V. MORTALITY IN SUB-SAHARAN AFRICA

*Ian M. Timæus**

A. INTRODUCTION

Mortality in sub-Saharan Africa is higher than in the other major regions of the world. Moreover, among infants and children at least, the rate of decline in mortality has been slower in sub-Saharan Africa than elsewhere (Hill and Pebley, 1989; United Nations, 1988). The level of mortality varies markedly across Africa, both between countries and between regions and social groups within particular countries. Until the 1960s, most of the highest mortality countries lay in the far west of the continent and a gradient existed in the level of mortality across Africa, with the lowest mortality countries being found to the south and east (Hill, 1991a; Timæus, 1991a). During the 1970s and early 1980s, however, this pattern became less clear: mortality fell rapidly in some Western African countries but stagnated at a rather high level in parts of Eastern and Southern Africa (Hill, 1993; Timæus, 1993).

Several developments suggest that mortality decline in Africa may have slowed further or been reversed in recent years. The first reason for pessimism is the economic difficulties that have afflicted most African countries since the 1970s. Output per head in the region as a whole fell between the end of the 1970s and mid-1990s and only a handful of countries, notably Botswana, experienced significant growth. Economic difficulties have been shown to have had a short-run adverse impact on infant and child mortality in several African countries, notably Ghana and Nigeria (Working Group on Demographic Effects of Economic and Social Reversals, 1993). Moreover, economic decline and adjustment programmes designed to reduce inflation and budgetary deficits have had a longer-term adverse impact on social development programmes (Barbieri and Vallin, 1996). In particular, while the proportions of girls attending both primary and secondary school have continued to rise in most African countries, they grew more slowly in the 1980s than the 1970s. Thus, growth in the proportion of mothers who have attended school has now begun to slacken in much of Africa, suggesting that the pace of decline in childhood mortality may also slow. The health sector has been affected even more severely. Government expenditure on health services has stagnated since the beginning of the 1980s in many African countries, leading to declines in the resources per head of the population devoted to health.

Another reason for pessimism about mortality trends in parts of Africa is civil warfare and other conflicts. A long history of military conflict has left countries and areas such as Eritrea, Ethiopia, Mozambique, Somalia and southern Sudan among the poorest parts of Africa. The murder of approaching one million Rwandans in 1994 was of major demographic significance. Other recent conflicts, such as those in Liberia and Sierra Leone, have involved fewer violent deaths. Warfare in Africa, however, as elsewhere, often brings in its wake substantial mortality from famine and disease.

Despite these problems, some reasons exist for a degree of optimism about the evolution of mortality in Africa. In at least some countries, economic reform has met with a degree of success. Ghana was the first African country to experience a major economic crisis. Equally, standards of living began to rise again in Ghana as early as the mid-1980s. During the last couple of years, average output per head has probably grown in sub-Saharan Africa as a whole. Most notably, Uganda's economy has grown rapidly since

*Centre for Population Studies, London School of Hygiene and Tropical Medicine, United Kingdom.

civil order was re-established in most of the country at the end of the 1980s. Favourable political developments have also occurred, notably in Southern Africa. The establishment of a democratic political system in South Africa has helped to stabilise this area of Africa as a whole. Conflict has ended in Mozambique and, to a large extent, Angola. Other wars, such as that in Ethiopia, have also ended. In addition, despite financial constraints, some important advances in health care have been achieved during the past 20 years. The most notable of these is the rapid spread of immunisation against the common childhood diseases. While the record of certain countries (including some of the most populous) is lamentable, in much of Africa the majority of children now receive all the EPI vaccines.

The influence on mortality of recent changes in infectious disease ecology in sub-Saharan Africa is likely to be wholly negative. One worrying development is the spread of chloroquine-resistant malaria across the continent between the early 1980s and early 1990s. Without doubt, malaria is a major killer in Africa. Treatment and self-treatment of fevers with chloroquine have been very common and are thought to have had a substantial impact on child mortality. By implication, chloroquine-resistant malaria must now be exerting a significant upward influence on mortality (Bradley, 1991; Ewbank and Gribble, 1993; Nájera and others, 1993). However, too little is known about the scale of mortality from malaria in Africa, about how many deaths are averted by treatment of fevers with antimalarials and about the epidemiology of drug-resistant malaria to attempt to quantify this impact.

A development in relation to which it is even harder to find any grounds for optimism is the epidemic spread of HIV in Africa. Reconstructing the growth of the HIV epidemic in much of Africa is extremely difficult. Nearly all the available data on the prevalence of HIV infection are based on the testing of women attending antenatal clinics. Such women are unlikely to be representative of all women and provide no information on the severity of the epidemic among men. In addition, most of these seroprevalence data refer to urban populations. To obtain national estimates usually involves the assumptions that data from a few rural surveillance sites are representative of other rural areas and that the ratio of rural-to-urban seroprevalence at one date can be extrapolated to other years (Stanecki and Way, 1997).

Such calculations suggest that more than 10 per cent of the adult population were infected with HIV by the early 1990s across a belt of Africa extending from Botswana to Kenya (Bongaarts, 1996; Stanecki and Way, 1997). Côte d'Ivoire and the Central African Republic are also thought to be affected severely but the infection remains relatively rare in much of Western Africa. By contrast, the prevalence of HIV infection has risen very rapidly in Zimbabwe and much of Southern Africa since the end of the 1980s.

AIDS in Africa is primarily a heterosexually transmitted disease. Its impact extends to both men and women but is concentrated among adults in the age range that typically forms new sexual partnerships. Death rates in early adulthood and early middle age are expected to rise several fold. While appreciable increases in mortality in the first few years of life also occur due to vertical transmission (Nicoll and others, 1994), the mortality of older children and older adults will rise by less. Thus, the HIV epidemic is likely to have a dramatic effect on the age pattern of mortality in Africa as well as on its overall level.

B. Availability of data

No mainland country in sub-Saharan Africa has an adequate vital registration system. South Africa is the only country where sufficient deaths are registered routinely to attempt to produce national estimates of mortality from this source. Even in this country, coverage is far from complete. Thus, apart from research studies of localised populations, the main sources of information on mortality in Africa are national censuses and household surveys. Table 6 provides an inventory of the data on mortality collected in censuses and Demographic and Health Survey (DHS) in-

TABLE 6. MORTALITY DATA COLLECTED IN SUB-SAHARAN AFRICAN POPULATION CENSUSES, 1985-1994 AND DHS SURVEYS

	Census data					*DHS data*[a]	
Country	*Date*	*CEB/CS*	*Mother alive?*	*Father alive?*	*Recent deaths*	*Survey date(s)*	*Data on adults*[b]
Eastern Africa							
Burundi	1990	✓[c]	✓	✓	(✓)	1987	O[d]
Djibouti	no census						
Eritrea	no census					1995	(S)
Ethiopia	1994	✓[c]					
Kenya	1989	✓	✓	✓		1988, 1993, 1998	-, -, (S)
Madagascar	1993	(✓)	(✓)	(✓)	(✓)	1992, 1997	-, -
Malawi	1987	✓			(✓)	1992	S
Mozambique	no census					1996-1997	(S)
Rwanda	1991	(✓)	(✓)	(✓)		1992	-
Somalia	1987	(✓)					
Uganda	1991	✓	✓	✓		1988-1989, 1995	-, S
United Republic of Tanzania	1988	✓[c]	✓		✓	1991-1992, 1996	-, S
Zambia	1990	✓			(✓)	1992, 1996-1997	-, S
Zimbabwe	1992	✓	(✓)	(✓)	✓	1988-1989, 1994	-, S
Middle Africa							
Angola	no census						
Cameroon	1987	✓[c]	✓	✓	✓	1991, 1997	-, (S)
Central African Republic	1988	✓[c]			✓	1994-1995	S
Chad	1993	(✓)			(✓)	1997	(S)
Congo[e]	1994					1997	-
Congo, D. R.	no census						
Equatorial Guinea[e]	1994						
Gabon[e]	1993						
Northern Africa							
Sudan (Northern)	1993	✓[c]	✓		✓	1989-1990	S[c]
Southern Africa							
Botswana	1991	✓			✓	1988	-
Lesotho	1986	✓	✓	✓	✓		
Namibia	1991	✓[c]				1992	S
South Africa[e]	1985, 1991					1997-1998	(S)
Swaziland	1986	✓[c]	✓	✓			
Western Africa							
Bénin	1992				(✓)	1996	S
Burkina Faso	1985	✓			(✓)	1993, 1998	-, -
Côte d'Ivoire	1988	✓				1994, 1997	-, -
The Gambia	1993	(✓)	(✓)	(✓)			
Ghana	no census					1988, 1993	O, -
Guinea	no census					1992	-
Guinea-Bissau	1991	(✓)					
Liberia	no census					1986	-
Mali	1987	✓	✓	✓		1987, 1995-1996	-, S
Mauritania	1988	✓[c]					
Niger	1988	✓[c]	✓	✓		1992, 1998	S, -
Nigeria	1991	(✓)			(✓)	1990	
Senegal	1988	✓[c]	✓	✓	✓	1986, 1992-1993	O, S
Sierra Leone	1985	✓	✓				
Togo	1993	(✓)	(✓)	(✓)	(✓)	1988	

Source: See note 1.

NOTES: O Data collected from ever-married adult women about orphanhood before and since first marriage.
S Sibling histories collected.
( ) Data not known to have been published by 1997 (see note 1).

[a] All these DHS surveys collected birth history data that can be used to estimate infant and child mortality.

[b] Except in Guinea, the household schedule for all DHS surveys in sub-Saharan Africa since 1991 has asked about the orphanhood of children aged less than 15.

[c] Information not obtained for this study.

[d] More detailed questions about adult mortality were also asked in this survey (Makinson, 1993).

[e] Census schedule not seen.

quiries since 1985.[1] In addition, a few African countries such as South Africa have collected data on mortality in nationally representative sample surveys conducted outside the DHS programme.

