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THE APPLICABILITY OF THE METHOD OF ESTIMATION OF ADULT MORTALITY FROM INFORMATION ON ORPHANHOOD FOR ESTIMATING ADULT MORTALITY IN DEVELOPING COUNTRIES

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The traditional way of obtaining information about mortality is through vital registration sysems combined with regular population censuses and surveys. In developed countries these systems yield sufficiently accurate estimates of mortality, so there is no need to seek for alternative ways of deriving mortality estimates. However there are many developing countries where threre are no reliable sysems of vital registrations and in these countries the levels and patterns of adult mortality have to be estimated, by some indirect means.

Until recently, adult mortality was estimated by selecting a single parameter model life table to match the child mortality estimated by some indirect methods. However recently some demographers have pointed out the dangers of using single parameter models to estimate adult mortality from infant and child mortality. For example Adlakha (1972) shows that the United Nations or Coale-Demeny model life tables cannot be fitted to the mortality patterns in Turkey, Punjab, Costa Rica, Maxico or Chile. Also Brass (1971) shows the wide deviations of the mortality patterns in Mauritius, Guyana, the Philippines, the USSR and Ceylon from the Coale-Demeny models. The direct means of obtaining some indices of adult mortality such as survey questions on deaths in the past year, have proved unsucessful because of time scale biases and incomplete coverage. For these reasons demographers have proposed various methods for estimating adult mortality in developing countries and in this Paper I will critically examine the method based on information on orphanhood.

The Appliction of the Method

The theoretical basis of the method was fully described by Brass and Hill (1973) and further developments are reported by Hill and Trussell (1972). Some applications of the method can be found in Hill (1975) and Blacker (1977).

The informations about parental survivorship can be collected by asking very simple questions ; "Is your father alive ?" "Is your mother alive?" in a census or survey. When the responses are tabulated by age of respondents, the proportions with surviving mother, ${}_5\bar{M}_n$, and the proportions with surviving fathers, ${}_5\bar{M}^*_n$ can be calculated. By relating the model life-table surviversship probabilities to a weighted average of the model values of $_5M_n$ in adjacent age groups Brass and Hill (1973) have calculated multipliying factors, W(n) to extract the life-table survivorship probabilities from $_5\bar{M}_n$ values. The weightes for female, W(n), have been published for n=10,60 (5), K=22,30 (1) and the weights for male, W* (n), have been published for n-=10,55 (5), k= 36,44 (1). Here k is the mean age of childbearing of females and k* is the mean age of childbearing of males. Using these weights female survivorship are estimted by

$$\frac{l\,(25+n)}{l\,(25)} = W(n)_5\,\bar{M}_{n-5} + (1-W(n))_5\,\bar{M}_n$$

and male surviverships by

$$\frac{l^*\,(35+n)}{l^*\,(32.5)} = W^*(n)_5\,\bar{M}^*_{n-5} + (1-W^*(n))_5\,\bar{M}_n^*$$

or

$$\frac{l^*(40+n)}{l^*\,(37.5)} = W^*(n)_5\,\bar{M}_{n-5} + (1-W^*(n))_5\,\bar{M}_n^*$$

depending on the (estimated) mean age of childbearing for fathers.

Hill and Trussell (1977) used a regression approach to obtain survivorship probabilities from proportions not orphaned in five year age-groups of respondents. They argued that survivorship from birth could be taken as the dependent variable provided the probability of survival to age 2 was taken into account amongst the explanatory variables. The other explanatory variables were, of course, the proportion not orphaned and the mean age of childbearing (as in the previous method). They found that the most satisfactory regression equation included a term in the product of the proportion not orphaned and l(2). Thus an equation of the form.

$$l\,(25+n) = a + bk + c_{5n}M_{n-5}\,l\,(2)$$

was fitted, where a, b and c are regression co-efficients. The values of l(25+n), k, $_5M_{n-5}$ and l(2) used for the fitting were obtained from Brass's two-parameter model life-table system and the model schedules of fertility. For each of seven values of n, n=20,50(5) nine hundred sets of values of the variables in the above equation were generated using various combinations of the model schedules. The equation was then fitted, by least squares, and an excellent fit was obtained in all cases.

The estimated values of a, b and c, published in Hill and Trussell (1977) for n=20, 50 (5), can be used to estimate female adult mortality for an actual population from the equation

$$l(25+n) = a + b\,\bar{k}, + c_5\bar{M}_{n-5}\,l\,(2)$$

where $\bar{k}$ is an estimate of k for the actual population and ${}_5\bar{M}_{n-5}$ is the observed value of ${}_5M_{n-5}$* The value of l(2) can be estimated by the childhood mortality technique. The method for estimating adult male mortality is the same except for the differences in mean age of childbearing.

