at least twice, and the cost of each round can approach that of a single-round survey (Adlakha and Nizamuddin, 1984).

Multiround surveys have been conducted in most regions of the world and a great deal of attention has been devoted to their assessment (e.g., Adlakha and Nizamuddin, 1984; Seltzer, 1969; Scott, 1973; Tabutin, 1984). If well conducted, they provide one of the more reliable ways of measuring mortality in countries that lack effective routine sources of data. However, they reduce rather than eliminate errors such as age misreporting and suffer from distinctive technical problems. The field operations are inherently complicated; they require meticulous record keeping and supervision; and loss to follow-up is almost always a problem, especially in highly mobile groups such as the populations of many urban areas. Events only occur in a small minority of households between any two rounds of the inquiry, and maintaining the motivation of interviewers is difficult. Multiround surveys are highly demanding of technical and managerial expertise. At their worst, they combine the problems of both single-round and continuous data collection systems.

Population surveillance systems involve the detailed study of the population of a limited area for a number of years. They are usually set up to provide the demographic data needed to support a range of epidemiological investigations and intervention trials. Such studies have generated a wealth of information on health in developing countries, but the measurement of adult mortality has been at most a subsidiary aim of those conducted up until now. Some studies have not collected any information on adult mortality and few have devoted much effort to estimating the ages of adults accurately (although see Pison, 1985). Most surveillance systems are too small to investigate adult mortality in detail. For example, several life tables have been constructed from surveillance data collected in Senegal and the Gambia, but they are all based on deaths recorded over a period of more than a decade (Billewicz and McGregor, 1981; Cantrelle et al., 1986; Pison and Langaney, 1985).

To summarize, longitudinal studies can provide reasonably up-to-date and accurate measures of the level of adult mortality, but only very large studies are of much value for studying other aspects of the subject (see Table 1). Population surveillance systems of the size usually envisaged can accumulate sufficient data over a number of years to investigate either trends or age patterns or socioeconomic differentials in adult mortality, but cannot examine more than one of these axes of variation at a time. While both multiround surveys and surveillance systems yield information on components of population change other than adult mortality, fertility surveys and indirect questions on census schedules can usually provide reasonable estimates of fertility and child mortality more cheaply. Thus the expense of longitudinal studies seems difficult to justify except as exceptional enterprises with wider research objectives than the estimation of demographic rates.

Intercensal Estimates

Methods based on the change in the size of a population between two censuses are among the oldest ways of attempting to measure adult mortality in the absence of

registration data. Traditional procedures for estimating mortality from two census age distributions are based on cohort survival. In other words, the attrition of cohorts is examined by comparing the size of the population in each age group at the first census with the equivalent older age group at the second enumeration. In practice, age-reporting errors almost always raise problems, and a variety of methods have been proposed to adjust for and smooth out their impact (e.g., Brass, 1975; United Nations, 1967, 1983).

Recently, Preston and Bennett (1983) and Preston (1983) have proposed alternative methods that use information on the growth in the size of the *same* age groups between two censuses to calculate a life table. The methods are easy to apply if the censuses are not separated by exactly five or ten years and reduce the impact of equivalent, though not changing, age-reporting errors on the mortality estimates. In general, therefore, they have advantages over methods based on cohort survival.

The information required to estimate mortality using intercensal methods is available for most countries. While the approach does not necessarily involve the use of demographic models, in practice the estimates are usually too erratic to yield evidence on the pattern of mortality by age. They are also inevitably somewhat out of date. If international migration has a substantial impact on the population, estimating adult mortality in this way can be difficult. A more fundamental drawback is that the results are very sensitive to changes in enumeration completeness over time, which frequently introduce large errors. Thus, intercensal methods can provide only limited information on adult mortality (see Table 1). On the other hand, estimates can be produced very cheaply. In most countries, rather than treating data on intercensal survival as an independent source of estimates of mortality, it is probably more realistic to use an intercensal population projection as a check on census coverage and on the accuracy of fertility and mortality estimates derived from other sources.