Most of the information available on child mortality comes from one of two sources (Hill, 1991b). The first is questions put to adult women about how many children they have ever borne and how many of these children remain alive. These questions have been asked in numerous censuses and other inquiries in Africa. Methods were developed over 30 years ago for converting such data into life table indices of mortality (United Nations, 1983). Data on different age groups can provide a time series of estimates of overall child mortality. The approach cannot be used, however, to partition precisely the under-five mortality rate into infant mortality and mortality between ages one and four.

The second main source of information on child mortality is the detailed birth histories collected retrospectively from women in fertility surveys. In a fertility survey, women are asked about the date of birth of each of their children and the ages at death of those of their children who have died. From these data, one can calculate age and period-specific mortality directly (Somoza, 1980) and can investigate mortality differentials according to a wide range of characteristics of the mother and household. Between 1977 and 1982, such surveys were conducted in ten African countries as part of the World Fertility Survey (WFS). Since 1986, 32 more national fertility surveys have been completed in sub-Saharan Africa under the auspices of the DHS programme and 12 more are underway.

Table 6 reveals that almost every African country has collected data on child mortality since 1985 in either the population census or a DHS survey. Not all of these data are yet published. Nevertheless, the only major African country in which no prospect exists currently of obtaining estimates of mortality under age five is the Democratic Republic of Congo (ex-Zaire), together perhaps with some of the Middle African countries where it is unclear what information was collected in the 1990-round census.

Unfortunately, both forms of retrospective data on child mortality are vulnerable to bias resulting from reporting errors. Failure to mention dead children can be a problem and direct measures based on birth histories only represent an improvement over the indirect approach if reasonably accurate data can be collected on ages and dates. In countries affected by AIDS, a major selection bias also afflicts data on child survival. Infected women transmit the HIV virus to 25 to 35 per cent of their children. Both these children and their mothers suffer extremely high mortality. Thus, no report is made on many of the children with the highest mortality.

In a major review of levels and trends in child mortality, Hill (1991a; 1992) presents national estimates of under-five mortality in sub-Saharan Africa for the 1920s to 1970s based on census and WFS and other survey data. In a later paper (Hill, 1993), she presents updated estimates for 16 African countries that had published the results of their 1980 round census or Phase 1 DHS survey by 1992. This extends the temporal scope of her analysis up to the mid-1980s.

During the last five years, the results have been published of some 19 African censuses conducted during the period 1986 to 1992, together with the results of Phase 2 and 3 DHS surveys for 14 new countries, and for six of the countries that also participated in Phase 1 of the programme (see table 6). These data can be used to update Hill's (1991a; 1993) earlier work and track trends in child mortality in a number of countries into the early-1990s.

Collecting data on adult mortality retrospectively in censuses and surveys has proved more difficult than collecting data on child mortality (Timæus, 1991d). Several questions have proved useful but none of them is reliable. Moreover, retrospective data are of limited value for the study of socio-economic differentials in adult mortality as information is seldom collected on the characteristics of dead individuals.

Questions about recent deaths in the household have been asked in many African censuses and some large surveys. Most fertility surveys, however, visit too few households to attempt to measure mortality by this approach. On occasion, these questions have worked well. In other inquiries, only a small fraction of the expected number of deaths has been reported. A range of methods has been developed for evaluating the completeness of data on recent adult deaths (Preston, 1984). In favourable circumstances these methods allow one to rehabilitate incomplete data. In Africa, however, they have often yielded inconclusive findings.

The second main source of information about adult mortality in sub-Saharan Africa is questions in surveys and censuses about orphanhood. As with data on children ever-born and surviving, methods exist for estimating time series of life table indices from information by age on the proportions of respondents with living mothers and fathers (Timæus, 1992). Unfortunately, individuals who are orphaned at a young age are often not reported as such in parts of Africa. A large downward bias can result in mortality estimates made from orphanhood data for children. Mortality estimates based on data supplied by adults are affected less. They usually reflect conditions a decade or more before their collection. However, more up-to-date estimates of mortality can be obtained if data are available on whether parents died before or after the respondent first married (Timæus, 1991b). This information was collected in several Phase 1 DHS surveys.

Like reports by mothers on the deaths of their children, reports by children on their parents' survival, particularly that of their mothers, are subject to bias as a result of vertical transmission of HIV. Only a minority of children of infected mothers become infected themselves but, because deaths of their mothers account for a substantial proportion of all orphanhood, the bias in the mortality estimates is again large. Nevertheless, if one can estimate the proportion of the mothers who were infected at the time that their children were born, one can adjust data on orphanhood to correct for this bias (Timæus and Nunn, 1997).

A third source of information on the adult mortality in Africa has become available recently. It is the sibling histories collected as part of the maternal mortality module of some Phase 2 and Phase 3 DHS surveys (Rutenberg and Sullivan, 1991). These surveys asked women about the date of birth of each of their brothers and sisters and the ages at death of any of their siblings who have died. Thus, like birth histories, sibling histories provide the information needed to calculate age and period-specific mortality directly. Most respondents have several siblings and one can analyse data on a reference period of several years. Thus, these histories can provide useful estimates of adult mortality in surveys with samples of the size interviewed in DHS inquiries.

Little experience in the analysis of sibling history data has been accumulated. It remains unclear how complete and accurate are the reporting of deaths. An initial investigation of these issues suggests that, while respondents can report the ages and ages at death of their siblings, reporting of when siblings died is both less complete and subject to rounding errors (Stanton and others, 1997). Throughout the world, the sibling histories tend to yield lower adult mortality estimates for the period 7 to 13 years ago than for 0 to 6 years before the data were collected. This is implausible and suggests that such data are of little value for study of medium-term trends in mortality. Moreover, on the basis of comparison of the more recent estimates with other estimates 'of good quality', the report suggests that even the recent sibling history estimates may underestimate adult mortality, especially for women. For Africa, however, the only comparison is with a set of estimates of mortality that may be too high: they were made using the 1988 Census data for Senegal (Pison and others, 1995) and these can be interpreted in several ways.

In contrast to the situation with regard to data on child mortality, in at least a dozen African countries no data at all have been col-

lected that can be used to estimate adult mortality at any point in the 1980s or 1990s (see table 6). This group includes the most populous countries in the region: Nigeria, Ethiopia, and the Democratic Republic of Congo. In much of the rest of the continent, moreover, the data on adult mortality are more limited and less reliable than those on children. Timæus (1991a) presents estimates of life expectancy at age 15 by sex in 20 sub-Saharan African countries for some point in the period 1965 to 1981. This analysis was subsequently updated to take into account the census and DHS survey results published by 1992 (Timæus, 1993). The later paper presents estimates of the probability of surviving from age 15 to 60 at some point between 1970 and 1986 for 24 countries. It also examines trends in adult women's mortality in a subset of 15 countries.

Nearly all the African censuses published since Timæus (1993) produced his review paper have collected information on either recent deaths or orphanhood (see table 6). However, the most up-to-date of these data were collected in 1993. The DHS sibling history data for 11 sub-Saharan African countries were analysed in time for them to be presented here (Timæus, 1998 in press). Some of these data were collected back in 1992 but some as recently as the end of 1996. In addition, adult mortality can be estimated from information on orphanhood of children aged less than 15 years collected on the household schedule used in most DHS surveys conducted in Africa during the 1990s (Timæus, 1998 in press).

The underdevelopment of vital statistics and low coverage of the health services in sub-Saharan Africa combine to obstruct the investigation of causes of death. Incomplete data are available for South Africa. In addition, something has been learnt about the diseases that kill infants and children from prospective population-based research studies conducting some form of verbal autopsy (Feachem and Jamison, 1991; Garenne and Fontaine, 1990). Unfortunately, both the accuracy and detail of verbal autopsy data remain limited. Too little such information exists to develop even a crude map of how patterns of cause of death vary across Africa. In addition, only very few prospective studies have been conducted on a large enough scale to yield useful information on causes of death in adulthood (Chandramohan and others, 1994; Kitange and others, 1996).

As part of their study of the global burden of disease, Murray and Lopez (1996; 1997) synthesised the fragmentary data available on causes of death in sub-Saharan Africa with models based on other high-mortality populations to produce a comprehensive series of cause-of-death estimates for the region. As in any such exercise in systematic guesswork, some of their results will be misleading. Nevertheless, the estimation process was designed to ensure that the results remain epidemiologically plausible and consistent with what is known of the demography of Africa. The main findings refer to 1990, when AIDS deaths were far less common than today. In other ways, however, they are the best indication available of the main public health problems in sub-Saharan Africa. No attempt is made to improve on those estimates here.

C. Infant and child mortality

Table 7 compiles the direct estimates of the under-five mortality rate, that is, the probability of dying before age five, obtained in 32 DHS surveys conducted in sub-Saharan Africa between the mid-1980s and mid-1990s. Estimates are presented for the three quinquennia preceding each survey. Figure 23 presents these data graphically and compares them with earlier estimates produced by Hill (1993). Figure 23 also includes indirect estimates of under-five mortality for several countries based on children ever-born and surviving data collected in the 1990-round census (see table 6). No attempt has been made to reconcile the various sets of measures and produce best estimates of child mortality.

