5 New Estimates of the Decline in Adult Mortality since 1950

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1. Introduction

Only in a handful of Latin American countries is the registration of deaths effectively complete (Chackiel, 1990). In the rest of the region, it is necessary to apply indirect techniques of analysis to estimate adult mortality. A wide range of methods exist for measuring adult mortality in countries with limited and defective data. Those based on intercensal survival are perhaps the oldest of all indirect techniques. Moreover, during the last 20 years, two further approaches to the measurement of adult mortality in the absence of reliable registration statistics have been explored. The first set of techniques is based on questions about the survival of specific relatives that can be asked in single-round surveys and censuses. The second comprises a range of methods that can be used to evaluate and adjust data on recent deaths obtained from deficient vital registration systems or household surveys.

Straightforward procedures for calculating indices of adult mortality from the survival of parents (Brass and Hill, 1973), first spouses (Hill, 1977) and siblings (Hill and Trussell, 1977) were developed during the 1970s. At about the same time, Brass (1975) proposed using the growth balance equation to adjust data on recent deaths. Further important methodological advances occurred around 1980. Brass and Bamgboye (1981) derived a way of estimating the time reference of estimates of mortality obtained from orphanhood and widowhood data, while Zlotnik and Hill (1981) proposed calculating synthetic cohort estimates of orphanhood from data collected on two separate occasions. These developments facilitated interpretation of data on the survival of relatives in countries where the level of adult mortality was changing. In addition, a range of new methods that can be used to evaluate data on recent deaths was devised (Brass, 1979; Courbage and Fargues, 1979; Preston and Hill, 1980; Preston *et al.*, 1980; Bennett and Horiuchi, 1981). The United Nations' (1983) manual on indirect estimation incorporated much of this work and marked the coming of age of the field: during the 1980s attention has focused on the refinement and assessment of existing methods of estimation (Blacker, 1984; Blacker and Mukiza-Gapere, 1988; Hill, 1984; Palloni and Heligman, 1986; Palloni *et al.*, 1984; Timæus, 1986, 1987, 1991a).

Techniques based on the survival of relatives can measure only the broad trend in adult mortality and provide no information about the age pattern of mortality within adulthood. Estimates of adult mortality obtained from orphanhood data about children are sometimes biased downward by under-reporting of parental deaths (the `adoption effect'). The widowhood method, in turn, has yielded mixed results and often overestimates recent mortality. For analysis of data on recent deaths to be feasible, on the other hand, information must be collected from a large sample and the majority of events must be reported (Preston, 1984). The first criterion rules out asking about recent deaths in surveys such as those conducted by the Demographic and Health Surveys (DHS) programme. The second vitiates many data collection efforts that supposedly cover entire populations but fail to achieve reporting that is 50 per cent complete.

Thus, there is no fully satisfactory way of measuring adult mortality in the absence of accurate registration statistics. Asking questions about the survival of relatives on household survey questionnaires has its limitations but provides estimates at minimal cost. Depending on the context, the results may be the only source of data on adult mortality or a useful external check on the validity of estimates obtained from other data collection systems. New methods for analysing orphanhood data have been proposed recently that circumvent some of the limitations of the approach.

Chackiel and Orellana (1985) suggest supplementing the question about the survival of mothers with one about the date of orphanhood. With this item of information it is possible to calculate the time location of the mortality estimates directly, without resorting to Brass and Bamgboye's (1981) procedure, and also to construct synthetic cohorts from data collected in a single survey. This question has yielded promising results in some Latin American applications (Chackiel and Orellana, 1985) but has performed poorly in sub-Saharan Africa, where respondents appear unable to supply accurately the dates when their parents died (Timæus, 1991b).

This chapter focuses on a second technique for obtaining more up-to-date mortality estimates than those yielded by the basic orphanhood method. The approach also avoids some of the biases that can affect the basic method. It is based on a supplementary question about whether orphanhood occurred before or after marriage. This provides some indication of the timing of parental deaths but makes fewer demands on respondents than the question proposed by Chackiel and Orellana (1985). Rather than having to recall the date when their parent died, respondents have only to indicate the relative timing of two major events in their lives. After a brief explanation of the techniques proposed for the analysis of such data, the chapter uses them to investigate the decline in adult mortality since 1950 in four Latin American countries.

2. Sources of Data

Adult mortality can be estimated 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. Only data on respondents aged 25 years or more can be analysed. At younger ages, the relationship between parental survival and life table survivorship is sensitive to the exact shape of the first marriage distribution. For age groups in which most women have married, in contrast, the estimates depend on the average timing of first marriages but not on their distribution around the mean.

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 (${}_5S^m_x$). 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 the proportion of respondents with a living mother or father at marriage by the proportion whose parent has survived since marriage should yield the proportion who still have living parents (${}_5S_x$).

Questions about whether ever-married women lost their parents before or after their first marriage were asked in about half the surveys conducted during Phase I of the DHS programme. They included several enquiries in Latin American countries. This chapter focuses on the application of the new methods to data from Colombia, Ecuador, the Dominican Republic and Peru. The basic data used in the analysis are presented in Table 5.A1.

