New Estimates of Adult Mortality from DHS data on the Timing of Orphanhood Relative to Marriage

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Introduction

During the last 20 years, a great deal has been learnt about child mortality in less developed countries. The Demographic and Health Surveys (DHS) programme and earlier World Fertility Survey (WFS) have both made substantial contributions to our knowledge. Far less is known about adult mortality. One reason for this is that improving child survival has been seen widely as the more important public health issue. Another is that the development of robust and precise techniques for measuring adult mortality has proved a difficult challenge. Reflecting such considerations, neither the WFS nor DHS have accorded central importance to the investigation of adult mortality.

The WFS did make a major effort to measure adult mortality in a minority of its surveys. It developed an optional mortality module for the collection of data that can be used to estimate adult mortality both directly and indirectly. The module was implemented by 11 countries that fielded an enlarged household survey. A review of the results concluded that, while none of the questions had provided reliable data in every country, the module as a whole usually yielded useful estimates of adult mortality (Timæus, 1987). Other commentators have interpreted the same results more pessimistically (Sullivan, 1990).

Considering the concern of the DHS programme with health, it is perhaps surprising that it has devoted less attention to the measurement of adult mortality than the WFS. The range of information collected on the subject approached the scope of the WFS mortality module only in Burundi (Segamba *et al*., 1988). On the other hand, the core questionnaire designed for the Phase I surveys did ask ever-married women about the survival of their parents. The questions were included as filters. They precede a block of the questionnaire that inquires about residence with parents and parents-in-law after marriage, in order to examine the impact of this on fertility. As the basic documentation points out, however, such orphanhood data are also useful for the indirect estimation of adult mortality (IRD, 1987). Unfortunately, despite being part of the core questionnaire, this information was obtained in little more than half of the countries participating in Phase I.

The analysis of orphanhood data is the oldest and most successful of the techniques proposed for estimating adult mortality from the survival of specific categories of respondents' relatives. A simple and robust way of analyzing data on the survival of mothers and fathers was

proposed by Brass and Hill in 1973. Further estimation procedures based on regression models have been developed since (United Nations, 1983; Palloni and Heligman, 1986; Timæus, 1990). To improve upon the results, Chackiel and Orellana (1985) propose supplementary questions about the dates when parents died. With this information one can construct synthetic measures of parental survival for five-year periods prior to a survey. Mortality estimates based on such data have a more clearly defined and recent time reference than those from the basic method.

The DHS questions about the survival of parents are followed by further filter questions that establish whether dead parents died before or after the respondent began living with her first partner. Such data were collected in 15 of the Phase I DHS surveys that asked about lifetime orphanhood. In an unpublished note produced during the development of the DHS questionnaire, Brass pointed out that this information could be used to refine mortality estimates based on orphanhood data. First marriage is an event that divides more recent parental deaths, occurring at older ages, from more distant deaths at younger ages. While this information on the timing of orphanhood is less detailed than that obtained by asking about the dates when parents died, it may be reported more accurately. The question requires respondents to recall only the order in which two major events in their lives occurred.

To exploit the potential of these DHS data, new procedures had to be developed for the estimation of adult mortality from orphanhood before marriage and orphanhood since marriage (Timæus, 1990, 1991a). This paper applies both the basic orphanhood method and these new techniques to DHS data from Sri Lanka and three West African populations. Results have been presented elsewhere for Burundi and Morocco (Timæus 1991a) and for four Latin American countries (Timæus, 1991b). The application to Sri Lanka is of particular interest as Sri Lanka is one of the few developing countries in which a lengthy and fairly reliable series of registration data exists that can be used to evaluate these new methods. The significance of the West African applications is different. Indirect estimates are of most value in countries that lack effective civil registration systems, but age reporting and other errors are usually more serious in such countries than in those with better developed administrative systems and more educated populations such as Sri Lanka. It is important, therefore, to assess whether data on orphanhood relative to marriage yield plausible mortality estimates in countries where it is difficult to collect accurate data.

Methods of Analysis

It has proved possible to develop robust procedures for estimating adult mortality from both orphanhood before marriage and orphanhood since marriage. Data on fathers provide estimates of male mortality and data on mothers estimates of female mortality. The information on orphanhood before marriage used to estimate life table survivorship is the proportion of ever-married respondents in each five-year age group who had living mothers or fathers when they first married ($_5$S). For orphanhood since marriage, information on two adjoining age groups is used. It comprises the proportion of those respondents who had a living mother or father at first marriage whose

mothers or fathers still remain alive (${}_5S_x/{}_5S^m_x$). With complete reporting, multiplication of these two items of information should yield the proportion who still have living parents (${}_5S_x$). The data used in the analyses presented here can be found in Appendix 1.

Regression models have been estimated for the prediction of conditional survivorship in adulthood from information on parents surviving to female respondents' first marriage and since their marriage.(Timæus, 1990, 1991b). The coefficients are presented in Appendix 2.[1] Only information on respondents aged 25 years or more can be analyzed. At younger ages, the relationship between parental survival and life table survivorship depends on the exact shape of the first marriage distribution. Once most women have married, in contrast, the estimates depend on the timing of first marriages but are affected very little by the shape of the marriage distribution.

To control for variation in the length of time and range of ages over which parents are exposed, estimates are required of the cohort mean age at first marriage of the female respondents (m) and the period mean age at childbearing of their mothers or fathers (M). The first item of information can be calculated from the retrospective reports of age at first marriage obtained by the DHS surveys. Such reports are prone to recall errors. Nevertheless, in the countries considered here, after examining other evidence about marriage patterns it was decided to estimate from these retrospective data.[2] Because the trend to later marriage and truncation of the experience of younger cohorts tend to offset each other, the same estimate of is used for all cohorts of respondents.