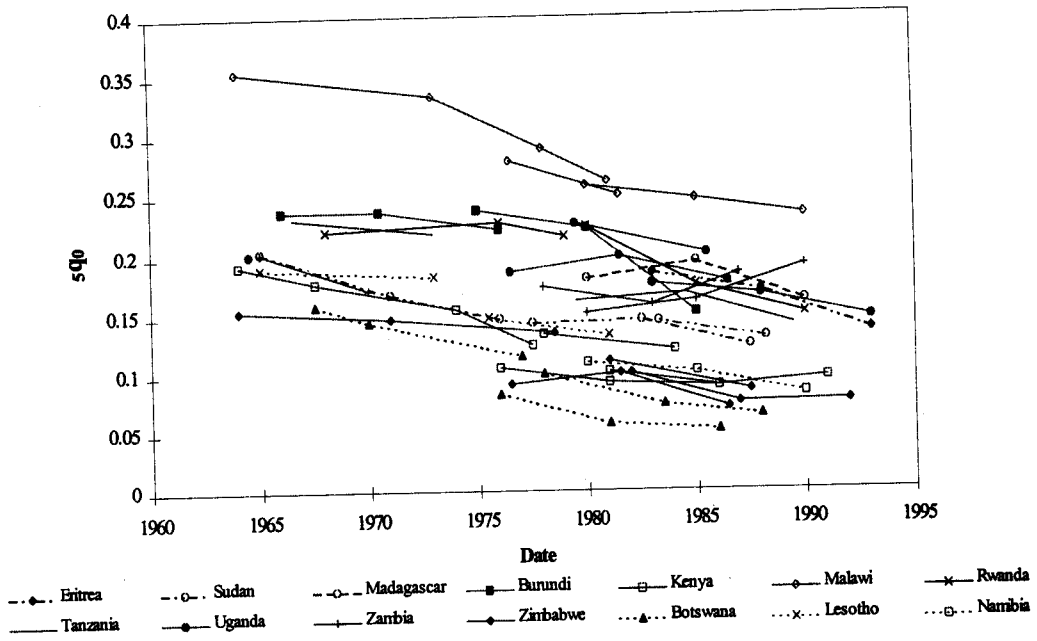
In general, the data collected by DHS surveys indicate levels and trends in mortality that are broadly consistent with earlier estimates. In addition, in most of the countries that have conducted two DHS surveys the estimates from them agree quite well. However, the majority of the triplets of estimates

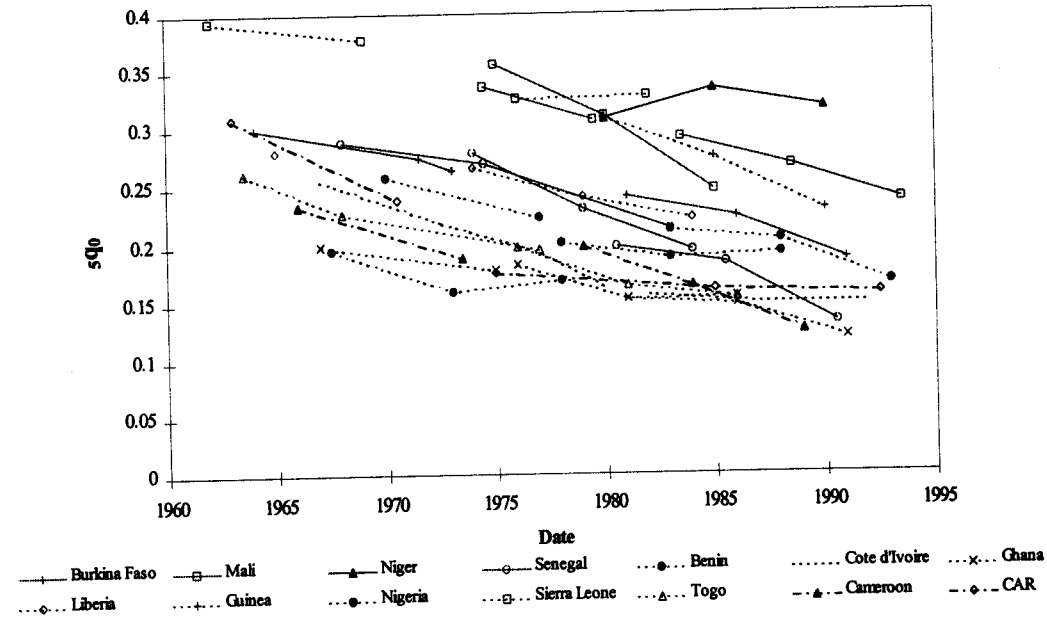
TABLE 7. UNDER-FIVE MORTALITY RATE ($_5q_0$), DEMOGRAPHIC AND HEALTH SURVEYS, BIRTH HISTORIES, COUNTRIES OF SUB-SAHARAN AFRICA, VARIOUS DATES

Country	Date of fieldwork	Years before survey			Reduction in mortality (%)	
		10-14	5-9	0-4	10-14 to 5-9 years	5-9 to 0-4 years
Eastern Africa						
Burundi	1987	0.233	0.224	0.152	4	32
Eritrea	1995	0.185	0.170	0.136	8	20
Kenya	1988	0.106	0.093	0.090	12	3
	1993	0.102	0.090	0.096	12	-7
Madagascar	1992	0.181	0.195	0.162	-8	17
Malawi	1992	0.259	0.247	0.234	5	5
Rwanda	1992	0.225	0.176	0.151	22	14
Uganda	1988-1989	0.187	0.200	0.177	-3	16
	1995	0.176	0.167	0.147	7	11
U. R. of Tanzania	1991-1992	0.163	0.168	0.141	-7	12
	1996	0.166	0.154	0.137	5	12
Zambia	1992	0.152	0.162	0.191	-7	-18
	1996-1997	0.174	0.187	0.197	-7	-5
Zimbabwe	1988-1998	0.092	0.101	0.071	-10	30
	1994	0.101	0.075	0.077	26	-3
Middle Africa						
Cameroon	1991	0.198	0.165	0.125	17	24
Central African Republic	1994-1995	← 0.161 →		0.157		2
Northern Africa						
Sudan (Northern)	1989-1990	0.144	0.146	0.124	-1	15
Southern Africa						
Botswana	1988	0.083	0.058	0.053	30	9
Namibia	1992	0.110	0.102	0.084	7	18
Western Africa						
Bénin	1996	0.212	0.203	0.167	4	18
Burkina Faso	1993	0.242	0.224	0.187	7	17
Côte d'Ivoire	1994	0.157	0.150	0.150	4	0
Ghana	1988	0.183	0.153	0.155	16	-1
	1993	0.153	0.148	0.119	3	20
Guinea	1992	0.310	0.275	0.229	11	17
Liberia	1986	0.266	0.241	0.223	9	7
Mali	1987	0.356	0.310	0.247	13	20
	1995-1996	0.292	0.268	0.238	8	11
Niger	1992	0.308	0.334	0.318	-8	5
Nigeria	1990	0.201	0.189	0.193	6	-2
Senegal	1986	0.280	0.231	0.195	18	16
	1992-1993	0.198	0.185	0.132	7	29
Togo	1988	0.198	0.165	0.155	17	6

Sources: Bicego, G. and O. B. Ahmad, *Infant and Child Mortality,* DHS Comparative Studies, 20 (Calverton, Maryland, Macro International, 1996); Sullivan, J. M., S. O. Rutstein and G. T. Bicego, *Infant and Child Mortality,* DHS Comparative Studies, 15 (Calverton, Maryland, Macro International, 1994); Demographic and Health Surveys country reports.

Figure 23. Trends in under-five mortality, Eastern and Southern Africa and Middle and Western Africa





Sources: Table 7; Althea L. Hill, "Trends in childhood mortality", in *Demographic Change in Sub-Saharan Africa*, Karen A. Foote, Kenneth H. Hill and Linda G. Martin, eds. (Washington, D. C., Population Dynamics of Sub-Saharan Africa, National Academy Press, 1993); national censuses.

obtained from DHS surveys follow a convex curve, indicating an accelerating decline in mortality. In instances where the earliest of the three points can be checked against an estimate from an earlier inquiry for about the same time, it tends to be lower. Thus, it seems likely that in Africa many of the DHS estimates for 10-14 years before the data were collected are biased downward by omission of deaths.

In a few countries more serious inconsistencies exist between the estimates of under-five mortality from different sources. In most such countries, the DHS surveys indicate lower mortality than other data. In Botswana, for example, the three estimates based on the 1988 DHS survey are substantially lower than the slightly more up-to-date triplet of estimates based on the 1991 Census (see figure 23). One explanation could be that the DHS survey interviewed an unrepresentative sample of women with children who have low mortality (Blanc and Rutstein, 1994; Thomas and Muvandi, 1994a; Thomas and Muvandi, 1994b). Similar discrepancies exist in Uganda, where both the DHS surveys yield lower mortality estimates than the 1991 Census, and Kenya, where about 30 per cent of all but the most recent child deaths were not reported in the 1988 DHS survey (Brass and Jolly, 1993).

The under-five mortality rate reported in 1990 for these 26 sub-Saharan African countries ranges from nearly one third in Niger down to about 70 per 1,000 in Botswana and Zimbabwe. The level of mortality in most countries, however, lies in a somewhat more restricted range. Namibia and Kenya are probably the only mainland sub-Saharan African countries other than Botswana and Zimbabwe in which under 10 per cent of children die in the first five years of life. Extrapolating forward from the earlier census-based estimates, it seems likely that in 1990 the under-five mortality rate remained above 30 per cent in Sierra Leone as well as Niger (see figure 23). Though no nationally representative data exist, mortality may also have been this high in Angola, Mozambique, and southern Sudan. In contrast to Niger, however, mortality has fallen substantially since the 1960s in the western Sahel. Thus, in all sub-Saharan African countries except those just mentioned, the under-five mortality rate in 1990 was probably somewhere in the range 125 to 250 per 1000.

Only limited evidence exists of any regional patterning in infant and child mortality at the end of the 1980s. Mortality in Southern Africa is relatively low. Many of the countries in the eastern half of Africa had an under-five mortality rate of between 140 and 190 per 1000. In Western and Middle Africa, however, the situation was more varied. Even after making considerable progress during the 1970s and 1980s, many Sahelian countries still had comparatively high mortality. In contrast, sustained and rapid mortality decline during the 1970s and 1980s left Senegal with low infant and child mortality for the region. By 1990, it ranked alongside Ghana and Cameroon with an under-five mortality rate of around 125 per 1,000.

The overall impression that one gains from figure 23 is that under-five mortality continued to decline in Africa during the 1980s. After stagnating in the early 1980s, under-five mortality in Ghana began to fall again in the second half of the decade. Moreover, mortality may have fallen particularly rapidly in some of the higher mortality countries. Nevertheless, quite widespread evidence exists of a slowdown in the rate of mortality decline in recent years. First, improvements in child survival seem to have tapered off at some point during the 1980s in a number of the lower mortality countries including Botswana, Central African Republic, Côte d'Ivoire, Kenya, Togo, and Zimbabwe. The rate of decline in mortality was also slow in several high mortality countries, namely Malawi, Liberia, and Niger. In Nigeria, no improvement occurred in under-five mortality between the late-1970s and the late-1980s. The most worrying development, however, is in Zambia, where both DHS and census data suggest that infant and child mortality rose substantially during the 1980s.