Retrospective Survey Questions on the Survival of Relatives

Methods of estimation based on questions about relatives attempt to circumvent the difficulties that arise in the direct collection of information about deaths, and especially about deaths that occurred a considerable time ago. These methods are based on simple questions about the survival of some clearly defined category of relatives of the respondent that can be used in multi-purpose, single-round surveys or censuses. For example, information on orphanhood is collected by asking "Is your mother alive?" and "Is your father alive?" No attempt is made to collect the ages of the dead relatives. Instead they are estimated from the ages of the respondents, which should be reported more accurately, using simple demographic models. The length of time for which the relatives were exposed to the risk of death can also be calculated from information about the respondents. For example, respondents' mothers must have been alive when the respondents were born, and so the duration of exposure is simply the respondents' age. On this basis, procedures can be derived whereby information on the survival of relatives can be translated into life table measures of conditional survivorship in adulthood on the basis of a simple index of the mean difference between the ages of the respondents and their relatives (Brass and Hill, 1973; Hill and Trussell, 1977; Palloni and Heligman, 1986; Timæus, in press; United Nations, 1983).

The two main limitations to such indirect methods do not arise from the approximations that are involved in the process of estimation, but rather stem from the basic nature of the data analyzed. The proportion of mothers, fathers, or any other category of relatives that remain alive depends on the level of mortality over a range of ages and a number of years. If it is assumed that the age pattern of mortality can be represented adequately by some model pattern and that mortality has declined linearly in terms of that model, it becomes possible to estimate the date at which the mortality of the cohort of relatives reported on by each age group of respondents equals the period measure of mortality prevailing in the population (Brass, 1985; Brass and Bamgboye, 1981). As these dates are nearer to the present for younger respondents than for older ones, these "time

location" methods make it possible to measure the general trend in mortality. Their development has greatly increased the value of the orphanhood and related techniques of estimation. However, indirect methods can yield only broad measures of the overall level and trend in adult mortality. They are inherently unable to detect abnormal age patterns of mortality within adulthood or short-term trends in mortality.

One advantage of the orphanhood and other indirect techniques over direct methods of estimating mortality is that the information used is based on respondents' lifetime experience. Thus, fairly precise estimates of the proportions of respondents with living relatives can be obtained from surveys of moderate size, such as those conducted by the DHS and WFS programs. Likewise, because the questions involved are simple and can be included on census forms, it is operationally feasible to collect such data on a large scale and to use them for detailed studies of mortality in comparatively small districts of a country.

Questions about Orphanhood

The collection of orphanhood data in developing countries began in the mid-1960s. Questions about the survival of parents have been asked in numerous censuses and surveys in Africa and Latin America, but fewer in Asia. They were included in 12 WFS surveys that used the expanded household schedule, in the World Bank's Living Standards Measurement Study (LSMS) surveys, and in many of the first phase of DHS surveys. Unfortunately, the questions have not been incorporated in the core questionnaire for the second phase of DHS surveys. In many countries, questions about the survival of parents have been asked in more than one inquiry. This greatly assists assessment of the resulting estimates of mortality. Thus, orphanhood data are widely available and there is considerable experience with their analysis.

Views on the value of the orphanhood method as a way of estimating adult mortality have varied over time. After comparing some of the early results with those from other sources, Blacker (1977) concluded that the method was a cheap and simple way of obtaining a rough index of adult mortality that compared well with the available alternatives. Somoza (1981) was of the opinion that the method gave valuable results in four Latin American inquiries. Shortly afterward, however, one of the originators of the method emphasized its limitations (e.g., Hill, 1984; Zlotnik and Hill, 1981). Recent reviews have been more optimistic (Blacker and Mukiza-Gapere, 1988; Timæus, 1986, 1990), but no clear consensus currently exists among demographers about the technique's validity.

Applications of the orphanhood method have met with mixed success. While some external evaluations of its validity have been possible (Pison and Langaney, 1988; van Poppel and Bartlema, 1985), the method's performance usually must be assessed on the basis of the internal consistency of two or more sets of data. In several Latin American and African countries, successive sets of orphanhood data have indicated consistent levels and trends in adult mortality that closely agree with estimates from other sources (e.g., Timæus, 1991a). In contrast, results for many East African countries offer clear evidence of errors in the data or the method of estimation. In particular, the mortality estimates obtained from the reports of young respondents seem too low, exaggerating the apparent decline in the level of mortality.

It is now clear that, as has long been suspected, the main factor underlying such errors is what Hill and Trussell (1977) termed the "adoption effect" (Blacker, 1984; Blacker and Mukiza-Gapere, 1988; Timæus, 1986, 1990, 1991a). Most orphaned children are reared by another adult and may not even know that this person is not their biological parent. If this foster parent is reported on mistakenly, mortality will be underestimated. The problem is most severe for young children, whose "adopted" parent may answer the question on their behalf or be assumed by the interviewer to be the biological parent.