Estimates of mean ages at childbearing should refer to the experience of the parents and thus to fertility patterns in the middle decades of this century. In the African applications considered here fertility patterns are unlikely to have changed greatly until recently and women's mean age at childbearing was estimated from DHS and WFS birth history data. In Sri Lanka, in contrast, the estimate was calculated from registration data for the early 1950's. Information on the relative ages of women of childbearing age and their husbands is required to estimate the timing of male fertility. Because husbands' ages were not collected in most DHS surveys, the estimates used are based on a range of data, including the results of WFS surveys.[3]

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[1] New coefficients are also used to analyze the data on lifetime orphanhood discussed in this paper (Timæus, 1991c). They are based on the same assumptions as the coefficients in Appendix 2.

[2] The exception is Ghana, where the singulate mean age at marriage calculated from single-year data was used.

[3] In Ghana, the DHS Husbands Survey provided the necessary information. The estimate for Ondo State is little more than an educated guess.

Table 1 *Estimation of adult male mortality from orphanhood before marriage, Sri Lanka.*

Age n	Proportion not orphaned before marriage ${}_5S^m_x$	Survivorship from age 35 to 55 ${}_{20}p_{35}$	Mortality level α	Survivorship from age 15 to 60 ${}_{45}p_{15}$	Date
25	0.7850	0.8432	-0.451	0.708	1972.5
30	0.8080	0.8712	-0.590	0.757	1967.6
35	0.7801	0.8466	-0.467	0.714	1962.5
40	0.7715	0.8385	-0.429	0.700	1957.4
45	0.7408	0.8096	-0.300	0.652	1952.3

Data on orphanhood before marriage yield estimates of $l(45)/l(25)$ for women and $l(55)/l(35)$ for men, representing survivorship from about the mean age at childbearing to about parents' average age when their daughters marry. Data on orphanhood since marriage yield estimates of $l(25+n)/l(45)$ for women and $l(35+n)/l(55)$ for men, where n divides the two age groups of respondents considered. The measures represent parents' survivorship from about their average age when the respondents married to their average age when the data were collected. Applications of the procedures to Sri Lankan data on paternal orphanhood before marriage and maternal orphanhood since marriage are shown in Tables 1 and 2.

Table 2 *Estimation of adult female mortality from orphanhood since marriage, Sri Lanka.*

Age n	Proportion not orphaned since marriage ${}_5S_{n-5}/{}_5S^m_{n-5}$	Survivorship from age 45 to 25+n ${}_{25+n}p_{45}$	Mortality level α	Survivorship from age 15 to 60 ${}_{45}p_{15}$	Date
30	0.9592	0.9687	-1.185	0.905	1984.0
35	0.9227	0.9244	-1.036	0.877	1982.4
40	0.8538	0.8637	-1.002	0.870	1981.2
45	0.7449	0.7708	-0.990	0.867	1980.3
50	0.6008				
Averages:			-1.053	0.880	1982.0

The time location (T) of the survivorship ratios can be estimated using the procedures developed by Brass and Bamgboye (1981) and Brass (1985). The former approach is used here. For

orphanhood before marriage, the index of the age when exposure starts (M) is either the mothers' mean age at childbearing (M) or the fathers' mean age at the conception of their live-born children (M-0.75). The index of the duration of exposure (N) is the respondents' mean age at marriage (m) for maternal orphanhood and m+0.75 for paternal orphanhood. On average, the parents' exposure ceased n-m years ago, where n is the mid-point of the age group of respondents. Using Brass's (1985) notation, one obtains for maternal orphanhood estimates:[4]

$$T = (n\text{-}m) + {}_{m}g_{M}. \quad (1)$$

As Table 1 illustrates, the time references of the different mortality estimates span a 20 year period, commencing some 36 years before the data were collected.

For orphanhood since marriage, the index of the age at which exposure starts is M+m and the index of the duration of exposure is n-m, where n divides the two age groups considered. Therefore:

$$T = {}_{n\text{-}m}g_{M+m}. \quad (2)$$

As the fathers' exposure begins well after the birth of their daughters, Equation (2) applies to both men's and women's mortality. It indicates that all the estimates obtained from orphanhood since marriage refer to four to eight years before the data were collected (see Table 2). Rather than trying to measure mortality trends over this period, the results can be averaged to obtain a single estimate for about six years ago.

The indices obtained from the three forms of orphanhood data measure survivorship between varying ages in early adulthood and middle age. To compare the measures and examine mortality trends, they must be translated into the same index. In this paper, results are presented in terms of the life table probability of surviving from age 15 to age 60 (${}_{45}p_{15}$). This is a straight-forward measure of the overall level of adult mortality that avoids any assumptions about the severity of old age mortality. To calculate ${}_{45}p_{15}$ from the survivorship ratios yielded by the regression models, it is necessary to fit one-parameter model life tables to them. While I use relational-logit model life tables based on the General Standard (Brass, 1971), other systems of models would yield similar results across the range of ages considered here (15 to 75 years).

Results

Sri Lanka

Estimates of the probability of surviving from age 15 to 60 in Sri Lanka are shown for both men and women in Figure 1. The estimates based on paternal orphanhood before marriage and maternal

[4] With the slight adjustments to the definitions of M and N just mentioned, the same formula applies to estimates from paternal orphanhood.