Can these adverse trends in the under-five mortality rate be accounted for by the HIV epidemic or are other factors also important? One can attempt to answer this question because estimation of the impact of the HIV epi-

demic on infant and child mortality is simpler than estimation of its impact on adult mortality. First, data on the prevalence of HIV infection collected at antenatal clinics measure directly the proportion of births at risk of infection through vertical transmission of the virus from their mothers. Second, most African infants who acquire HIV infection from their mothers will die in the first five years of their life. Thus, the impact on mortality of a rise in the prevalence of HIV infection is lagged by only a couple of years.

If about one-third of infected women giving birth transmit the HIV virus to their child, one would expect each 1 per cent rise in seroprevalence among women attending antenatal clinics to raise the under-five mortality rate by about 3 per 1,000. More sophisticated modelling of the impact of the HIV epidemic on infant and child mortality indicates that this is a robust approximation (Nicoll and others, 1994). Thus, in countries where the seroprevalence rate among pregnant women is 6.5 per cent, the under-five mortality rate could rise by about 20 per 1,000. If the seroprevalence rate rises to 20 per cent, an increase in under-five mortality of nearly 60 per 1,000 is likely to follow.

Such calculations suggest that the HIV epidemic may be responsible for the slowdown or reversal of the decline in infant and child mortality in some African countries. In Malawi, Rwanda, Uganda, Zambia and Zimbabwe, HIV may have become sufficiently prevalent by the mid-1980s to account for rises in the under-five mortality rate of 15 to 20 per 1,000 by the late 1980s. By the early 1990s, paediatric AIDS mortality could have been 25 to 30 per 1000 births. HIV infection could also have driven up the most recent mortality estimates available for Burkina Faso, Central African Republic, Côte d'Ivoire, and Kenya by 10 to 20 per 1,000. In all these countries, a proportion of these additional deaths will not be reflected in the birth history data because the children's mothers have also died of HIV-related disease.

Thus, the impact of HIV could account for the adverse trends in under-five mortality in Kenya and Zimbabwe during the early 1990s revealed by the most recent DHS surveys. Moreover, the HIV epidemic might also account for the slow decline in early-age mortality in Malawi in the 1980s and the large rise in mortality in Zambia. In Zambia at least, however, it seems likely that the overall under-five mortality rate rose by so much only because other factors were not exerting a strong downward influence on infant and child mortality. It seems unlikely that infant and child mortality would have improved much in Zambia during the 1980s and early 1990s even without the HIV epidemic.

Elsewhere, it is unlikely that the HIV epidemic is responsible and the explanation for the adverse trend in the under-five mortality rate must be sought among other causes. For example, AIDS cannot explain the stagnation or rise in early-age mortality in Nigeria since the 1970s. Similarly, it is unlikely that the slowdown in the early 1980s of mortality decline in Botswana, Côte d'Ivoire and the Central African Republic is related to HIV. However, the epidemic might be implicated in the continuing lack of improvement in child survival in these countries during the early 1990s.

It is worth emphasising that infant and child mortality fell in Uganda in the early 1990s despite the severity of the HIV epidemic in this country. Presumably developments acting to improve child health have outweighed the impact on mortality of the spread of HIV. Thus, these estimates suggest that the HIV epidemic exerts only an important, not a decisive, influence on trends in infant and child mortality.

D. ADULT MORTALITY

Table 8 presents estimates of adult survivorship by sex for 24 sub-Saharan African countries. The estimates are the most up-to-date available and refer to a range of dates between 1981 and 1992. In the other 19 mainland sub-Saharan countries, data on adult mortality are non-existent, could not be obtained for this study, or reflect the death rates of the 1970s. A quarter of the estimates refers to the first half of the 1980s, half to the later 1980s, and a quarter to the period 1990 to 1993. The index

TABLE 8. SURVIVORSHIP FROM AGE 15 TO AGE 60 ($_{45}P_{15}$) BY SEX, COUNTRIES IN SUB-SAHARAN AFRICA, 1980S AND 1990S

Country	*Date*	*Women*	*Men*	*Both sexes*	*Source*
Eastern Africa					
Burundi	1981	0.699	0.622	0.660	1987 DHS and 1990 Census: orphanhood
Kenya	1984	0.854	0.773	0.813	1979 & 1989 Censuses: intercensal orphanhood
Madagascar	1987	0.650	0.691	0.670	1992 DHS: orphanhood
Malawi	1989	0.649	0.662	0.656	1992 DHS: sibling histories
Uganda	1992	0.560	0.530	0.545	1995 DHS: sibling histories
U. R. of Tanzania	1988	0.675	0.656	0.665	1988 Census: recent deaths and orphanhood
Zambia	1993	0.546	0.430	0.488	1996 DHS: sibling histories
Zimbabwe	1992	0.675	0.581	0.628	1992 Census: recent deaths
Middle Africa					
Cameroon	1987	0.710	0.651	0.680	1987 Census: recent deaths and orphanhood
Central African Rep.	1991	0.550	0.477	0.513	1994-5 DHS: sibling histories
Congo	1984	0.703	0.656	0.680	1984 Census: recent deaths and orphanhood
Northern Africa					
Sudan (Northern)	1992	0.797	0.773	0.785	1993 Census: recent deaths and orphanhood
Southern Africa					
Botswana	1990	0.711	0.625	0.668	1991 Census: recent deaths
Lesotho	1985	0.741	0.576	0.658	1986 Census: recent deaths and orphanhood
Namibia	1989	0.813	0.670	0.742	1992 DHS: sibling histories
South Africa	1985	0.766	0.638	0.702	1985: adjusted vital registration
Swaziland	1981	0.773	0.569	0.670	1976 & 1986 Censuses: intercensal orphanhood
Western Africa					
Bénin	1993	0.796	0.747	0.771	1996 DHS: sibling histories
Ghana	1982	0.880	0.778	0.828	1988 DHS: orphanhood since marriage
Mali	1986	0.541	0.579	0.560	1986 Census: recent deaths and orphanhood
Mauritania	1980	0.823	0.782	0.802	1980 WFS: orphanhood and recent deaths
Niger	1988	0.766	0.782	0.774	1992 DHS: sibling histories
Senegal	1989	0.841	0.766	0.803	1992-3 DHS: sibling histories
Togo	1981	0.760	0.704	0.732	1981 Census: recent deaths

Sources: Ian M. Timæus, "Adult mortality", in *Demographic Change in Sub-Saharan Africa* (Washington, D.C., National Academy Press, 1993); original analyses of published and unpublished census and survey data.

of adult mortality used is the life table probability of surviving from age 15 to age 60. Recent deaths data usually underestimate old age mortality and neither the DHS sibling histories nor orphanhood data reflect the mortality of older children or of the elderly population. Moreover, because AIDS is expected to reshape age patterns of mortality in Africa, to use existing model life tables to extrapolate from mortality in the central adult ages to a wider age range is inappropriate. Thus, no basis exists in most of these countries for the calculation of such summary indices of mortality as life expectancy at age five.

Table 8 contains estimates based on a range of sources, including various forms of orphanhood data, census questions about recent deaths in the household, and the DHS sibling histories. The orphanhood estimates were calculated using methods proposed by Timæus (1991b; 1991c; 1992). The completeness of retrospective reports of recent deaths and of the civil registration statistics for

South Africa have been evaluated using the growth balance equation (Brass, 1975) and Preston-Coale (1980) method. Recent deaths data for women in Botswana and for Cameroon, Tanzania, and Zimbabwe are treated as complete. Those for the Central African Republic, Congo, Lesotho, Mali, South Africa, and Togo have been adjusted for underreporting, while those for men in Botswana and for Senegal and Sudan are adjusted for overreporting.

All the estimates calculated from sibling history data are based on deaths in the period 0 to 6 completed years before the survey. This seven-year reference period was chosen to reduce the impact of heaping of reported times of death on five completed years before the survey (Stanton and others, 1997). The mortality rates have been smoothed against a reference standard in seven countries and by fitting a fourth-order polynomial of age to the log death rates in Uganda, Tanzania, Zambia and Zimbabwe, where the age pattern of mortality differs markedly from that in existing model life tables. The models were fitted using Poisson regression and allow for the strong skew of the exposure of siblings toward younger ages.

The number of African countries in which one can measure adult mortality has not grown since the publication of Timæus' (1993) paper. However, the amount of information available has tended to increase for those countries where one can estimate adult mortality at all. Table 8 indicates the primary source of each of the pairs of estimates. In most countries, however, this information has been supplemented with data obtained in earlier inquiries or by using other questions. In Central African Republic, Senegal, and Zimbabwe, for example, broadly consistent estimates exist based on the DHS sibling histories and on recent deaths data collected in a recent census. Similarly, in Niger and Uganda the sibling histories have been checked against orphanhood data from a recent census. Only in Bénin, Malawi, Namibia and Zambia are the estimates based on sibling history data that cannot be checked against other up-to-date sources. The estimates for Botswana, Madagascar, and Togo are also based on single questions that cannot be checked against other information. In addition, in Congo, Mali and Tanzania such crosschecks suggest that considerable uncertainty exists as to the actual level of mortality in the country. One can have somewhat more confidence in the estimates for the other 14 countries.

The results in table 8 reveal that adult mortality continues to vary markedly across sub-Saharan Africa. At the level of mortality prevailing in the Central African Republic and Zambia in the early 1990s, about half of those who live to their fifteenth birthday die before age 60. The mortality of adults in Uganda also approaches this level. So did adult mortality in Mali in the mid-1980s. Moreover, in over half the African countries where one can estimate adult mortality, the probability of dying between ages 15 and 60 exceeds 30 per cent. Few countries outside this region have such elevated adult mortality. On the other hand, by the 1980s the probability of dying between ages 15 and 60 had fallen below 20 per cent in several African countries. They include Ghana, Kenya and, by the end of the decade, Senegal. This represents a moderate level of mortality by world standards.

No clear regional patterning exists in these estimates of adult mortality. Assessment of this is complicated because the estimates for Western Africa are, on average, slightly more out of date than those for other parts of Africa. Nevertheless, it is clear that any tendency for Southern and Eastern African countries to have relatively low adult mortality had disappeared completely by the 1980s. In contrast, many of the countries with the lowest adult mortality are now to be found in Western Africa.