Apart from this problem, questions about parental survival appear to be well understood by developing-country populations and are answered accurately. While there is obviously scope for misunderstanding in cultures where the terms "mother" and "father" are applied to a broad spectrum of kin, in general the quality of data collected in censuses has

been broadly similar to that of data obtained in carefully controlled surveys with well-trained interviewers. Poor reporting of age by respondents is a more prevalent problem and may explain the tendency for men to report more living parents than women of the same age. Fortunately, age exaggeration is more serious for older respondents than for those aged less than 50 years who supply the data used to estimate adult mortality.

An intrinsic problem with the orphanhood method is that most parents are reported on by several children but no information is obtained at all about people with no surviving children. Biases will arise if parents' probabilities of surviving are related to their number of living children. Both theoretical arguments and empirical evidence suggest that the biases are small, but that they lead the method to underestimate mortality slightly (Blacker, 1984; Blacker and Mukiza-Gapere, 1988; Palloni et al., 1984; Timæus, 1990).

A further limitation of the basic orphanhood method is that it provides estimates of mortality that refer to dates well before the inquiry was conducted. Deaths of parents occur over a period extending back to when the respondents were born in the case of mothers' deaths, and about nine months earlier for fathers. The most recent estimates are based on the reports of the youngest respondents, whose responses are most likely to be biased seriously by the adoption effect. Even these estimates are for four to five years before the survey. If information on respondents aged under 15 is either discarded or not collected, the most recent estimates refer to at least eight years prior to the inquiry. Furthermore, in DHS surveys, only ever-married women were asked about the survival of their parents. Orphanhood and women's ages at marriage are associated in most populations, and the responses are only representative of the entire population for age groups in which nearly all women are married (Timæus, 1991b). The resulting estimates are 11 or more years out of date.

When two sets of orphanhood data have been collected in successive surveys of the same population, it is possible to derive from them a single set of proportions orphaned by age that reflects adult mortality during the interval between the inquiries. Zlotnik and Hill (1981) propose an estimation procedure based on cohort changes in parental survival, while Preston and Chen (1984) and Timæus (1986) suggest a more flexible approach using the growth rate in the proportion of the population with living parents. As the estimates refer to the period between the inquiries, they have an unambiguous and recent time reference. Unfortunately, they are vulnerable to biases stemming from differential reporting and sampling errors in the two inquiries. More recently, Timæus (1991c) has developed procedures for producing mortality estimates from synthetic cohort data based at age 20 years. The results reflect the mortality of middle-aged parents. Because it uses only information on the recent incidence of orphanhood among young adults, this approach eliminates biases due to the adoption effect. Though differential errors remain a problem, the method has given promising results in several applications.

In another extension of the orphanhood method, Chackiel and Orellana (1985) examine the value of asking supplementary questions about the dates when parents died. This allows the empirical calculation of the mean time at which parents died, avoiding the need to use the time-location methods proposed by Brass and Bamgboye (1981). The data can also be analyzed as if three separate inquiries had been conducted at five-year intervals, using the methods just mentioned. The main limitation of the approach is that it requires respondents to remember accurately when their parents died. This did not appear to be a problem in Honduras (Chackiel and Orellana, 1985), but trials of the method in Burundi and Uganda suggest that African populations are unable to do this accurately (Timæus, 1991c).

In an unpublished note, Brass suggested using information on whether a parent died before or after the respondent first married to similar effect. The relative timing of orphanhood and first marriage may be reported more accurately than the date when a parent died. Moreover, the data required to implement this approach were collected in 15 Phase I DHS surveys. Methods for analyzing this type of information have been developed recently and have yielded encouraging results (Timæus, 1991b). Data on orphanhood since marriage yield a reasonably up-to-date estimate of the mortality of the middle-aged, referring back to about six years before their collection. They are not subject to bias by the adoption effect. On the other hand, in applications in which the adoption effect is not a serious

problem, data on orphanhood before marriage can be used to estimate early adult mortality over a period extending back to at least 35 years before they were collected.

None of the variants of the orphanhood method represent ideal ways of measuring adult mortality (see Table 1). The approach usually provides reasonable estimates of the level of adult mortality, but these are rather out of date. It can be used to study the long-term trend in adult mortality, but not changes in the short term. Information on the characteristics of respondents can be used to study differential mortality, but usually nothing is known about their parents' characteristics. The strength of the orphanhood method, however, is that it provides some information on all these aspects of adult mortality at a moderate cost. Often this information is sufficient to provide a basis for forecasting and the allocation of resources.