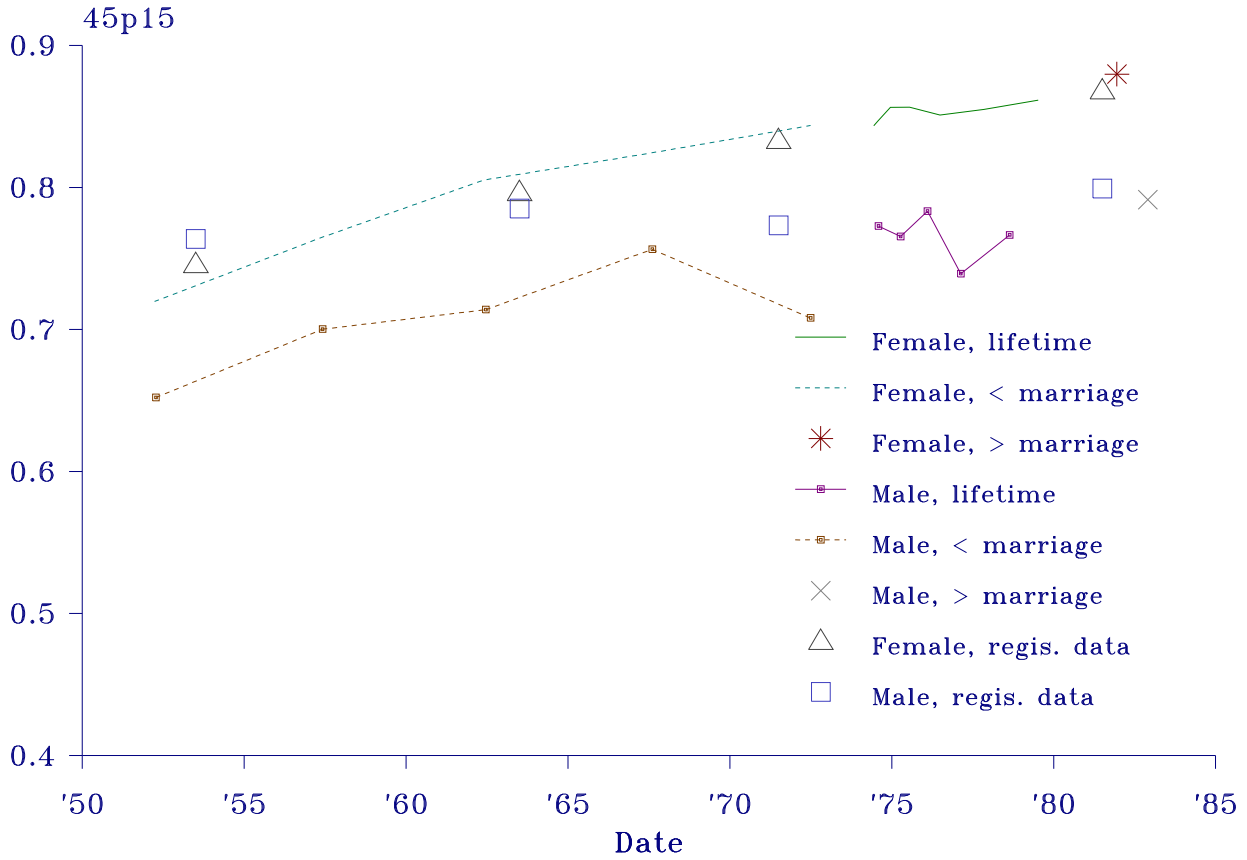

Figure 1 *Trends in adult mortality in Sri Lanka.*

orphanhood since marriage are taken from Tables 1 and 2. The orphanhood results are compared with published life tables calculated from registration data (United Nations, 1982, 1987).[5] The two sets of results refer to somewhat different populations. Civil disturbances meant that the Sri Lanka DHS was unable to conduct fieldwork in the Northern and Eastern provinces of the country. They contain 14 per cent of the population, including the majority of Sri Lanka Tamils. However, 1946 and 1971 data for Sri Lanka Tamils living in the north and east, presented by Langford (1984), indicate that the area covered by the DHS survey has similar mortality to the country as a whole. Its restricted coverage might lead the survey to underestimate ${}_{45}p_{15}$ nationally by about half a percentage point.

The three different variants of the orphanhood method yield very consistent estimates of the level and trend in adult mortality. As the DHS only collects orphanhood data from adult women, the results from the basic method all refer to a limited period of time in the second half of the

[5] To calculate these life tables the United Nations adjusted the registered death rates for 1953, 1963 and 1971 upward by 10 per cent, 6 per cent and 2 per cent respectively.

1970's. The new estimates from orphanhood relative to marriage span a thirty year period from the early 1950's to the early 1980's.

The most recent estimate of male mortality from orphanhood before marriage and the most recent two estimates from the basic method indicate slightly higher mortality than the rest of the series. This is probably because the DHS data refer to ever-married women. These three estimates are calculated from data on age groups in which a substantial number of women remain unmarried in Sri Lanka. If girls with dead fathers tend to marry young, these data will not reflect the level of orphanhood in the population as a whole. Analyses of several other DHS surveys have revealed that the orphanhood data supplied by young women overestimate mortality (Timæus, 1991a, 1991b). In Morocco, the proportions of parents surviving when the respondents married can be compared with earlier data on women of all marital statuses collected by the WFS. The results confirm that orphans tend to marry young (Timæus, 1991a).

The orphanhood based estimates of women's mortality agree very closely with those calculated from registration data. The minor discrepancies between the two series are within the range that can be accounted for by sampling errors. The results from paternal orphanhood since marriage and from the lifetime data supplied by older respondents agree just as closely with the registration based life tables for 1971 and 1981 as the maternal orphanhood estimates. The data on orphanhood before marriage, however, suggest higher male mortality in the 1950's and 1960's than the life tables for 1953 and 1963. The discrepancy seems too large to be accounted for by the limited coverage of the DHS survey.[6] Either registration of adult male deaths in the 1950's and 1960's was less complete than the United Nations assumed when calculating these two life tables or the estimates of male survivorship from orphanhood before marriage are biased downwards.

There are four possible sources of error in the orphanhood estimates: the estimation procedure, the values adopted for the mean age of childbearing of fathers and for the mean age at first marriage of respondents and the data on the proportion of fathers who were alive when the respondents married. None of these potential problems seem likely to lead the method to overestimate mortality substantially in this application.