In most of Africa, adult men have higher mortality than adult women. The excess in men's mortality is particularly large in Southern Africa and the updated estimates in table 8 reveal that this pattern persisted into the second half of the 1980s. Nevertheless, comparison of the estimates for Botswana and Lesotho with those for a decade earlier (Timæus, 1993) suggests that men's mortality is improving slowly in these countries but that the survival of women is not. Thus, sex differen-

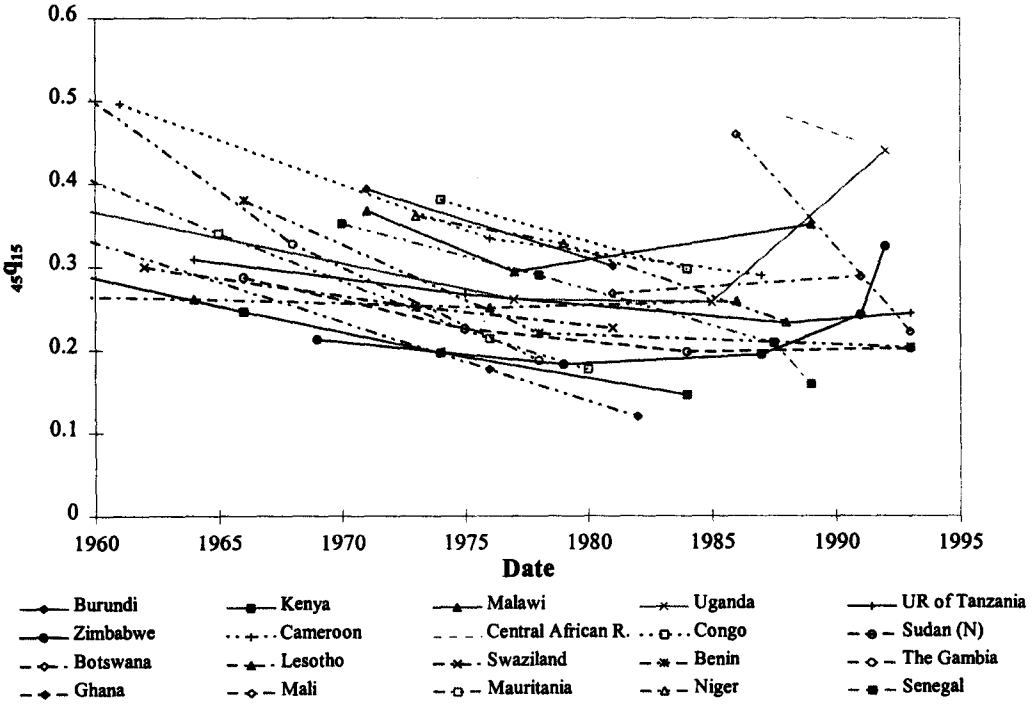
tials in mortality in Southern Africa probably narrowed somewhat between the 1970s and 1980s.

The DHS sibling histories suggest that adult women's mortality in Malawi is higher than that of adult men. A series of inquiries since the early 1970s, measuring adult mortality by a wide range of methods, have all found the same thing (Timæus, 1993). Thus, Malawi almost certainly is anomalous in this respect, although the reasons for this are unknown. The sibling history data also suggest that women have higher mortality than men in Niger. The same pattern is reported in the neighbouring country of Mali. While this is suggestive, these reversed differentials may reflect no more than errors in the data.

Figure 24 examines trends in women's survivorship from age 15 to 60 for the 18 countries in table 8 in which survivorship can be estimated at more than one point in time. The figure also presents estimates for the 1960s and 1970s for The Gambia and Mauritania. During the 1970s, adult women's mortality fell fairly rapidly in many African countries, especially those in Western Africa. In contrast, progress was slow in Southern Africa and in some eastern African countries, such as Tanzania and Zimbabwe, but not others, such as Burundi and Kenya.

Adult women's mortality can be tracked into the late 1980s or the early 1990s in 13 countries. In Central African Republic, however, the estimates convey little more than that mortality remains high while, in Mali, the apparent drop in mortality is implausibly rapid, suggesting that at least one of the sets of estimates is biased severely. The other results suggest that the pace of mortality decline has remained rapid in Cameroon, Niger, and Senegal but has slowed in Bénin and northern Sudan. In Botswana, Lesotho, and Tanzania, progress has continued to be limited and, in Botswana and Tanzania at least, women's mortality may have risen over the decade. Mortality rose more markedly in the 1980s in Malawi, although the data are insufficiently detailed to indicate exactly when the previous trend was reversed. In Uganda and Zimbabwe, however, mortality began to rise sharply in the second half of the 1980s. The

Figure 24. Trends in women's mortality between ages 15 and 60



Source: Table 8.

adverse trend extends into the 1990s and, in Zimbabwe at least, appears to be accelerating.

Two obvious questions arise about these recent increases in adult mortality: are they genuine and can they be accounted for by the spread of the HIV epidemic? Because adults infected with HIV tend to survive longer than infected children, the delay between a rise in the prevalence of HIV infection and the subsequent rise in mortality is longer for adults than children. The lag may be four to five years. Table 8 includes estimates of adult mortality for four of the countries that are believed to have been affected most severely by the HIV epidemic in the 1980s: Malawi, Uganda, Zambia and Zimbabwe (Stanecki and Way, 1997). As the mortality estimates for Malawi are three or four years more out-of-date than those for the other countries, one would expect them to be affected less by AIDS deaths. In addition, some 2 to 3 per cent of women in the Central African Republic in the mid-1980s and Tanzania in the early 1980s may have been infected with HIV. Even prevalence rates this low could raise adult mortality by a significant amount. In the other countries in table 8, however, including Botswana, the prevalence of HIV infection probably rose too late to have had measurable effect on these estimates of adult mortality. Thus, the adult mortality estimates in table 8 and figure 24 are consistent with what is known about the spread of the HIV epidemic in Africa.

Data have been released so far for 11 African countries that conducted a DHS survey that collected sibling histories. HIV was prevalent in six of these countries by the time that these data were collected. The histories are analysed further, therefore, to see whether they can document the trend in adult mortality during the seven-year period prior to their collection (Timæus, 1998 in press). To do this, the Poisson regression models used to smooth the data were expanded to include a term measuring the log-linear trend in mortality over the seven years. Fitted estimates of survivorship from age 15 to 60 by sex for three points in time are shown in table 9. Because reports of when siblings died are affected by digital preference and have been imputed in some instances, considerable uncertainty surrounds the estimated trends in adult mortality indicated by table 9. However, the overall direction and magnitude of the changes are probably meaningful.

The results of this analysis are striking. A clear split exists between those countries where one would expect significant HIV mortality by the time that the data were collected and those where one would not. Ac-

TABLE 9. RECENT TRENDS IN THE PROBABILITY OF DYING BETWEEN AGE 15 AND 60 ($_{45}Q_{15}$) BY SEX, DEMOGRAPHIC AND HEALTH SURVEYS, SIBLING HISTORIES, COUNTRIES IN SUB-SAHARAN AFRICA, VARIOUS DATES

		Women's mortality			*Men's mortality*		
Country	*Date of fieldwork*	*6 years before survey*	*3 years before survey*	*Year before survey*	*6 years before survey*	*3 years before survey*	*Year before survey*
Eastern Africa							
Malawi	1992	*0.328*	*0.348*	*0.369*	0.270	0.326	0.389
Tanzania	1996	*0.229*	*0.243*	*0.257*	0.232	0.296	0.373
Uganda	1995	0.282	0.404	0.556	0.365	0.451	0.547
Zambia	1996-1997	0.355	0.437	0.530	0.386	0.525	0.678
Zimbabwe	1994	0.146	0.220	0.324	0.176	0.306	0.498
Middle Africa							
Central African Republic	1994-1995	0.391	0.438	0.488	*0.481*	*0.514*	*0.547*
Southern Africa							
Namibia	1992	*0.199*	*0.189*	*0.179*	*0.346*	*0.333*	*0.320*
Western Africa							
Bénin	1996	*0.215*	*0.205*	*0.196*	*0.249*	*0.253*	*0.257*
Mali	1995-1996	0.270	0.230	0.194	*0.301*	*0.310*	*0.319*
Niger	1992	0.333	0.240	0.170	*0.236*	*0.221*	*0.206*
Senegal	1992-1993	0.207	0.163	0.127	0.273	0.239	0.208

Source: Ian M. Timæus, "Impact of the HIV epidemic on mortality in sub-Saharan Africa: evidence from national surveys and censuses", *AIDS Supplement*, vol. 12 (1998 in press).

Italics indicate that the estimated trend in mortality is statistically insignificant.

cording to the sibling histories, huge increases occurred in adult mortality in Uganda, Zambia and Zimbabwe between the late 1980s and mid-1990s. In just six years, adult mortality in Uganda rose from a moderate level to the highest level documented in Africa since the 1960s. Zambia already had fairly high adult mortality in 1990. Nevertheless, during the next six years adult death rates doubled and, by 1996, men's probability of surviving from age 15 to 60 may have dropped to below one third. Zimbabwe had low adult mortality in the late-1980s. By 1994, men's death rates were about three and a half time higher and women's death rates two and a half time higher.

The sibling history data also suggest that mortality rose in the other countries in the high HIV-prevalence belt of Africa. Adult mortality in the Central African Republic and Malawi remained fairly high in the 1980s but this has not stopped it rising further. Over a six-year period, men's death rates rose by about 55 per cent in Malawi and women's death rates by about 35 per cent in the Central African Republic. Similarly, although reported adult mortality is surprisingly, and perhaps implausibly, low in Tanzania, men's death rates apparently rose about 80 per cent during the first half of the 1990s.

It is worth noting that, according to these sibling history data, large rises have occurred in the mortality of both men and women. In two of the higher mortality countries, the Central African Republic and Uganda, women's mortality rose faster than men's mortality during this seven-year period. However, in Zambia and in the lower mortality countries, Malawi, Tanzania and Zimbabwe, men's mortality rose faster than that of women. These data offer no support for the suggestion that more women than men in Africa have become infected with HIV (Berkley and others, 1990; Gregson and others, 1994).