In all four countries, the results obtained using the new methods are compared with estimates of survivorship extracted from life tables constructed by CELADE (1989). This comparison is of particular interest for Colombia and Ecuador because the life table estimates of adult mortality are based on vital statistics data generated by systems that register the majority of adult deaths. Thus, once the registration statistics have been adjusted by means of the growth balance equation, they represent an independent source of information on adult mortality. In the Dominican Republic, several sources of data on adult mortality were used to construct CELADE's (1989) life tables, including maternal orphanhood estimates for the 1970s, while in Peru the estimates of adult mortality are based solely on orphanhood data. Nevertheless, the comparison between the new estimates and those incorporated in the life tables is of interest even in Peru because the lengthy series of estimates yielded by the new techniques suggests a different interpretation of the earlier data from that adopted by CELADE.

3. Methods of Analysis

In an extension of methods proposed for analysing data on lifetime orphanhood (Hill and Trussell, 1977; United Nations, 1983; Palloni and Heligman, 1986; Timæus, 1992), regression models have been estimated for the calculation of conditional survivorship in adulthood from proportions of female respondents with parents surviving to the respondents' first marriage and since their marriage. The models are presented in Table 5.A2. An exposition of the theoretical basis of these methods, the derivation of the estimation procedures and the calculation of the time location of the estimates has been published elsewhere (Timæus, 1991c). This material is not reiterated here, though the following paragraphs outline the main features of the approach. Estimates from data on lifetime orphanhood and orphanhood in synthetic cohorts based at age 20 are also calculated using new sets of coefficients (Timæus 1991b, 1992). These are based on the same assumptions as the coefficients in Table 5.A2.

To use the equations, estimates are required of both the cohort mean age at 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 directly from the retrospective reports of age at first marriage obtained by the DHS surveys. As such reports are prone to recall errors, other evidence was examined as well, but it was eventually decided to estimate from these data. Because the secular trend to later marriage and truncation of the experience of younger cohorts tend to offset each other, a single estimate of m is used for respondents of all ages.

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. The estimates used for women are based on a range of evidence, with most emphasis being given to the fertility patterns reported retrospectively in the World Fertility Survey (WFS) birth histories. 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 the DHS surveys, estimates are again based on WFS data. The approach adopted was to calculate the differences between both the singulate mean ages at marriage of men and women and the median ages of currently married men and currently married women. An estimate of the mean age of men at the birth of their children was then obtained by adding the average of these two differences to the value of M calculated for the mothers.

Data on orphanhood before marriage yield estimates of $l(45)/l(25)$ for women and $l(55)/l(35)$ for men, representing the parents' survivorship from about their mean age at childbearing to about their 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 is the age dividing the two age groups of respondents considered and the measures represent survivorship from about the parents' average age when the respondents married to their average age when the data were collected. As an illustration, applications of the procedures to Colombian data on maternal orphanhood before marriage and paternal orphanhood since marriage are shown in Tables 5.1 and 5.2.

Approximate estimates of the time location (T) of the survivorship ratios can be obtained using the procedures developed by Brass and Bamgboye (1981) and by Brass (1985). The latter approach is used here. For orphanhood before marriage, the index of the age at which exposure starts (M) is either the mothers' mean age at childbearing (M_f) or the fathers' mean age at the conception of their live-born children (M_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 considered. Using Brass's (1985) notation, one obtains for maternal orphanhood estimates:

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

where ${}_{m}g_{M}$ is the time reference relative to m of mortality estimates based on deaths before m, calculated using the formula proposed by Brass (1985). As Table 5.1 illustrates, the time references of the different mortality estimates span a twenty-year period, commencing some thirty-seven 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 is the age dividing the two age groups of respondents considered. Therefore:

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

As the fathers' exposure to the risk of death begins well after the birth of their daughters, Equation (2) applies to estimates of both men's and women's mortality. The estimates obtained from orphanhood since marriage in different age groups all refer to the period four to eight years before the data were collected (see Table 5.2). Rather than trying to measure trends over this period, it is probably more realistic to average the results to obtain a single estimate of mortality for about six years ago.

The indices obtained from data on lifetime orphanhood, orphanhood before marriage and orphanhood since marriage measure survivorship over varying age ranges in early adulthood and middle age. To compare the measures and examine mortality trends, they must be translated into a common index of mortality. Different analysts have used various indices for this purpose. In this chapter, results are presented in terms of the life table probability of surviving from age 15 to age 60 (${}_{45}p_{15}$). This is a straightforward measure of the overall level

of adult mortality that does not incorporate 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. In this chapter relational-logit model life tables are used based on the General Standard (Brass, 1971). Other systems of models would yield similar results for the range of ages with which we are concerned (15 to 75 years). Moreover, the life tables published by CELADE (1989) suggest that, in the four countries considered, the General Standard is probably a reasonable representation of the pattern of mortality at these ages for the period 1950 to 1985.