Firstly, because orphanhood before marriage reflects survivorship over a limited range of ages, the procedure for estimating mortality from such data is one of the more robust variants of the orphanhood method. According to the registration statistics, the age pattern of mortality within adulthood in Sri Lanka is similar to that used to estimate the coefficients. Errors from this source could not affect the estimates of ${}_{20}p_{35}$ and their conversion into ${}_{45}p_{15}$ by more than 2 or 3 per cent. Moreover, though the regression model tends to underestimate ${}_{20}p_{35}$ if fathers' ages at childbearing are much more dispersed than is usual, only an exceptionally wide distribution of the type found in

[6] Another factor that might affect the comparison is the large-scale `repatriation' of Indian Tamils to India after 1971. This seems unlikely to be important. Only a few per cent of the total population were involved. Moreover, though in 1946 Indian Tamil men had lower mortality than the rest of the male population, by 1971 they had lost this advantage (Langford, 1984).

highly polygynous societies, but not Sri Lanka, could account for an important part of the discrepancy between the orphanhood and registration statistics.

If the mean age of men at the birth of their children in Sri Lanka was much higher than assumed here, the survivorship ratios estimated from paternal orphanhood data would be too low. To raise survivorship to the level indicated by the registration data in Sri Lanka, would have to be between 39 and 40 years. This is implausible: the average age of men when their children are born is only this high in a few polygynous populations in which the age gap between men and their wives is very large. Moreover, the impact of on the estimates obtained from orphanhood before marriage, lifetime orphanhood and orphanhood since marriage is broadly comparable. Using a higher value of would merely shift the discrepancy between the orphanhood and registration estimates forward in time.

Similar considerations suggest that the discrepancy between the two sets of estimates of male mortality cannot be explained by errors in the estimation of the timing of first marriage. Firstly, the results are not that sensitive to this measure. Secondly, any adjustment to would shift the estimates from orphanhood since marriage in the opposite direction to those from orphanhood before marriage and affect the results for women as well as men.

The other possible source of error in the orphanhood based estimates of men's mortality is over-reporting of orphanhood in childhood. The two sources could be reconciled if about 20 per cent of the women who stated that their father died before they married really had living fathers. It is difficult to see why inaccurate reporting should occur on this scale. The daughters of some divorced and widowed women might believe mistakenly that their father died when they were children, but not nearly 5 per cent of the entire population. In addition, orphanhood before marriage is a component of lifetime orphanhood. Reconciliation of the direct and indirect estimates for the 1950's and 1960's in this way would again introduce discrepancies into the results for the 1970's.

Thus, even if the estimates of male survivorship from orphanhood before marriage are affected by several biases, it seems unlikely that the actual level of male mortality in the 1950's and 1960's could be as low as suggested by the registration statistics. Such an interpretation of the results would imply that the consistency between the other orphanhood results and registration data is the result of a further set of offsetting biases. The orphanhood data suggest that male survivorship has risen steadily in parallel with the survivorship of women. This is perhaps more plausible than the trend suggested by the registration data, which indicate that male mortality stagnated, and actually worsened between 1963 and 1971, during a period when women's mortality fell markedly. In short, it seems reasonable to conclude that the straightforward view that the life tables for 1953 and 1963 underestimate adult male mortality is probably correct.

This tentative conclusion is of considerable substantive interest. A great deal of attention has been directed to the problem of excess female mortality in the Indian sub-continent and to the evidence suggesting that men's advantage has been eroded over time in Sri Lanka (e.g. D'Souza and Chen, 1980; Nadarajah, 1983; Langford, 1984). The results presented here pertain neither to young