The sibling history data for Eastern and Middle Africa therefore provide evidence in support of the pattern of mortality increase by country revealed in figure 24. They suggest further that very dramatic rises in adult mortality have occurred in some countries during the 1990s that no other data are up-to-date enough to reveal. If respondents' reporting of dead siblings was less complete toward the beginning of the seven-year reference period, the apparent rise in adult mortality in countries in the high HIV prevalence belt could be partly or wholly spurious. The sibling history estimates for the Sahel, however, suggest that the decline in adult mortality in this region apparent in figure 24 continued into the early 1990s. They also confirm that adult mortality is stagnant in Bénin and suggest that the same is true of Namibia, which is what the experience of other Southern African countries would lead one to expect. Reporting errors have not occurred on a sufficient scale to suggest that mortality is rising rapidly in Western Africa. No obvious reason exists for suspecting the data on Eastern Africa to be of worse quality.

The other data on adult mortality collected in Phase 2 and 3 DHS inquiries in Africa are the questions on the household schedule about the orphanhood of children aged less than 15 years. Data on the survival of the mothers of children aged 5-9 and 10-14 years yield a pair of estimates of adult women's mortality, while data on the survival of fathers of children in these two age groups can be combined to produce a single estimate of men's mortality (Timæus, 1992).

These orphanhood data are potentially very valuable for examining the impact of AIDS on all-cause mortality because they largely reflect the mortality of women in their late twenties and thirties and of men in their late thirties and forties. These are probably the age groups in which AIDS deaths are most common. Thus, in populations where HIV is prevalent, mortality in this age range should be much higher, relative to mortality across the age range 15 to 60 years, than in existing model life tables. Unfortunately, as section B points out, orphanhood of children has often been underreported severely. If this is a problem in these surveys, one might expect the mortality estimates to be lower, relative to mortality between ages 15 and 60, than in existing model life tables.

In populations affected by HIV, mortality estimates based on maternal orphanhood data collected in surveys are biased because infected women tend to have low fertility and because a proportion of the potential respondents are infected by their mothers and die at an early age. The maternal orphanhood data for Eastern African countries (excluding Madagascar), Central African Republic, and Côte d'Ivoire have been corrected for these selection biases using estimates of the prevalence of infection among mothers at the time the children were born and a recently developed adjustment procedure (Timæus and Nunn, 1997). In these countries, life table survivorship was estimated from data on children aged 5-9 using regression models that embody the unusual age pattern of mortality in populations with significant numbers of HIV-related deaths (Timæus and Nunn, 1997). By contrast, data on children aged 10-14 in these countries (which reflect more distant mortality), and on both age groups in other parts of Africa, were analysed using methods developed for populations with more usual age patterns of mortality (Timæus, 1992). Men's survivorship was estimated from age 35 to 50 using an unpublished regression model fitted to the simulations described in Timæus (1992). For this first pair of age groups, this model yields more robust estimates than the published model, which estimates fathers' survivorship over the average of ten years that the respondents have been alive.

Mortality estimates obtained from the DHS household schedule data using these methods are presented in table 10. The most up-to-date of the three sets of estimates are those of women's mortality between ages 25 and 35. These estimates suggest that early adult mortality is higher throughout Eastern Africa, in the Central African Republic, and in Côte d'Ivoire than in countries where HIV was less prevalent at the time that the data were collected. The proportion of women dying between ages 25 and 35 is 9 per cent or more in seven countries, all of which developed a severe epidemic in the 1980s. It was 13 per cent in Uganda and Zambia by the early 1990s.

The estimates for women across the age range 25 to 40 years and those for men reflect

TABLE 10. PROBABILITIES OF DYING IN ADULTHOOD PER 1,000 ESTIMATED FROM ORPHANHOOD, DEMOGRAPHIC AND HEALTH SURVEYS, HOUSEHOLD DATA, COUNTRIES IN SUB-SAHARAN AFRICA, VARIOUS DATES

Country	Date of fieldwork	Women's mortality		Men's mortality
		$_{10}A_{25}$	$_{15}A_{25}$	$_{15}A_{25}$
Eastern Africa				
Kenya	1993	61	36	95
Madagascar	1992	61	90	110
Malawi	1992	111	91	98
Rwanda	1992	88	80	123
Uganda	1995	134	137	175
U. R. of Tanzania	1991-1992	74	61	92
	1996	89	80	108
Zambia	1992	96	73	94
	1996-1997	130	119	155
Zimbabwe	1994	90	72	117
Middle Africa				
Cameroon	1991	29	49	80
Central African Republic	1994-1995	100	79	133
Southern Africa				
Namibia	1992	27	43	93
Western Africa				
Bénin	1996	37	49	71
Burkina Faso	1992-1993	46	63	97
Côte d'Ivoire	1994	74	57	74
Ghana	1993	38	54	86
Mali	1995-1996	31	43	63
Niger	1992	38	73	70
Senegal	1992-1993	27	46	75

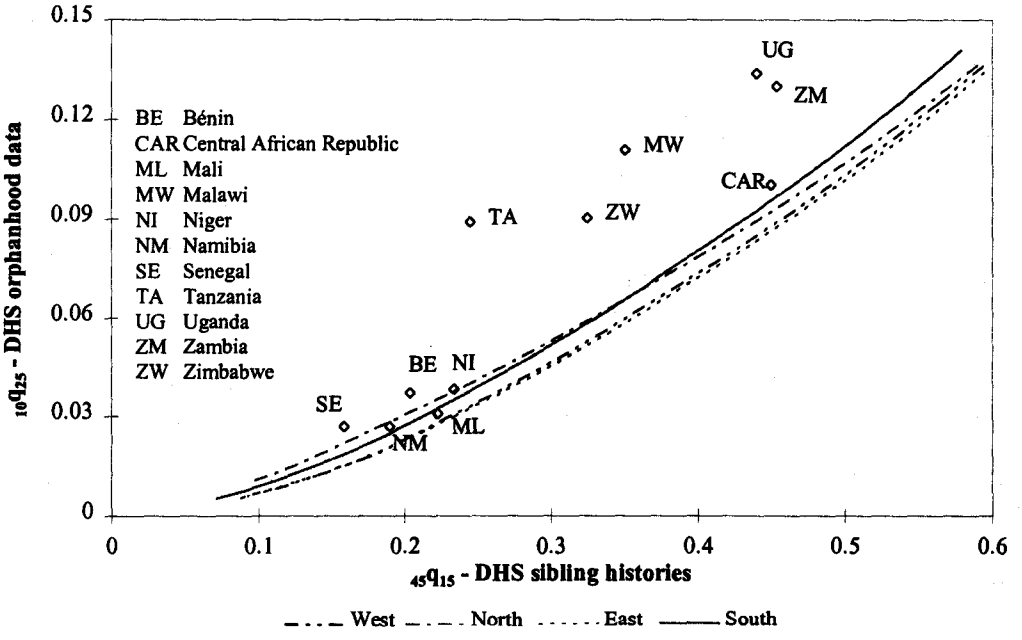
Source: Ian M. Timæus, "Impact of the HIV epidemic on mortality in sub-Saharan Africa: evidence from national surveys and censuses", *AIDS Supplement*, vol. 12 (1998 in press).

mortality over a longer period before their collection. Again, nearly all the estimates for countries in which HIV is believed to be prevalent are higher than those for other countries. Madagascar also shows up as a high mortality country, however, while Kenya has fairly low mortality. In Côte d'Ivoire and in all the Eastern and Middle African countries except Cameroon and Uganda, more mothers of children aged 5-9 years died between ages 25 and 35 than mothers of children aged 10-14 years died between ages 25 and 40. This suggests that the mortality of young women has risen sharply in recent years.[2]

Because of the profound but poorly understood effect that AIDS has on the overall age pattern of mortality, it impossible to extrapolate from the measures in table 10 to mortality over a wider range of ages. However, the estimates of women's mortality between ages 25 and 35 reflect mortality in the eight or so years before they were collected. This is approximately the period referred to by the sibling history estimates. Figure 25 compares these two sets of data. The relationship between ${}_{45}q_{15}$ and ${}_{10}q_{25}$ in the four families of Princeton model life tables is also shown (Coale and Demeny, 1983).

The orphanhood and sibling history estimates correlate closely: two very different methods of estimation agree as to the severity of adult mortality in these countries. In the five low mortality countries, the relationship between the mortality of young women and overall adult mortality is very close to that in existing systems of model life tables. In the Central African Republic, the mortality of young women is somewhat higher than expected. In the other five countries, young women have exceptionally high mortality relative to mortality in middle age. The size of the excess could be exaggerated in Tanzania, where the sibling histories may underestimate mortality. Malawi, Uganda, Zambia,

Figure 25. Relationship between women's mortality between ages 25 and 35, according to orphanhood data, and women's mortality between ages 15 and 60 according to sibling history data



Source: Table 8.

and Zimbabwe, however, are the countries in which the sibling history data indicate that mortality has risen most.

Similar plots (not shown) reveal that none of the maternal orphanhood estimates based on 10-14 year old respondents or paternal orphanhood estimates represent much higher early adult mortality than one would expect. These estimates reflect the mortality of slightly longer ago than the maternal orphanhood data for children aged 5-9. Thus, the unusual age pattern of mortality found in Eastern Africa results from a very recent rise in the mortality of young women. The conclusion that mortality increase in this part of the continent has been concentrated in early adulthood adds weight to the view that the cause of the rise in mortality is HIV.

E. DISCUSSION

The availability of data for the study of mortality in sub-Saharan Africa has improved during the last five years. This reflects the large number of DHS surveys conducted in the region. Unfortunately, no DHS survey has been undertaken in two of the most populous countries in Africa, the Democratic Republic of Congo and Ethiopia. Few other data are available for either of these countries and nationally representative data on mortality in Nigeria are also rare. Moreover, the information that is available on countries such as Botswana and Burundi is too out of date to provide anything more than a baseline against which the impact of HIV could be measured in future.