Questions about Widowhood

The widowhood method, which estimates adult mortality from information about the deaths of husbands and wives, was developed by Hill (1977). Techniques were derived for estimating male mortality from the reports of female respondents and vice versa (see also United Nations, 1983). In order to circumvent the difficulty involved in modeling the effects of remarriage of the widowed and divorced, information is collected on the survival of *first* spouses. To maximize the accuracy of the answers, the WFS and other surveys have found it useful to ask explicitly whether the respondent has been married more than once, prior to asking "Is your first husband (or wife) alive?"

If the mortality of spouses is associated, estimates from the widowhood method will be biased. The scale of such biases has not received the detailed attention directed to the equivalent biases affecting the orphanhood method. In populations with a major AIDS epidemic, at least, they are likely to be large. The technique should not be used in such countries.

While questions on the survival of first spouses have been asked in a number of inquiries, the experience gained with this method of measuring adult mortality is far more limited than that with the orphanhood method. In some surveys the method has given plausible results, judged on the basis of consistency with other adult mortality estimates. In other applications the results have been obviously biased. While orphanhood data sometimes yield implausibly steep declines in mortality, estimates based on the questions about widowhood have often suggested constant or increasing adult mortality (Blacker and Mukiza-Gapere, 1988).

One problem is that, in societies in which marriage is ill-defined and getting married is more accurately conceived of as a process rather than an event, it may be difficult to establish whether a previous union was a marriage. Unions that ended because of the death of a partner may be ignored. On the other hand, where social stigma attaches to divorce, respondents whose unions have broken up may tend to state that they are widowed rather than divorced. In some parts of the world divorce and remarriage are very common and divorced respondents may not know whether their first spouse is still alive. Problems also arise with the data on female widowhood in surveys where information on the whole household is provided by the household head. Men appear to be ignorant of, or unwilling to report, their wives' former marriages (Blacker et al., 1983).

In general, the strengths and weaknesses of the widowhood method are similar to those of the orphanhood method (see Table 1). The value of the data, however, seems to depend crucially on the social and cultural context in which the method is applied. It should not be used without careful consideration of the likely problems in the population concerned.

Questions about the Survival of Siblings

The principles on which the orphanhood and widowhood methods are based can be extended to the estimation of mortality from data on other relatives. Hill and Trussell

(1977) propose a procedure using the proportion of surviving siblings. It has seldom been applied but appears vulnerable to serious reporting errors, as respondents are often unaware of the existence of siblings who died before they were born or when they were very young. More recently, it has been suggested that better-quality data would be obtained if questioning about deaths was restricted to those siblings who survive to age 15 years or survive to marry. In the form of the sisterhood method (Graham et al., 1989), this approach has been used to measure maternal mortality.

Discussion

The health information systems of many developing countries are in desperate need of rationalization (Graham, 1986; Hill and Graham, 1988; Timæus et al., 1988). In too many countries different ministries and other organizations are duplicating efforts or are engaged in conflicting activities. Often organizations and individuals are so overloaded with demands for statistical information that the quality of the data suffers. Much information that is collected is never processed and analyzed, and even less is put to good use in the formulation and administration of health and other programs. A few reliable indicators covering the whole population would be of much more use than a mass of information of doubtful accuracy and completeness. Developing countries need statistical systems that they have the financial and technical resources to sustain without permanent international assistance.

It is against this background that the measurement of adult mortality must be considered. As summarized in Table 1, the different sources of adult mortality data considered in this paper vary in cost and in the accuracy, detail, and timeliness of the information that they can supply. No single approach is fully satisfactory, and much can be learned from the comparison of data from different sources. Thus, there is a case for adopting an eclectic approach to trying to improve our knowledge of adult mortality in the developing world. While the following paragraphs make some general suggestions, assessments of the most appropriate measures and methods should be carried out at a country level in terms of the existing development of the health and statistical infrastructure and the resources potentially available to the health sector.