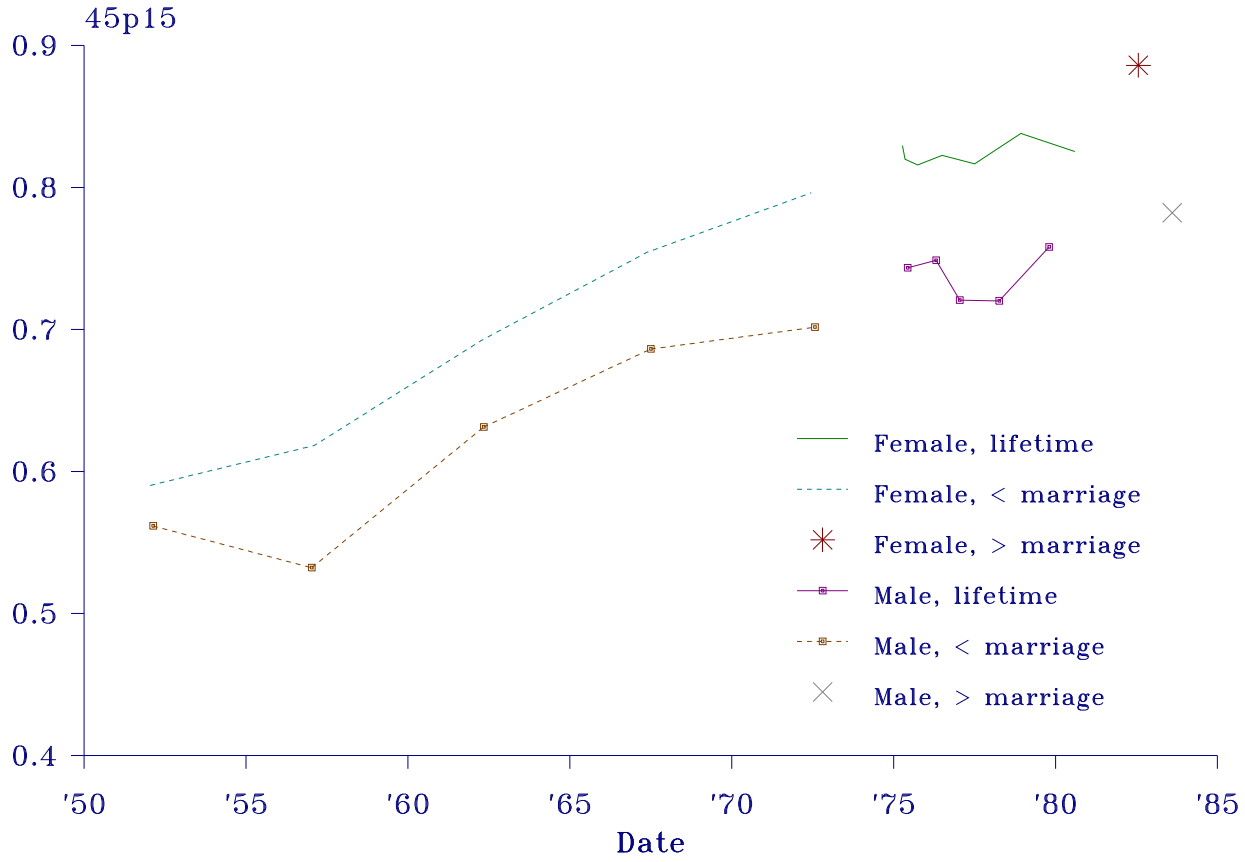

Figure 2 *Trends in adult mortality in Ghana.*

children, where the female disadvantage persists in the registration statistics for 1971 and 1981, nor to the period before the precipitous decline in mortality of the second half of the 1940's. They do suggest that, in early adulthood and middle age, a consistent and wide mortality differential in favour of women has existed since at least 1950.

Ghana

Orphanhood based estimates of adult male and female survivorship for Ghana are shown in Figure 2. As in Sri Lanka, the estimates obtained from lifetime orphanhood, orphanhood before marriage and orphanhood since marriage combine to produce a series spanning a period of over 30 years. The different variants of the method yield broadly consistent results for both males and females, though there is some indication that either the estimate of women's survivorship from orphanhood since marriage is a little high or the most recent estimate from the lifetime data underestimates survivorship, perhaps because of the selection into marriage of teenage girls with dead mothers. The estimates for men and women follow the same path of decline and suggest a stable gender differential in adult mortality in favour of women.

The results reveal that adult mortality in Ghana fell fairly rapidly from a moderately high level in the 1950's to quite a low level in the early 1980's. The most recent estimates suggest that adult mortality in Ghana is lower than in most other sub-Saharan African countries. They are similar to those for Zimbabwe (Timæus 1991d). Although these results seem plausible, few other data on adult mortality exist for Ghana against which they can be assessed. To the extent that they can be relied upon, the life tables constructed by Gaisie (1976) for 1968-9 indicate that the orphanhood data underestimate adult mortality at that time substantially.

Ondo State

Adult survivorship ratios for Ondo State, Nigeria are shown in Figure 3. Although the estimates obtained from data on orphanhood before marriage are a little erratic, the three different variants of the orphanhood method and the data for males and females once again yield very plausible and consistent series of estimates. The one major exception is that the estimate obtained from the lifetime data on maternal orphanhood supplied by married teenage respondents. This indicates very light mortality, which is the opposite bias to that observed in most other countries. It could be that Yoruba populations are exceptional in that maternal orphans tend to marry late. Alternatively, the estimate may be a statistical fluke: the proportion is based on 127 respondents.

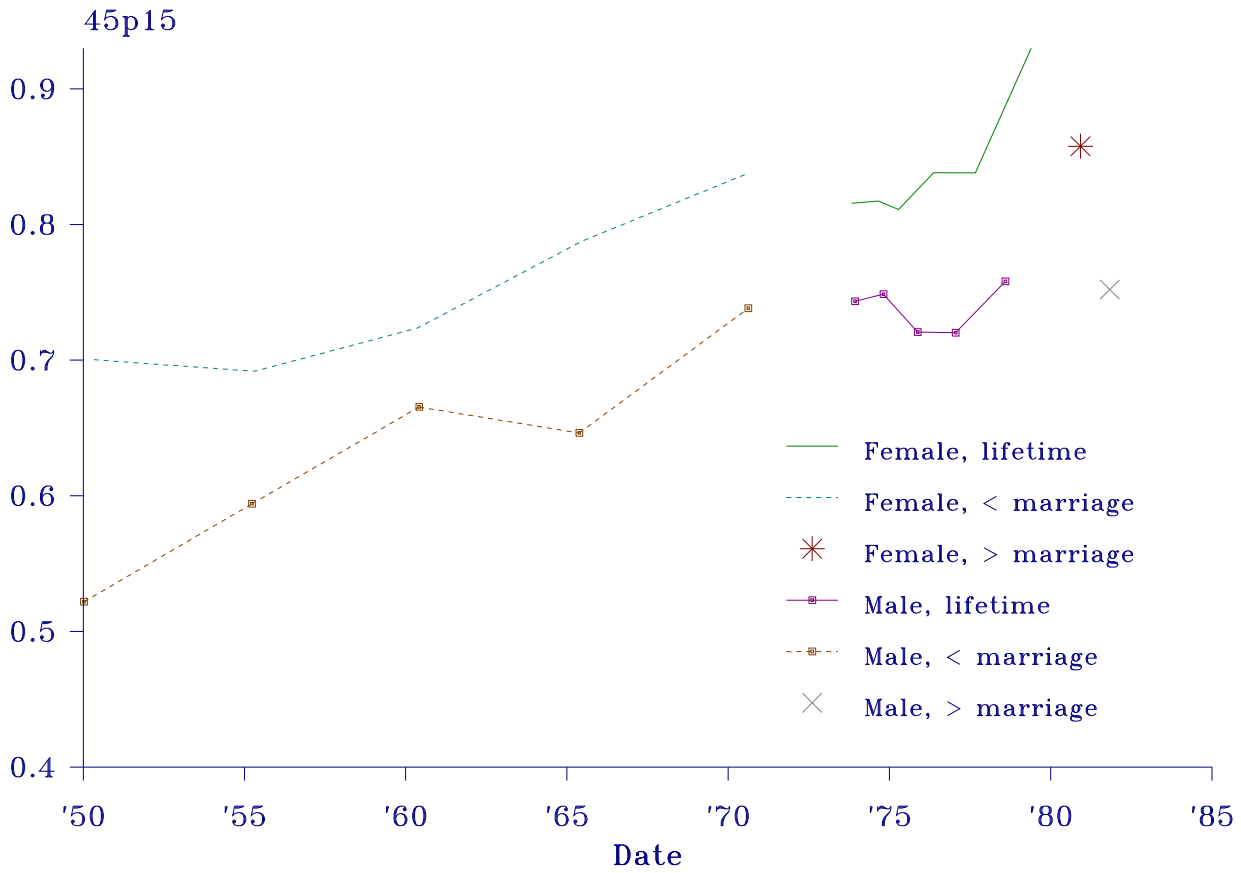

Figure 3 *Trends in adult mortality in Ondo State, Nigeria.*

According to these results, adult mortality in Ondo State had already fallen to a moderate level by the 1950's. Since then it has declined rather slowly. Although the level of mortality in Ondo State remains lower than in most of sub-Saharan Africa, these estimates suggest that it has probably been slightly higher than in Ghana since the early 1970's.