4. Results

4.1. Colombia

Estimates of the mortality of adult men and women in Colombia, presented in terms of the probability of surviving from age 15 to age 60, are shown in Figure 5.1. The estimates based on maternal orphanhood before marriage and paternal orphanhood since marriage are taken from Tables 5.1 and 5.2. The direct estimates, based on civil registration statistics adjusted for under-reporting, have been taken from the quinquennial life tables published by CELADE (1989).

Two features of the orphanhood results deserve emphasis. Firstly, a very high estimate of women's mortality was obtained from data on the lifetime orphanhood of respondents aged 15-19 years. Only a minority of this age group are married and the estimate presumably reflects the selection of orphaned girls for early marriage. Therefore this estimate was discarded. Secondly, the results obtained from data on lifetime orphanhood reflect mortality over a limited period of time, centred on a date about twelve years prior to their collection. In contrast, analysis of information on the timing of orphanhood relative to marriage, yields estimates that span the entire period between 1950 and 1980.

The estimates for the 1970s, based on lifetime orphanhood, and those for 1980, based on orphanhood since marriage, agree fairly well with the vital statistics data as to the overall level of mortality. However, the orphanhood estimates indicate slightly higher mortality for men and a wider gender differential in adult mortality. According to the registration data, only modest improvements in adult survivorship occurred between 1950 and 1985, the decline slowed after 1960 and men benefited less than women. In contrast, the orphanhood estimates indicate that survivorship has risen rapidly and continuously from a much lower level and that men and women have benefited more-or-less equally. The estimates from orphanhood before marriage, in particular, suggest that male mortality in the 1950s and 1960s was much heavier than it appears according to the adjusted registration data on which CELADE based its life tables.

To determine definitively whether the orphanhood or registration based estimates of adult male mortality in Colombia are to be preferred would require a detailed re-assessment of the registration statistics, the adjustment procedures applied to them and other sources of demographic data on Colombia. While this investigation is not attempted here, the following paragraphs outline why the paternal orphanhood method is unlikely to have overestimated mortality substantially.

One possibility that can be discounted is that the discrepancies between the two sources arise from the imprecision of the procedures used to estimate survivorship from orphanhood. Because the incidence of orphanhood before marriage reflects survivorship over a limited range of ages, this technique is one of the more robust variants of the orphanhood method. Even if the age pattern of mortality within adulthood in Colombia prior to 1970 was very unusual, this would affect the estimates of ${}_{20}p_{35}$ and their conversion into ${}_{45}p_{15}$ by only a few per cent. Moreover, though the regression model can underestimate ${}_{20}p_{35}$ if fathers' ages at childbearing are much more dispersed than is assumed, only an unusually wide distribution, of the type found in highly polygynous societies, could account for an important part of the discrepancy between the orphanhood and registration statistics.

One factor that can lead to the overestimation of mortality from data on orphanhood before marriage is the use of too low a value for the mean age of men at the birth of their children. In Colombia, one would have to raise the estimate of M for men by 1.5 years merely to reduce the gender differential in adult mortality to the size indicated by the vital statistics data. Only an implausibly high estimate of M_m would raise survivorship to the level indicated by the registration data. As this would also have a broadly comparable effect on the estimates obtained from lifetime orphanhood and orphanhood since marriage, revising the results in this way would merely shift the discrepancy between the two series of estimates forwards 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. Although raising the value of m increases the level of survivorship estimated from orphanhood before marriage and lowers the level estimated from orphanhood since marriage, the results are not particularly sensitive to this measure. Such an adjustment might further improve the consistency between the orphanhood and registration estimates of female mortality but cannot explain the inconsistencies in the estimates for men.

The other possible source of error in the orphanhood based estimates of men's mortality is over-reporting of orphanhood in childhood. Reconciliation of the two sources would require that about a quarter of women who stated that their father died before they married 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 five per cent of the entire population.

Thus, to summarize this discussion, there are a number of factors that might lead to the overestimation of men's mortality from orphanhood data. Even if several such factors were acting in combination, it seems unlikely that estimates of survivorship as low as those obtained for Colombia in the 1950s and 1960s would result if the actual level of survivorship was that suggested by the registration statistics. Moreover, unless the only error is over-reporting of orphanhood before marriage, such an account implies that reasonable agreement between more recent estimates and the registration data occurs only because they are affected by a further set of offsetting errors. It seems more likely that the registration of adult male deaths in the 1950s and 1960s was less complete than has been realized until now.

4.2. Ecuador

Orphanhood and registration-based estimates of adult mortality in Ecuador are shown in Figure 5.2. As in Colombia, a high proportion of married teenage girls have lost their mother. In Ecuador, this group of women also suffers from a high level of paternal orphanhood. Thus, both mortality estimates based on orphanhood in this age group have been discarded. Furthermore, the estimates of female survivorship obtained from data on the lifetime orphanhood of respondents in their twenties also indicate appreciably higher mortality than those obtained from older respondents. They may also be biased downwards by an association between orphanhood and ages at marriage and should perhaps be discounted. If this is done, the orphanhood estimates tell a fairly consistent story. Although more erratic than those for Colombia, they suggest that survivorship of both men and women in Ecuador rose steadily between 1950 and 1980.