Except for the ideal of complete and accurate vital registration, all the methods reviewed in this paper are of limited value for the investigation of mortality in old age, of short-term trends in adult mortality, of the response to crises affecting mortality, or of the impact of interventions designed to reduce mortality. They also represent rather crude tools for the study of mortality differentials. In general, however, rather broad indicators of the level and trend in adult mortality and of differentials between regions and social groups will serve for population forecasting and the allocation of resources. Estimates that may be slightly outdated or of moderate accuracy are sufficient for most purposes, as only large differences are likely to be of substantive significance (United Nations, 1984). Most developing countries could reasonably aspire to collect adult mortality data that are useful for such purposes. These data would also complement and provide a background to more focused studies intended to establish etiology or to quantify the health impact of specific behaviors or services (Brass, 1980). Collecting representative data on causes of death is far more difficult but is potentially of great value. The development of improved ways of ascertaining causes of death from lay reports in a range of types of inquiry is an important priority for methodological research (see Table 1).

Vital registration systems represent the traditional source of mortality data in the developed world, but the basic rationale for the registration of births and deaths remains administrative rather than statistical. In countries where the majority of deaths are registered, administrative and financial reforms are needed rather than improvements in methods of measurement. On the other hand, where notification of deaths is very incomplete and medical certification of deaths is uncommon, one can question the high

priority accorded to producing mortality statistics from these records. There is no inherent reason why continuing attempts to improve the coverage of the civil registration system for administrative purposes should entail attempts to use it as a source of demographic estimates. In countries, or parts of countries, where only a minority of deaths are certified, this seems a waste of resources.

There are, nevertheless, major advantages to collecting mortality data on a routine and continuous basis rather than in ad hoc surveys. It is debatable, however, whether comprehensive national data are needed for most statistical purposes. Some form of sample inquiry may yield adequate district-level and national measures. To justify the expenditure, however, such a system would probably need to be combined with the collection of other statistical data. Disciplinary and organizational divisions have meant that the registration system has often developed in isolation from the routine production of statistics by the health services. A more integrated approach that focuses on a few key measures should be considered.

Whether or not the development of routine systems for providing adult mortality data is practical, most developing countries will continue to need to collect information in censuses and household surveys. Although suffering from its own limitations, such information can contribute to assessments of the accuracy and completeness of data derived from routine sources. Surveys can also collect a wider range of information on the characteristics of the population that can be used to study mortality differentials. Both the WFS and DHS programs, which have tended to become the models for other surveys collecting detailed data for the study of mortality, have had a major interest in contraception and family planning. Unfortunately, this has led to the concentration of effort on gathering data about children, to the neglect of those concerning adults.

Questions about recent deaths in the household seldom yield useful information in censuses and should only be contemplated if a major effort is to be put into collecting high-quality data. On the other hand, this approach is unable to measure mortality with any precision in surveys of a few thousand households. The success of fertility surveys, such as the WFS and DHS, at measuring both the levels and proximate determinants of fertility and child mortality has largely removed the justification for conducting large, single-round surveys of the kind that were common in the 1970s, in order to estimate vital rates (Timæus, 1987).

The main advantages of indirect methods for the measurement of adult mortality are that they are based on straightforward questions about respondents' lifetime experience that can be posed in single-round inquiries and that they are efficient in terms of sample size. Questions about orphanhood, in particular, offer the possibility of obtaining useful information fairly cheaply. Reporting errors are a problem in some countries, particularly those in East Africa. Moreover, indirect methods provide rather broad and nonspecific measures of mortality. Nevertheless, experience gained with this approach during the 1980s suggests that the widespread skepticism that developed early in the decade was overly pessimistic. Further development of these methods is leading to techniques for obtaining more reliable and more specific measures of adult mortality. Adding questions about whether parents died before or after respondents first married to those about the survival of parents seems a promising avenue for advance.

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draws on an earlier report commissioned by the Population and Human Resources Department of the World Bank (Timæus and Graham, 1989) and the author gratefully acknowledges Wendy Graham's contribution to it. Inspiration for the summary table came from Hill (1991).

NOTES

[1] I have in mind a more stringent criterion of completeness of registration than the nominal one wherein the country informs the United Nations that 90 percent of all deaths are reported.

[2] They arrive at this estimate by arguing that one can aim to restrict non-sampling error to about 10 percent and should therefore restrict sampling errors to about the same level. They then calculate the sample size needed to achieve this precision for the crude death rate for ages five and above. This, they suggest, should be indicative of the sampling error for a model life table fitted to the five-year rates for this age range.

[3] After examining the data for each region of the country separately and comparing the results with those from indirect methods of estimation, Timæus (1984) concludes that reporting was complete in most of the country but deficient in the Mountains region.

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