Senegal

The results of the analysis of the orphanhood data collected by the DHS in Senegal are shown in Figure 4.[7] The estimates made from data on orphanhood before marriage supplied by older women are rather erratic. In particular, women aged 40 to 44 years report that when they first married a very high proportion of their fathers had already died. It is probably unwise to place much reliance on the suggestion in these results that adult survivorship only began to improve in Senegal after about 1960.

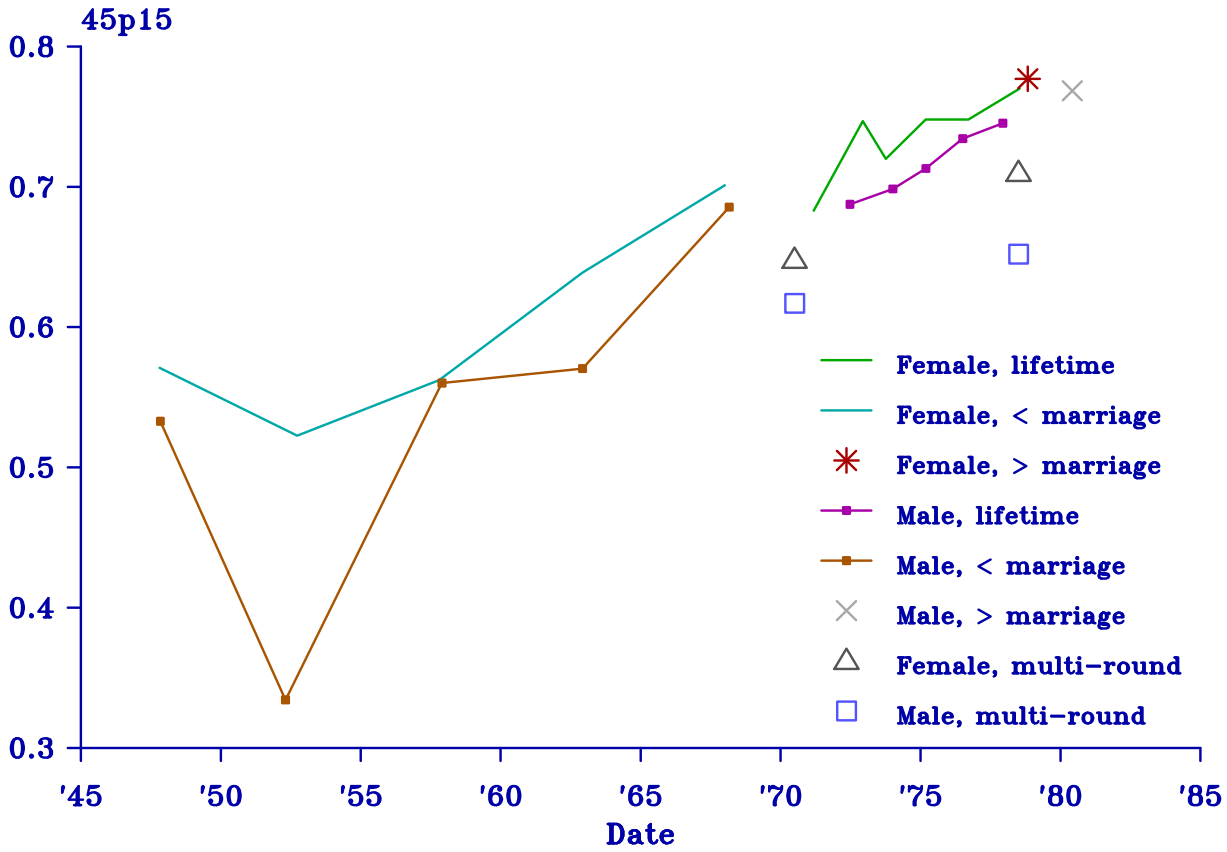

Figure 4 *Trends in adult mortality in Senegal.*

[7] Note the change of origin on Figure 4.

The estimates from data on orphanhood prior to marriage supplied by women aged 25 to 39 years, the estimates from lifetime orphanhood data and those from orphanhood since marriage form a much more consistent series. They suggest that a substantial decline in the level of adult mortality in Senegal occurred between 1960 and the early 1980's. Even at the end of this period, however, mortality remained much higher than in either Ghana or Ondo State,.

In Senegal independent estimates of the level of adult mortality are available from multi-round demographic surveys conducted in 1970 and 1978.[8] The results of these surveys indicate a very similar trend in adult mortality during the 1970's to the orphanhood data but suggest that the latter underestimate the level of mortality by a moderate amount. The discrepancy between the two sources is approximately equivalent to the change in survivorship occurring over a six-year period. In addition, the gender differential in adult mortality indicated by the multi-round surveys is slightly larger than that yielded by the information on orphanhood. The estimates of survivorship for men obtained from the orphanhood data may be biased systematically upwards by a moderate amount because they were produced using too high an estimate of men's ages at the birth of their children.[9]

Discussion

The development of reliable and affordable methods for the estimation of adult mortality in countries lacking adequate vital registration systems has proved difficult. While the information required to measure fertility and child mortality directly can usually be collected from the mothers of young children, no single, reliable respondent exists to provide data on adults that have died. Moreover, because age-specific mortality is much lower in adulthood than childhood, reasonably precise direct estimates of adult mortality cannot be obtained from surveys of the size usually mounted to study family planning and child health.