Comparison of the orphanhood estimates with those derived from the registration statistics, reveals that the two sources yield broadly comparable results for the 1950s and 1960s. They agree less well for the following decade. While the registration data suggest that recent improvements in adult survivorship have been modest, the data on lifetime orphanhood and orphanhood since marriage suggest that survivorship has continued to rise rapidly and that mortality in now substantially lower for both men and women than is indicated by CELADE's (1989) life tables.

Once again, it seems unlikely that the discrepancy between the two series stems from the imprecision of the estimation procedure or the use of an inappropriate value of M or m to calculate the orphanhood estimates. The translation of the recent estimates into ${}_{45}p_{15}$ is more sensitive to the age pattern of mortality than it is for data on orphanhood before marriage. However, the registration-based survivorship ratios for age ranges that correspond exactly to

those obtained from the regression models suggest that this potential problem does not distort the results shown in Figure 5.2. Secondly, even if the mean age at childbearing has been overestimated by two years for each sex, the orphanhood data still imply higher survivorship than the registration data.

It is possible that the estimates from lifetime orphanhood and orphanhood since marriage are in error because some women claim that parents who died recently are still alive. It seems unlikely, however, that respondents would do this on a large scale but report accurately about parents who died before they married. Secondly, while substantial exaggeration of ages would affect the results in the same way, for women this problem is not as characteristic of data on Latin America populations as it is of data on Africa and Southern Asia. Moreover, if the orphanhood data were affected by either of these errors one would expect the reports of women in their forties to indicate lighter mortality than those of women in their thirties. They do not. Thus, while it is possible that a series of errors and biases have led the orphanhood method to underestimate recent mortality, serious consideration must also be given to the possibility that the life tables based on registration data underestimate recent improvements in the survivorship of adults in Ecuador.

4.3. Dominican Republic

Estimates of adult mortality in the Dominican Republic are shown in Figure 5.3. Lifetime data on maternal orphanhood were collected in the 1975 WFS survey and lifetime data on both maternal and paternal orphanhood in the 1980 National Fertility Survey (NFS) and 1986 DHS study. The DHS enquiry also collected information on the timing of orphanhood relative to marriage. Using the WFS and NFS data, one can calculate synthetic indices of maternal orphanhood for the period 1975-80 (Timæus, 1991b). As the DHS data refer only to ever-married women, this has not been attempted for the period 1980-6.

There are a number of minor problems with the DHS data. Information on women aged 15-19 in the DHS survey again indicates very high mortality and has been discarded. Secondly, women aged 25-9 reported fewer living mothers in the DHS survey than one would expect on the basis of the other information available. The impact of this on both the most recent estimate obtained from orphanhood before marriage and the estimates from lifetime orphanhood is clear. It is also notable that older women in the DHS reported that rather high proportions of their fathers survived to their marriage. Women aged 45-9 years actually reported that, when they first married, fewer of their mothers than fathers were alive. As well as affecting the results from orphanhood before marriage, this feature of the data underlies the surprising trend in the estimates of men's mortality calculated from the data on lifetime

orphanhood collected by the DHS. It does not affect the estimate based on orphanhood since marriage.

If one ignores the estimates of men's mortality based on orphanhood before marriage, the orphanhood data collected in the DHS agree quite well with those collected in earlier enquiries and indicate a plausible gender differential in adult mortality. The close agreement between the estimate of women's mortality obtained from orphanhood since marriage and the synthetic cohort estimate is particularly impressive given that they are derived from data collected by means of different questions, posed in different surveys and analysed in different ways.

The estimates for both men and women also tie up quite well with CELADE's (1989) life tables, which are based on intercensal survival for the period up to 1970 and a combination of vital statistics data and data on lifetime orphanhood for the more recent past. Having said this, the orphanhood-based estimates consistently suggest that female survivorship is slightly higher than in the life tables adopted by CELADE. This could be accounted for in many ways and only an in-depth study of all the data now available could determine which estimates are to be preferred. Finally, it is notable that in this application, unlike those for Colombia and Ecuador, the new estimates provide support for the idea that the pace of decline in adult mortality has slowed since 1970.

4.4. Peru

Estimates of survivorship based on orphanhood data collected in a series of enquiries in Peru are shown in Figure 5.4. Questions about maternal orphanhood were asked in the 1976 Demographic Survey, the 1977 WFS survey, the 1986 DHS survey and the 1972 and 1981 censuses. Data on paternal orphanhood are available from the three surveys but not the censuses. Estimates are presented based on the lifetime orphanhood data from all these sources, the data on orphanhood before and since marriage provided by the DHS survey and synthetic indices of maternal orphanhood during the period 1977-81. Once again, the DHS data on married teenage girls indicate very high mortality and have been discarded. As in Ecuador, lifetime data on the maternal orphanhood of respondents in their twenties also indicate rather high mortality.