The DHS programme only collected information that can be used to measure adult mortality in a subset of the countries where it conducted surveys. Thus, no adult mortality data exist for many African countries in which levels and trends in child mortality are known. Even in countries where some data on adults exist, they have often been collected in just one inquiry using a single set of questions, thereby limiting the confidence with which estimates can be made from them. One reason for the shortage of data on adult mortality is that measuring it is more difficult than measuring child mortality. Arguably, however, against the background of the AIDS epidemic, this means that disproportionate resources should be put into the collection of data on adults, using the entire range of methods at our disposal.

Few population-based data on causes of death in Africa exist for either children or adults. Just about enough information exists to identify the main public health problems of the region. It is impossible however, to map variation in the profile of causes of death across Africa or to identify the progress of individual countries through the epidemiologic transition. In the least developed countries of Africa this is not a major problem: the priorities for action are clear. In those countries that have made more progress against infectious disease and in which administrative capacity is greater, however, the lack of such data is becoming a significant obstacle to the rational allocation of resources.

Africa remains a high mortality region. It also continues to be characterised by very diverse mortality conditions, making it difficult to summarise the situation in the continent. By the middle to late 1980s, Western Africa contained some of the lowest mortality countries in Africa, such as Ghana, but also some of those with the highest mortality, such as Niger. Both child and adult mortality fell rapidly in most of Western Africa during the 1970s and 1980s. However, this trend tapered off in some of the lower mortality countries during the 1980s.

All three Middle African countries on which we have data are characterised by high adult mortality but relatively low child mortality. At least until the onset of the AIDS epidemic, they were experiencing rapid mortality decline. Northern Sudan is characterised by low mortality in both childhood and adulthood, but by a slow rate of mortality decline. Southern Africa is characterised by some of the lowest levels of child mortality in Africa, by moderate mortality among adult women, but by quite high mortality among adult men. The rate of decline in mortality has been slow in this part of Africa, especially for adults.

By the mid-1980s, the level of mortality varied markedly across Eastern Africa. The area included both high mortality countries, such as Burundi and Malawi, and low mortality countries, such as Kenya and Zimbabwe. Child mortality fell steadily in most of Eastern Africa during the 1970s and early-1980s, although not as rapidly as in Western Africa, but typically adult mortality fell rather slowly. Since the late 1980s, adult mortality has risen substantially in several Eastern African countries. Child mortality in these countries has followed diverse paths: it has continued to fall slowly in the higher mortality countries, stagnated in Zimbabwe, and risen markedly in Zambia.

The estimates presented here of African mortality in the second half of the 1980s document the closing chapter of a history outlined in previous reviews of the subject (Hill, 1993; Timæus, 1993). By then, the continuing decline in mortality in the higher mortality Western African countries and Malawi, combined with limited decline in Southern Africa and the slowing of decline in some other low mortality countries, had almost obliterated the regional patterning of mortality that was so clear in the 1960s. Excepting those countries held back by civil war or particularly incompetent and corrupt governments, the level of mortality in different African countries was showing signs of partial convergence.

Earlier research suggested that, except in countries disrupted by civil war, mortality was in continuous decline throughout the African region. The estimates presented here dispel any illusion that this is an inevitable process. Mortality decline slowed or stopped in a number of African countries during the 1980s, albeit mainly those with fairly low mortality. War was not a factor in most of these countries and adverse trends developed too early in several of them for AIDS deaths to be the full explanation but what mechanisms were involved is unclear. While the stalling of the mortality transition must be rooted in the economic difficulties of much of Africa, the long-term failure to develop human resources is probably a more serious issue than the immediate impact of fluctuations in disposable income. While the history of Ghana in the 1980s reveals that renewed mortality decline remains a possibility, it is one that may not be realised elsewhere.

This study has documents the initial impact of the HIV epidemic on mortality in a few sub-Saharan African countries. All the data available for analysis here were collected more than two years before this chapter was written. In general, they can only document mortality up till three or four years before they were collected. Moreover, the prevalence of HIV infection has been rising rapidly and the number of AIDS deaths depends on how many people were infected several years earlier. Thus, many of the mortality data presented here reflect the state of HIV epidemic over a decade ago. It is unlikely that more than about 8 per cent of adult women were infected at that time in even the most severely affected countries. Today, this proportion is at least three times higher.

Even in its initial stages, the HIV epidemic had a dramatic impact on mortality in several African countries. For example, the probability of dying between ages 15 and 60 in Zimbabwe in the mid-1980s was less than 20 per cent; ten years later it was more than 40 per cent. In the space of a decade, one of the lowest mortality countries in Africa became one of those with the highest mortality. Even in the early stages of the HIV epidemic, adult mortality in affected countries rose to levels more characteristic of the 1950s than the 1990s. Such statistics emphasise, if it needs emphasising, that HIV is the most important public health problem facing Africa. By now, mortality will have begun to rise sharply not just in a few countries but across much of the continent. This huge increase in mortality represents a major setback to development. In many countries, AIDS mortality will overwhelm the progress made in the control of infectious disease mortality during the last half century. The primary determinant of life expectancy in the African region in future will be severity of the AIDS epidemic in the country concerned.

Reporting both of orphanhood and of the ages and dates of death of respondents' siblings are subject to errors and biases. Except

in Tanzania, however, the agreement between the two sources as to the relative severity of adult mortality is close. Furthermore, the evidence from the sibling histories as to where, and how rapidly, mortality has risen is supported by the comparisons with data collected in earlier inquiries in figure 24. Crosschecks such as these leave scope for considerable error in sibling-history estimates of both the level and trend in mortality. However, they suggest strongly that the approach can reveal broadly what is happening to adult mortality in Africa.

Failure to report deaths and other likely biases in the orphanhood and sibling data result in underestimation rather than overestimation of mortality. Equally, because these problems are more serious for distant events than recent ones, the results are more likely to exaggerate than underestimate the rate of increase in mortality. Thus, if the retrospective data are biased, mortality in Eastern Africa was probably even higher in the early 1990s than this chapter suggests but this situation may have developed more gradually than indicated.

Though retrospective data on adult mortality suffer from deficiencies, to try to put them to good use seems imperative. It is impossible to obtain the information that they can provide about the HIV epidemic in any other way. Knowledge of the epidemiology and natural history of HIV infection in Africa exists only for a few small populations. One cannot estimate levels and trends in mortality in particular African countries from mathematical models of the epidemic when few of the crucial parameters involved are known. To neglect the demographic data available for national populations in Africa leaves only the data from a few cities and longitudinal studies of small populations to provide direct documentation of this demographic catastrophe.

It is regrettable, therefore, that, more than a decade after the possible future impact on adult mortality of AIDS in Africa became clear (Anderson and others, 1988), little has been done to improve the scope and quality of the data collected on adult deaths. A first priority is to promote interest in existing data and the capacity to analyse them and to integrate the findings of such analyses into the policy and planning process at the national level. Second, a great deal would be learnt if the questions needed to apply existing methods were included in more of the 2000 round of censuses in Africa and in more of the national surveys that are to be conducted anyway. Third, research into improved methods is required.

The sibling histories collected by the DHS programme of surveys are one of the most useful sources available for study of the mortality impact of AIDS. In addition to countries examined here, such data have been collected in six further African countries. They include surveys of several other countries thought to be affected severely by the HIV epidemic. Nevertheless, it seems an ironic comment on the priorities of donors and governments that these crucial data have been generated as a by-product of efforts to measure maternal mortality. Moreover, the decision whether to continue to collect them is likely to ignore their value for monitoring the impact of the AIDS epidemic. Maternal causes kill between 100,000 and 200,000 women in Africa annually (Murray and Lopez, 1994; 1997). AIDS almost certainly already kills more Africans than this each year. Moreover, the number of AIDS deaths will rise sharply during the next decade.

One reason why so few data have been collected on adult mortality in the 1990s is simply inertia. Adult mortality has not been a priority for either health programmes or data collection for at least 25 years. Fertility surveys have become established as the main form of demographic inquiry in developing countries and have seldom included questions designed to measure adult mortality. Both officials in national statistical offices in Africa and their advisers and consultants have failed to rise to the challenge posed by the HIV epidemic. Equally, little impetus to change has come from donors. The DHS programme is funded by USAID. The only other donor with a major commitment to funding the collection of demographic data in the developing world is UNFPA. In recent years, both agencies have expanded their agenda from family planning to integrate other aspects of repro-

ductive health into their activities, including the prevention of HIV infection. However, AIDS mortality and adult mortality more generally do not fit well with their traditional concerns and have not been addressed in the same way.

It is also unfortunate that, while the US National Academy of Sciences' report, *Preventing and Mitigating AIDS in Sub-Saharan Africa* (Cohen and Trussell, 1996), emphasises the need to collect more data on the epidemiology of HIV, it does not recommend the collection of data on the mortality impact of AIDS. As a discipline, demography has not only failed in its intellectual and moral responsibility to describe one of the more important contemporary events in its field of study but has been remarkably unconcerned about this failure. While a great deal of intellectual energy has been devoted to modelling AIDS mortality in Africa, far less scientific effort has gone into the development, assessment and application of methods for the measurement of mortality impact. If demographic researchers fail to concern themselves with this issue, who else will?

NOTES

[1]The inventory of questions asked is based on published census reports and census schedules available in London or to the UN Population Division. Census data are classified in Table 6 as 'not known to have been published' if they could not be found by the author in London, by the UN Population Division in New York, or in the index of the International Census Collection maintained by the Population Research Center of the University of Texas at Austin. Some of these data will probably be published in the future - particularly those collected in 1993 and 1994. It is also likely that some mortality data have been collected and/or published that could not be traced for inclusion in table 6.

[2]In some countries, the finding that ${}_{10}q_{25}$ is greater than ${}_{15}q_{25}$ may be an artefact of the decision to use revised regression equations to estimate mortality from data on 5-9 year old children but not from those on children aged 10-14 years. However, both the conclusion that the six countries where HIV is thought to be most prevalent have exceptionally high early adult mortality and the conclusion that women's mortality has risen sharply would hold, albeit somewhat less dramatically, if the data on women in Eastern and Southern Africa were analysed using the methods presented in Timæus (1992).