The basic orphanhood method can indicate only the long-term trend in the overall level of adult mortality (Timæus and Graham, 1989). In some applications, orphanhood data on young respondents have been biased by underreporting. It appears that, on occasion, a proportion of responses about orphans refer to their foster-parents or step-parents (the `adoption effect'). On the other hand, unlike direct questions about recent deaths, questions about orphanhood can provide reasonably precise estimates from single-round household surveys of the size implemented by the DHS programme. Unfortunately, because the DHS only collected such information from ever-

[8] I do not have access to the full results of these surveys. The survivorship ratios shown in Figure 4 have been estimated from the summary indices presented by Cantrelle *et al*. (1986). They may differ slightly from those in the full life tables.

[9] The estimate used here was produced by averaging the difference between the singulate mean ages at marriage of men and women and the difference between the median ages of currently married men and women according to the tables produced from the WFS household data. This average was then added to the estimate of for women. I know of no published data that can be used to improve upon this estimate.

married women, the results have proved vulnerable to selection biases resulting from the association of early marriage with orphanhood. In many countries, data on respondents aged less than 25 years have had to be discarded and the only results that can be obtained from the basic orphanhood method refer to more than 10 years before the survey was conducted.

In countries where the DHS asked whether parents died before or after the respondents first married, much more can learnt about adult mortality from the information on orphanhood. Data on the survival of parents since first marriage supplied by respondents aged more than 25 years yield mortality estimates that refer on average to just six years before the survey was conducted. Most women marry before age 25 in nearly all developing countries. Thus the results are not affected by the selection effects that bias lifetime data supplied by younger respondents. The method has the further advantage that the results are less vulnerable than those from the basic method to underreporting of orphanhood in childhood. The impact of this on data on orphanhood since marriage is slight because, even if some of the `parents' to which the responses refer are not natural parents, they are all likely to have been exposed to the risk of death since well before the respondents married.

Information on orphanhood before marriage provides estimates of early adult mortality that refer to conditions more than 15 years before they were collected. In combination with other forms of orphanhood data, they yield a series of mortality estimates that covers a 30 year period. This makes it possible to document the longer-term history of adult mortality decline in countries where early estimates have not been available till now. Using this method, surveys conducted during the coming decade could provide baseline information on the level of early adult mortality before the onset of the AIDS epidemic in populations that currently lack data on past trends in adult mortality.

One limitation of data on orphanhood before marriage is that they remain prone to biases arising from the adoption effect. This does not appear to be a major problem in the four populations considered here, though it may account for the relatively low level of mortality indicated by the responses of older women in Senegal. The bias does not seem to affect DHS data from Latin America either (Timæus, 1991b), but did render the information on orphanhood before marriage collected in a survey in Uganda useless (Timæus, 1991a). These findings support the suggestion that the adoption effect is a problem restricted largely to East Africa (Timæus, 1991d, 1991e).

The application of the new methods to data collected in the Sri Lanka DHS is a convincing demonstration that high quality mortality estimates can be obtained in this way. The estimates made from orphanhood since marriage tie up extremely closely with the life table calculated from death registration data for 1981. The estimates of women's mortality from orphanhood before marriage also agree closely with the life tables for 1953 and 1963. For men, these data indicate higher mortality than the registration statistics but it seems likely that the orphanhood method provides more accurate estimates. The quality of age reporting in the Sri Lanka DHS was very high (Fisher and De Silva, 1988). These results are a striking illustration of what can be achieved by

both the basic orphanhood method and the new techniques in populations where people know their age.

The results from the applications of the new methods to West African data presented here are more difficult to assess. Several of the African countries participating in the DHS have collected data on adult mortality in a number of earlier enquiries. From the point of view of evaluation of the new approach, it is regrettable that none of these countries chose to ask the questions on whether parents died before or after the respondents married.[10] In the West African populations for which we have data it is possible to conclude no more than that the results are plausible. Fragmentary evidence for Senegal and Ghana suggest that the parental survival data may underestimate mortality somewhat. It is, however, difficult to know how much weight to give to this suggestion. Evidence has accumulated from a variety of sources that the orphanhood method may slightly overestimate survivorship because parents can be reported on by all of their surviving children. On the other hand, either this was not a problem in Sri Lanka and Latin America (Timæus, 1991b), or, if it was, even the better registration systems in developing countries perform no better. At the very least, one can conclude from the consistent series of results obtained when data on lifetime orphanhood are partitioned into orphanhood before and after marriage that African respondents answered the DHS questions on orphanhood sensibly: it can be hoped that they also answered them in the way intended.

Conclusions

The scepticism that developed about the orphanhood method in the early 1980's (eg. Hill, 1984), still informs the thinking of many experts (eg. Sullivan, 1990). Results presented here and elsewhere (Timæus, 1991a, 1991b) suggest that by asking an additional question about whether parents died before or after respondents first married one can overcome many of the limitations of the method. Because it makes fewer demands on respondents, this may be a more reliable way of improving the results than asking about dates when parents died (Timæus, 1991a). Surveys conducted in the first phase of the DHS programme generated a wealth of data on adult mortality in this way at minimal cost. The opportunity to collect more such data in most Phase II DHS surveys has already been missed. It should not be neglected in future single-round demographic surveys.

[10] In Burundi one set of earlier data are available, based on the multi-round survey of 1970 (Timæus, 1991a).