If the data supplied by younger respondents in the DHS are ignored, all the estimates of women's mortality based on lifetime data agree closely. They also tie up well with the estimates based on orphanhood before and since marriage. By using a slightly higher value of m to calculate the new estimates, one could produce an even more consistent series. As in the Dominican Republic, DHS data on orphanhood since marriage yield a level of survivorship very similar to that in the synthetic cohort constructed from data collected in earlier enquiries.

The estimates for males are broadly consistent with those for females and indicate slightly higher mortality. There is some indication that too few deaths of fathers were reported for children in both the 1976 and 1977 surveys. Depending on why this occurred, the DHS data on orphanhood before marriage might also underestimate mortality. Those on orphanhood since marriage should not be affected.

The life tables constructed by CELADE (1989) for Peru are based on estimates for the 1960s and early 1970s. The new estimates from orphanhood before and after marriage provide measures of adult mortality in the 1950s and late 1970s that were lacking before. These lengthy series of results make it much easier to assess the long-term trend in mortality. They suggest that it has undergone a rapid decline. It seems likely that levels of survivorship in adulthood were lower in the 1950s than CELADE assumed, but that survivorship is now higher than they predicted. There is no evidence that the rate of increase in adult survivorship has slowed over time.

5. Discussion

One aim of the collection of orphanhood data in the DHS surveys was the estimation of adult mortality (Institute for Resource Development, 1987). In practice, the basic information on lifetime orphanhood is of limited value for this purpose. This is because the data are available only for ever-married women. In Latin America, as elsewhere (Timæus, 1991c), women who have lost a parent tend to marry young. This is presumably, at least in part, because both early orphanhood and early marriage are concentrated among socio-economically disadvantaged groups. As a result, the information on lifetime orphanhood collected by the DHS programme yields little more than a single estimate of the level of adult mortality, based on the responses of age groups that have largely completed first marriage and referring to about a dozen years before the data were collected.

In the large subset of those countries asking about orphanhood, that asked about its timing relative to marriage, one can achieve much more. Information supplied by older women about orphanhood since marriage can be used to estimate the level of male and female adult mortality some six years earlier. These data are unlikely to be distorted by the `adoption effect' and, as most women marry before age 25, the estimates are robust to selection biases stemming from any association between orphanhood and age at marriage (Timæus, 1991c). While the issue has yet to be studied in Latin America, in sub-Saharan Africa a question about the timing of orphanhood relative to marriage has proved a more robust way of producing an up-to-date estimate than asking about the dates when parents died (Timæus, 1991c).

Information on orphanhood before marriage produces estimates of mortality that reach back more than thirty-five years into the past. The more recent results are a valuable check upon those obtained from lifetime orphanhood for about 15 years before the data were collected and the lengthy series of estimates yielded by the method provides an improved basis for assessing mortality trends and predicting the future.

The four applications of the new orphanhood methods presented here emphasize that, as with all techniques for estimating adult mortality in the absence of adequate vital registration statistics, critical assessment of the results is important. In three of the applications, estimates based on maternal and paternal orphanhood since marriage agree well with one another and with all the other evidence as to the level and trend in adult mortality. In Ecuador, the orphanhood data are internally consistent but disagree with those based on registration statistics. As one might expect, estimates obtained from orphanhood before marriage seem less precise. In Ecuador they are somewhat erratic, in the Dominican Republic they suggest that female mortality was higher than male mortality in the 1950s, while in Colombia they suggest much higher male mortality than estimates derived from civil registration statistics. In Colombia, at least, the information on orphanhood before marriage may be correct. Taken together, however, the applications suggest that orphanhood before marriage provides only a broad indication of more distant trends in adult mortality.

The new estimates of adult mortality presented for four Latin American countries present a picture of the history of decline in adult mortality in these populations that differs from that accepted up till now. They suggest that the decline in adult mortality has been both rapid and substantial. Only in the Dominican Republic is there evidence that the pace of decline has slowed since the 1950s or early 1960s. During the 1950s, male mortality in Colombia and the mortality of both sexes in Peru was probably higher than suggested by earlier studies. By 1980, adult mortality in Ecuador and Peru may have fallen to a lower level than anticipated.

6. Conclusions

Although more detailed and accurate demographic data are available for Latin America than for most other parts of the less developed world, in some countries orphanhood data still represent the most reliable information available on adult mortality. In other countries, they are a valuable adjunct to data obtained from vital registration. Further investigations may or may not support the suggestion that the decline in adult mortality since 1950 in many Latin American countries has been more substantial than believed previously. Either way, it is clear that by collecting data on orphanhood one gains a valuable external source of information that can contribute to the assessment of routinely collected data.

The scepticism that developed about the orphanhood method in the early 1980s (e.g., Hill, 1984), still informs the thinking of many experts (e.g., Sullivan, 1990). Results presented here and elsewhere (Timæus, 1991c) suggest that by asking an additional question about whether parents died before or after respondents married one can overcome many of the limitations of the method. 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.