REFERENCES

Anderson, Roy M., Robert M. May and Angela R. McLean (1988). Possible demographic consequence of AIDS in developing countries. *Nature*, vol. 332, No. 6161, pp. 228-234.

Barbieri, Magali, and Jacques Vallin (1996). Les conséquences de la crise économique africaine sur l'évolution de la mortalité. In *Crise et population en Afrique*, Jean Coussey and Jacques Vallin, eds. Les Etudes des CEPED, No. 13. Paris: Centre français sur la population et la développement, pp. 319-343.

Berkley, Seth, Warren Naamara, Samuel Okware, Robert Downing, Joseph Konde-Lule, Maria Wawer and others (1990). AIDS and HIV infection in Uganda - are more women infected than men?, *AIDS*, vol. 4, No. 12, pp. 1237-1242.

Blanc, Ann K., and Shea O. Rutstein (1994). The demographic transition in Southern Africa: yet another look at the evidence from Botswana and Zimbabwe. *Demography*, vol. 31, No. 2, pp. 209-215.

Bongaarts, John (1996). Global trends in AIDS mortality. *Population and Development Review*, vol. 22, No. 1, pp. 21-45.

Bradley, David J. (1991). Malaria. In *Disease and Mortality in Sub-Saharan Africa*, R. G. Feachem and D. T. Jamison, eds. Oxford: Oxford University Press, pp. 190-202.

Brass, William (1975). *Methods for Estimating Fertility and Mortality from Limited and Defective Data*. Chapel Hill: University of North Carolina, Laboratories for Population Statistics.

_____, and Carole L. Jolly (1993). *Population Dynamics of Kenya*. Population Dynamics of Sub-Saharan Africa. Washington, D.C.: National Academy Press.

Chandramohan, Daniel, Gillian H. Maude, Laura C. Rodrigues and Richard J. Hayes (1994). Verbal autopsies for adult deaths: issues in their development and validation. *International Journal of Epidemiology*, vol. 23, No. 2, pp. 213-222.

Coale, Ansley J., and Paul Demeny (1983). *Regional Model Life Tables and Stable Populations*. London: Academic Press.

Cohen, Barney, and James Trussell, eds. (1996). *Preventing and Mitigating AIDS in Sub-Saharan Africa*. Washington, D.C.: National Academy Press.

Ewbank, Douglas C., and James N. Gribble (1993). *Effects of Health Programs on Child Mortality in Sub-Saharan Africa*. Population Dynamics of Sub-Saharan Africa. Washington: National Academy Press.

Feachem, Richard G., and Dean T. Jamison, eds. (1991). *Disease and Mortality in Sub-Saharan Africa*. Oxford: Oxford University Press.

Garenne, Michel, and Oliver Fontaine (1990). Assessing probable causes of death using a standardised questionnaire: a study in rural Senegal. In *Measurement and Analysis of Mortality: New Approaches*, Jacques Vallin, Stan D'Souza and Alberto Palloni, eds. International Studies in Demography. Oxford: Clarendon Press, pp. 123-142.

Gregson, Simon, Geoffrey P. Garnett and Roy M. Anderson (1994). Assessing the potential impact of the HIV-1 epidemic on orphanhood and the demographic structure of populations in sub-Saharan Africa. *Population Studies*, vol. 48, No. 3, pp. 435-458.

Hill, Althea L. (1991a). Infant and child mortality: levels, trends, and data deficiencies. In *Disease and Mortality in Sub-Saharan Africa*, Richard G. Feachem and Dean T. Jamison, eds. Oxford: Oxford University Press, pp. 37-74.

_____ (1992). Trends in childhood mortality in sub-Saharan mainland Africa. In *Mortality and Society in Sub-Saharan Africa*, Etienne van de Walle, Gilles Pison and Mpembele Sala-Diakanda, eds. International Studies in Demography. Oxford: Clarendon, pp. 10-31.

_____ (1993). Trends in childhood mortality. In *Demographic Change in Sub-Saharan Africa,* Karen A. Foote, Kenneth H. Hill and Linda G. Martin, eds. Population Dynamics of Sub-Saharan Africa. Washington, D. C.: National Academy Press, pp. 153-217.

Hill, Kenneth (1991b). Approaches to the measurement of childhood mortality: a comparative review. *Population Index,* vol. 57, No. 3, pp. 368-382.

_____, and Anne R. Pebley (1989). Child mortality in the developing world. *Population and Development Review,* vol. 15, No. 4, pp. 657-687.

Kitange, Henry M., Harun Machibya, Jim Black, Deo M. Mtasiwa, Gabriel Masuki, David Whiting and others (1996). Outlook for survivors of childhood in sub-Saharan Africa: adult mortality in Tanzania. *British Medical Journal,* vol. 312, No. 7025, pp. 216-220.

Makinson, Caroline (1993). Estimates of adult mortality in Burundi. *Journal of Biosocial Science,* vol. 25, No. 2, pp. 169-186.

Murray, Christopher J. L., and Alan D. Lopez (1994). Global and regional cause-of-death patterns in 1990. *Bulletin of the World Health Organisation,* vol. 72, No. 3, pp. 447-480.

_____, eds. (1996). *The Global Burden of Disease: a Comprehensive Assessment of Mortality and Disability from Diseases, Injuries, and Risk Factors in 1990 and projected to 2020.* Global Burden of Disease and Injury Series, No. 1. Cambridge: Harvard University Press.

_____ (1997). Mortality by cause for eight regions of the world: Global Burden of Disease Study. *Lancet,* vol. 342, pp. 1269-1276.

Nájera, José A., Bernhard H. Liese and Jeffrey Hammer (1993). Malaria. In *Disease Control Priorities in Developing Countries,* Dean T. Jamison, W. Henry Mosley, Anthony R. Measham and José L. Bobadilla, eds. New York: Oxford University Press, pp. 281-302.

Nicoll, Angus, Ian Timæus, Rose-Mary Kigadye, Gijs Walraven and Japhet Killewo (1994). The impact of HIV-1 infection on mortality in children under 5 years of age in sub-Saharan Africa: a demographic and epidemiologic analysis. *AIDS,* vol. 8, No. 7, pp. 995-1005.

Pison, Gilles, Kenneth H. Hill, Barney Cohen and Karen A. Foote, eds. (1995). *Population Dynamics of Senegal.* Population Dynamics of Sub-Saharan Africa. Washington, D.C.: National Academy Press.

Preston, Samuel, Ansley J. Coale, James Trussell and Maxine Weinstein (1980). Estimating the completeness of reporting of adult deaths in populations that are approximately stable. *Population Index,* vol. 46, No. 2, pp. 179-202.

Preston, Samuel H. (1984). Use of direct and indirect techniques for estimating the completeness of death registration systems. In *Data Bases for Mortality Measurement.* Population Studies, No. 84. New York: United Nations, pp. 66-76.

Rutenberg, Naomi, and Jeremiah M. Sullivan (1991). Direct and indirect estimates of maternal mortality from the sisterhood method. In *Demographic and Health Surveys World Conference, August 5-7, 1991, Washington, D.C.* vol. 3. Columbia: Macro International, pp. 1669-1696.

Somoza, Jorge L. (1980). *Illustrative Analysis: Infant and Child Mortality in Colombia.* World Fertility Survey Scientific Reports, 10. Voorburg, Netherlands: International Statistical Institute.

Stanecki, Karen A., and Peter O. Way (1997). *The Demographic Impacts of HIV/AIDS, Perspectives from the World Population Profile: 1996.* International Programs Center Staff Paper, 86. Washington, D.C.: Population Division, U.S. Bureau of the Census.

Stanton, Cynthia, Noureddine Abderrahim and Kenneth Hill (1997). *DHS Maternal Mortality Indicators: An Assessment of Data Quality and Implications for Data Use.* DHS Analytical Reports, No. 4. Calverton: Macro International.

Thomas, Duncan, and Ityai Muvandi (1994a). The demographic transition in Southern Africa: another look at the evidence from Botswana and Zimbabwe. *Demography,* vol. 31, No. 2, pp. 185-207.

_____ (1994b). The demographic transition in Southern Africa: reviewing the evidence from Botswana and Zimbabwe. *Demography,* vol. 31, No. 2, pp. 217-227.

Timæus, Ian M. (1991a). Adult mortality: levels, trends and data sources. In *Disease and Mortality in Sub-Saharan Africa,* Richard G. Feachem and Dean T. Jamison, eds. New York: Oxford University Press, pp. 87-100.

_____ (1991b). Estimation of adult mortality from orphanhood before and since marriage. *Population Studies,* vol. 45, No. 3, pp. 455-472.

_____ (1991c). Estimation of mortality from orphanhood in adulthood. *Demography,* vol. 28, No. 2, pp. 213-227.

_____ (1991d). Measurement of adult mortality in less developed countries: a comparative review. *Population Index,* vol. 57, No. 4, pp. 552-568.

_____ (1992). Estimation of adult mortality from paternal orphanhood: a reassessment and a new approach. *Population Bulletin of The United Nations,* vol. 33, pp. 47-63.

_____ (1993). Adult mortality. In *Demographic Change in Sub-Saharan Africa,* Karen A. Foote, Kenneth H. Hill and Linda G. Martin, eds. Population Dynamics of Sub-Saharan Africa. Washington, D. C.: National Academy Press, pp. 218-255.

_____ (1998 in press). The impact of HIV/AIDS on mortality in sub-Saharan Africa: evidence from national surveys and censuses. *AIDS Supplement,* vol. 12.

_____, and Andrew J. Nunn (1997). Measurement of adult mortality in populations affected by AIDS: an assessment of the orphanhood method. *Health Transition Review,* vol. 7, No. S2, pp. 23-43.

United Nations (1983). *Manual X: Indirect Techniques for Demographic Estimation.* New York: United Nations Sales No. E.83.XIII.2.

_____ (1988). *Mortality of Children under Age 5.* New York: United Nations. Sales No. E.88.XIII.4.

Working Group on Demographic Effects of Economic and Social Reversals (1993). *Demographic Effects of Economic Reversals in Sub-Saharan Africa.* Population Dynamics of Sub-Saharan Africa. Washington, D.C.: National Academy Press.