Acknowledgements

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Appendix 1
Proportions of parents alive

Sri Lanka

	Survival of mothers			Survival of fathers		
Age	At survey	At marriage	Since marriage	At survey	At marriage	Since marriage
15-19	0.9537			0.8611		
20-24	0.9276			0.7856		
25-29	0.8909	0.9288	0.9592	0.6855	0.7850	0.8733
30-34	0.8455	0.9163	0.9227	0.6353	0.8080	0.7863
35-39	0.7739	0.9064	0.8538	0.4789	0.7801	0.6139
40-44	0.6607	0.8870	0.7449	0.3732	0.7715	0.4837
45-49	0.5197	0.8651	0.6008		0.7408	

M_f = 27.7 years, M_m = 35.7 years, m = 22.0 years.
Date of survey: 1987.2

Ghana

	Survival of mothers			Survival of fathers		
Age	At survey	At marriage	Since marriage	At survey	At marriage	Since marriage
15-19	0.9403			0.8543		
20-24	0.9177			0.7395		
25-29	0.8655	0.9169	0.9439	0.6495	0.7866	0.8257
30-34	0.8121	0.8956	0.9067	0.5383	0.7726	0.6967
35-39	0.7235	0.8656	0.8358	0.4508	0.7383	0.6105
40-44	0.6175	0.8272	0.7465	0.2951	0.6757	0.4368
45-49	0.4914	0.8114	0.6056		0.6947	

M_f = 28.0 years, M_m = 37.2 years, m = 20.4 years.
Date of survey: 1988.3

Ondo State

Age	Survival of mothers			Survival of fathers		
	At survey	At marriage	Since marriage	At survey	At marriage	Since marriage
15-19	0.9685			0.9055		
20-24	0.9080			0.7359		
25-29	0.8651	0.9306	0.9296	0.6641	0.8112	0.8187
30-34	0.7810	0.9088	0.8594	0.5292	0.7555	0.7005
35-39	0.6967	0.8808	0.7910	0.3954	0.7657	0.5164
40-44	0.6130	0.8661	0.7077	0.2908	0.7238	0.4017
45-49	0.4319	0.8700	0.4964		0.6792	

M_f = 29.7 years, M_m = 38.0 years, m = 19.4 years.
Date of survey: 1986.9

Senegal

Age	Survival of mothers			Survival of fathers		
	At survey	At marriage	Since marriage	At survey	At marriage	Since marriage
15-19	0.9245			0.8208		
20-24	0.8786			0.7532		
25-29	0.8290	0.9035	0.9176	0.6401	0.8108	0.7895
30-34	0.7374	0.8756	0.8422	0.5094	0.7476	0.6814
35-39	0.6701	0.8389	0.7988	0.3674	0.7421	0.4951
40-44	0.4867	0.8182	0.5948	0.2333	0.6061	0.3850
45-49	0.4407	0.8433	0.5226		0.7269	

M_f = 26.8 years, M_m = 38.2 years, m = 16.75 years.
Date of survey: 1986.35

Appendix 2
Coefficients for Orphanhood Estimation

1. Coefficients for maternal orphanhood after marriage

Estimation of $l(25+n)/l(45)$ from proportions of mothers alive
among women with living mothers when they married

$$l(25+n)/l(45) = \beta_0(n) + \beta_1(n)M + \beta_2(n)m + \beta_3(n){}_5S_{n-5}/{}_5S^m_{n-5} + \beta_4(n){}_5S_n/{}_5S^m_n$$

n	$\beta_0(n)$	$\beta_1(n)$	$\beta_2(n)$	$\beta_3(n)$	$\beta_4(n)$	R^2
30	0.5617	0.00836	-0.00261	-1.1231	1.4199	0.964
35	0.0476	0.01396	-0.00536	-0.3916	1.1354	0.966
40	-0.3715	0.01966	-0.00744	0.5394	0.5286	0.976
45	-0.6562	0.02587	-0.00716	1.0208	0.1789	0.987
50	-0.8341	0.03045	-0.00561	1.1898	0.0541	0.990

2. Coefficients for paternal orphanhood after marriage

Estimation of $l(35+n)/l(55)$ from proportions of fathers alive
among women with living fathers when they married

$$l(35+n)/l(55) = \beta_0(n) + \beta_1(n)M + \beta_2(n)m + \beta_3(n){}_5S_{n-5}/{}_5S^m_{n-5} + \beta_4(n){}_5S_n/{}_5S^m_n$$

n	$\beta_0(n)$	$\beta_1(n)$	$\beta_2(n)$	$\beta_3(n)$	$\beta_4(n)$	R^2
30	0.0676	0.01588	-0.00633	-1.2070	1.8284	0.979
35	-0.5459	0.02273	-0.01083	-0.2509	1.3867	0.980
40	-0.8674	0.02622	-0.01135	0.6057	0.7198	0.974

3. Coefficients for maternal orphanhood before marriage

Estimation of $l(45)/l(25)$ from proportions of
women with living mothers when they married

$$l(45)/l(25) = \beta_0(n) + \beta_1(n)M + \beta_2(n)m + \beta_3(n)_5S^m_n + \beta_4(n)m_5S^m_n$$

n	$\beta_0(n)$	$\beta_1(n)$	$\beta_2(n)$	$\beta_3(n)$	$\beta_4(n)$	R^2
25	-0.9607	0.00418	0.04466	1.8178	-0.04291	0.988
30	-0.9921	0.00429	0.04700	1.8428	-0.04501	0.988
35	-1.0129	0.00433	0.04822	1.8607	-0.04611	0.988
40+	-1.0206	0.00434	0.04861	1.8680	-0.04648	0.988

4. Coefficients for paternal orphanhood before marriage

Estimation of $l(55)/l(35)$ from proportions of
women with living fathers when they married

$$l(55)/l(35) = \beta_0(n) + \beta_1(n)M + \beta_2(n)m + \beta_3(n)_5S^m_n + \beta_4(n)m_5S^m_n$$

n	$\beta_0(n)$	$\beta_1(n)$	$\beta_2(n)$	$\beta_3(n)$	$\beta_4(n)$	R^2
25	-1.2719	0.01060	0.04480	1.8383	-0.04007	0.969
30	-1.2977	0.01068	0.04652	1.8530	-0.04124	0.969
35	-1.3203	0.01070	0.04769	1.8726	-0.04225	0.970
40+	-1.3232	0.01070	0.04783	1.8753	-0.04238	0.970