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Table 5.A1. Proportions of parents alive

Colombia

Age	Survival of mothers			Survival of fathers		
	At survey	At marriage	Since marriage	At survey	At marriage	Since marriage
15-19	0.9070			0.8547		
20-24	0.9213			0.8183		
25-29	0.8520	0.9115	0.9347	0.7141	0.8065	0.8855
30-34	0.8306	0.9082	0.9145	0.6264	0.8100	0.7734
35-39	0.7148	0.8949	0.7987	0.4925	0.7688	0.6406
40-44	0.6066	0.8684	0.6986	0.3852	0.7557	0.5097
45-49	0.4337	0.8320	0.5213		0.7245	

M_f = 27.2 years, M_m = 32.1 years, m = 20.1 years. Date of survey: 1986.88

Ecuador

Age	Survival of mothers			Survival of fathers		
	At survey	At marriage	Since marriage	At survey	At marriage	Since marriage
15-19	0.8945			0.8744		
20-24	0.9122			0.8150		
25-29	0.8754	0.9249	0.9464	0.8329	0.8853	0.9408
30-34	0.8475	0.9361	0.9054	0.7000	0.8344	0.8389
35-39	0.7818	0.8824	0.8860	0.6357	0.8216	0.7736
40-44	0.6897	0.8939	0.7715	0.5199	0.8170	0.6364
45-49	0.5355	0.7908	0.6771		0.7951	

M_f = 27.1 years, M_m = 31.2 years, m = 20.0 years. Date of survey: 1987.13

Dominican Republic

Age	Survival of mothers			Survival of fathers		
	At survey	At marriage	Since marriage	At survey	At marriage	Since marriage
15-19	0.9276			0.8832		
20-24	0.9227			0.8359		
25-29	0.8592	0.9182	0.9358	0.7878	0.8934	0.8818
30-34	0.8359	0.9406	0.8886	0.7225	0.8823	0.8188
35-39	0.7724	0.9118	0.8470	0.6237	0.8816	0.7075
40-44	0.6577	0.8978	0.7325	0.4964	0.8656	0.5735
45-49	0.5628	0.8619	0.6529		0.8598	

M_f = 26.3 years, M_m = 32.4 years, m = 18.3 years. Date of survey: 1986.83

Peru

Age	Survival of mothers			Survival of fathers		
	At survey	At marriage	Since marriage	At survey	At marriage	Since marriage
15-19	0.9071			0.8429		
20-24	0.8804			0.8562		
25-29	0.8347	0.8930	0.9347	0.8023	0.8752	0.9167
30-34	0.7945	0.8825	0.9002	0.7276	0.8532	0.8528
35-39	0.7107	0.8644	0.8222	0.5851	0.7989	0.7324
40-44	0.6115	0.8217	0.7442	0.4268	0.7580	0.5630
45-49	0.4828	0.7968	0.6060		0.7289	

M_f = 28.0 years, M_m = 32.0 years, m = 20.5 years. Date of survey: 1986.83

Table 5.A2. 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

$$l(55)/l(35) = {}_0(n) + \beta_1(n)M + \beta_2(n)m + \beta_3(n){}_5S^m{}_n + \beta_4(n)m_5S^m{}_n$$

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

Table 5.1. Estimation of adult female mortality from orphanhood before marriage, Colombia

Age n	Proportion not orphaned before marriage ${}_5S^m_n$	Survivorship from age 25 to 45 ${}_{20}p_{45}$	Mortality level α	Survivorship from age 15 to 60 ${}_{45}p_{15}$	Date
25	0.9115	0.9214	-0.633	0.770	1970.7
30	0.9082	0.9213	-0.631	0.770	1965.7
35	0.8949	0.9098	-0.547	0.742	1960.7
40	0.8684	0.8854	-0.389	0.685	1955.6
45	0.8320	0.8514	-0.201	0.614	1950.4

Table 5.2. Estimation of adult male mortality from orphanhood since marriage, Colombia

Age n	Proportion not orphaned since marriage ${}_5S_{n-5}/{}_5S^m_{n-5}$	Survivorship from age 55 to 35+n ${}_{35+n}p_{55}$	Mortality level α	Survivorship from age 15 to 60 ${}_{45}p_{15}$	Date
30	0.8855	0.7954	-0.442	0.705	1982.3
35	0.7734	0.6603	-0.507	0.728	1980.5
40	0.6406	0.5010	-0.587	0.755	1979.3
45	0.5097				
Averages:			-0.512	0.729	1980.7

Fig 5.1. Trends in adult mortality in Colombia

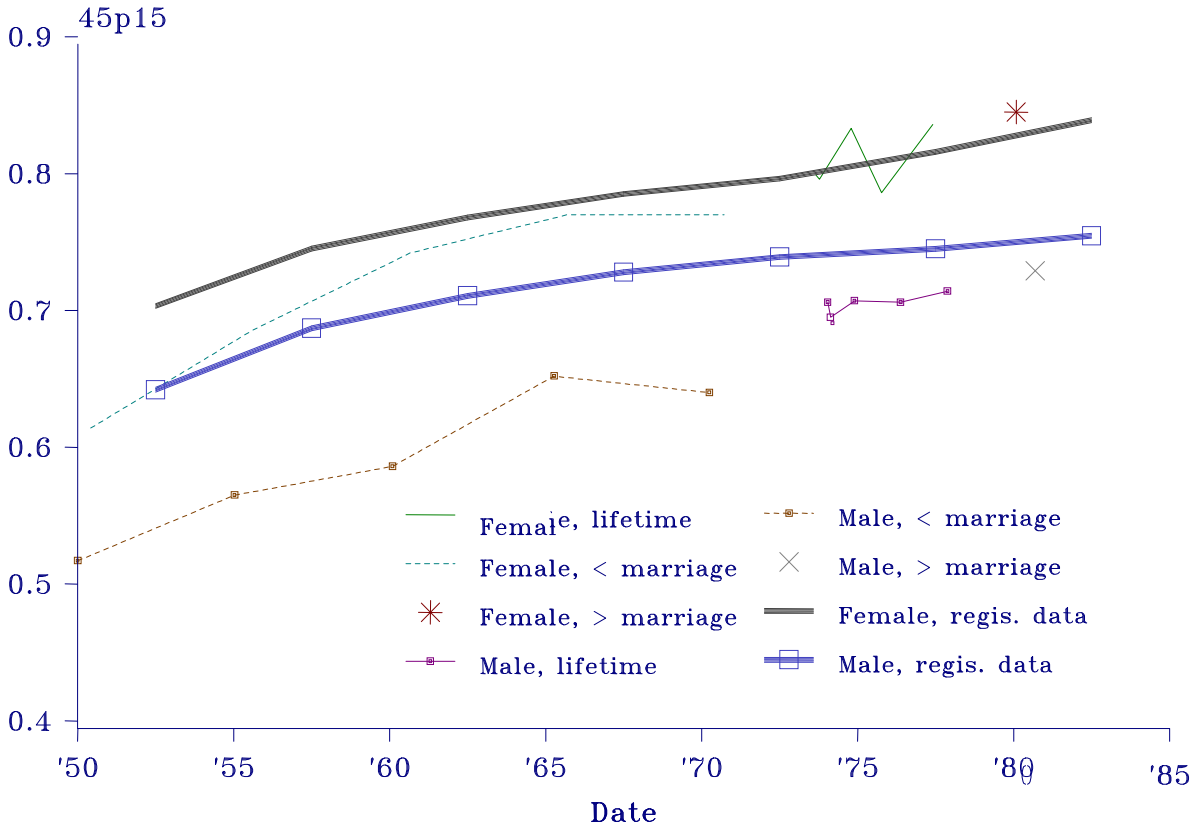

Fig 5.2. Trends in adult mortality in Ecuador

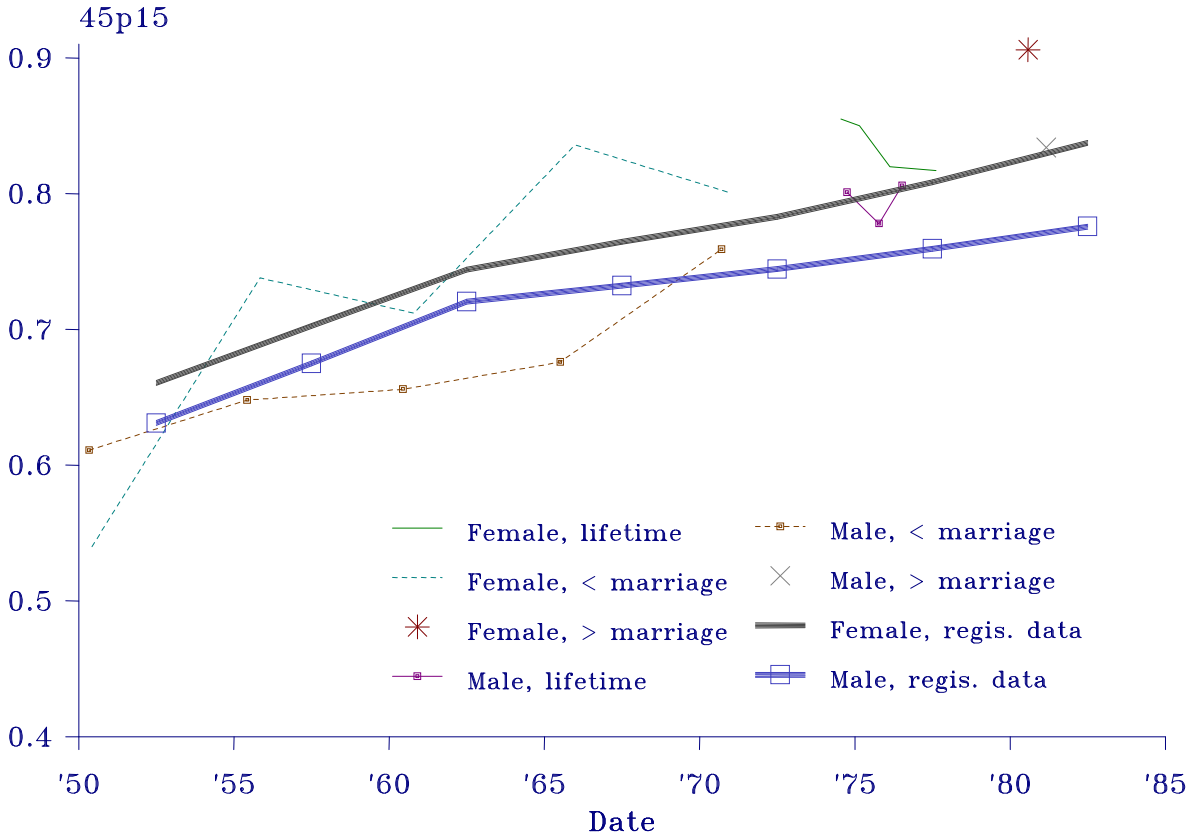

Fig 5.3. Trends in adult mortality in the Dominican Republic

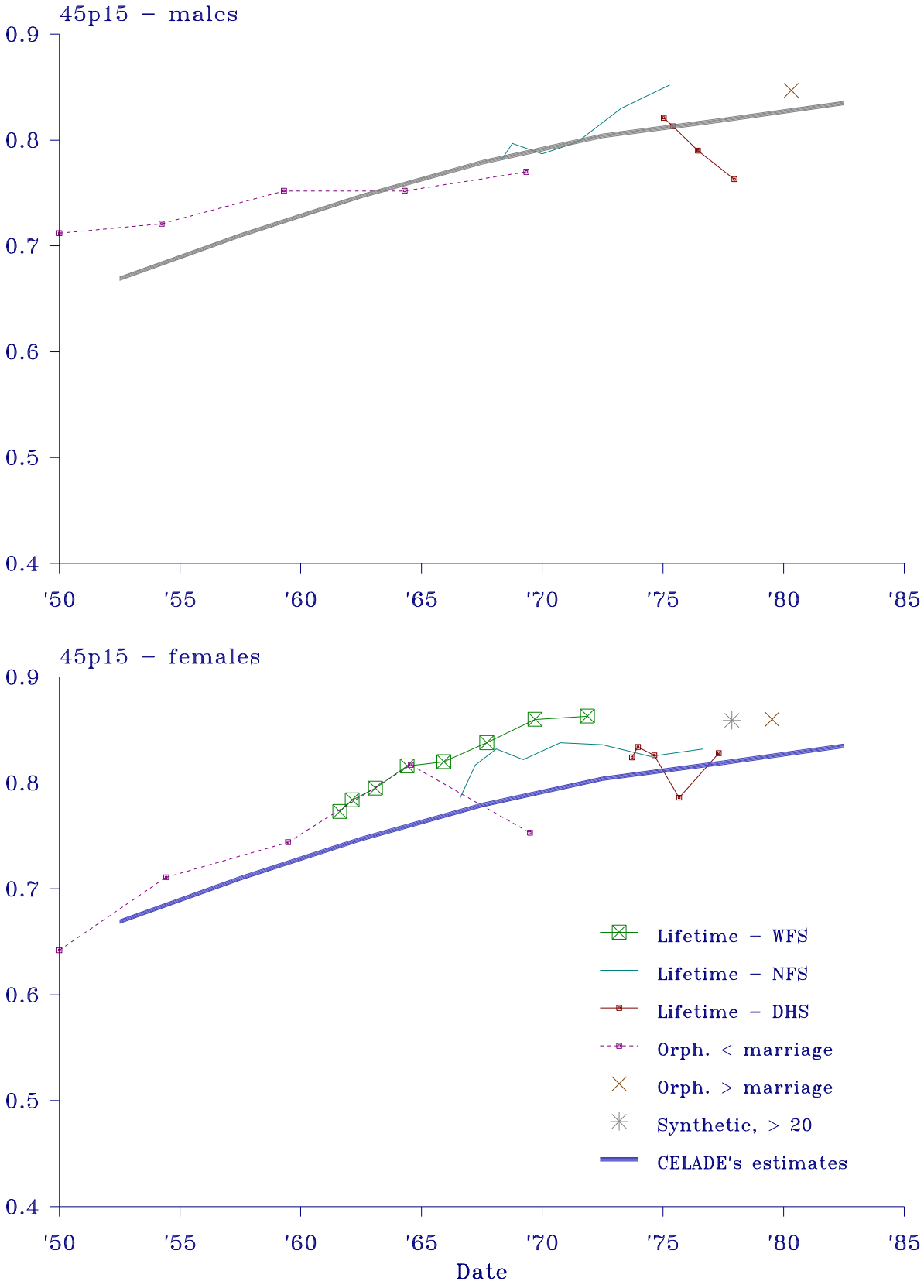

Fig 5.4. Trends in adult mortality in Peru