The Suitability of the Method for Estimating Adult Mortality in Developing Countries.

The method contains some potential sources of bias. The robustness of the method to diviations from the assumptions has not yet been fully investigated. The mortality experience of the childless population is totally unrepresented. This may be higher than the mortality of the fertile population. If this is the case the mortality for the population as a whole is underestimated. The proportion of surviving mothers is estimated by proportion of surviving children with surviving mothers. Thus a mother with two surviving children (within a 5-Year age group) is reported twice and a women with one surviving child only once. This will introduce a bias if mothers who bear several children within a 5-year interval have different survivorship from those who bear only one child. Suppose, for example, that mothers of high fertility who have very frequent childbirth have higher mortality than mothers of lower fertility. Since the former group tend to have more surviving children the proportion of children with surviving mothers will underestimate the true proportion of surviving mothers that is the true mortality of all mothers will be over-estimated. Such effect could occur if very frequent childbirth is associated with a higher risk of the mother dying at childbirth. It is not possible to predict the direction or extent of this course of bias without considerable further research.

In so far as a mother's fertility may be associated with social class and certain environmental conditions, the mortality of the children may also be correlated with the mother's level of fertility, as well as with the mother's mortality. This further complicates the picture. A very crude idea of some of these effects may be obtained in the following way.

Suppose at time — 1, s_1 mothers bore 1 child and s_2 mothers bore two children. Also suppose that the probability of surviving from time — 1 to time 0 is p_1 for a mother with one child and p_2 for a mother with two children. The corresponding probabilities for children will be denoted by p_1^* and p_2^* If the assumption of independence between the survivorship of mother and child holds then we can form the following table.

Time — 1		Time 0		
Mothers	Children	Mothers	Children	Children with Mothers
s_1	s_1	$p_1 s_1$	$\overset{*}{p_1} s_1$	$p_1 \overset{*}{p_1} s_1$
s_2	$2s_2$	$p_2 s_2$	$2\overset{*}{p_2} s_2$	$2p_2 \overset{*}{p_2} s_2$

We want to estimate the proportion

$$P = \frac{p_1 s_1 + p_2 s_2}{s_1 + s_2} \text{ by using}$$

$$\bar{P} = \frac{p_1 p_1^* s_1 + 2 p_2 p_2^* s_2}{\overset{*}{p_1} s_1 + 2 \overset{*}{p_2} s_2}$$

If $p_1 = p_2 = p$ then $\bar{P} = P = p$, so there is no bias in estimating P. However, If $p_2 < p_1$ and $p_1^* = p_2^*$ then $\bar{P} = \frac{p_1 s_2 + 2p_2 s_2}{s_1 + 2s_2}$ P ; overall proportion of surviving mothers underestimated, that is the true mortality of all mothers will be over estimated.

We can write $\bar{P}$ as

$$\bar{P} = \frac{p_1 s_1 + p_2 \frac{(2p_2^*)}{p_1^*} s_2}{s_1 + \frac{(2p^*_2)}{p_1^*} \cdot s_2}$$

This is an estimate of $P = \frac{p_1 s_1 + p_2 s_2}{s_1 + s_2}$. Thus even if $p_2^* < p_1^*$ the effects due to bias may become small by compensating the numerator and denomenator, that is if $\frac{2p_2^*}{p^{1*}}$ is very close to one,the bias is very small. The changes in vital rates over the period may affect the result since the vital events are aggregated over a long period. The method is of rather doubtful accuracy, in the case of male mortality because of the difficulties in estimating mean age of childbearing. Mortality estimates derived from information obtained from young children below age 20 cannot be utilised because of an adoption effect. Proportions reported as orphaned are far too low, perhaps because orphans are adopted by relatives who are then reported as the true parents (Hill and Trussell, 1977), Hill (1975) reported two recent refinements of the original methods to remove the possiblity of any multiple response bias One approach is to analyse orphanhood information for first-born children only. The information is collected by asking the orphanhood questions, with an extra question "Were you your (mother's father's) first-born child?". The advantages of this method are that there is only one report for a particular parent and that the parent's age at first birth has an earlier mean and smaller variance, thus, improving the robustness of the method. There are two serious disdvantages of this method. One is that the parents repoited are restricted to those with a surviving first born child, and the other is that reporting errors ate more likely with the questions on first-born children.

The second approach is to limit responses to the eldest surviving child of the parent. Now the extra questions is "Are you your (Mother's Father's) eldest surviving child". Again there is only one response per parent, but in this case no events are lost by first born children dying. However reporting errors are likely to be higher.

The ultimate justification of the method of estimating mortality from orphanhood data is that plausible estimates of adult mortality have been obtained by its application. For example, Hill (1975) applied this method to data from Bangladesh and Blacker (1977) has applied to Chad, Kenya and Malawi. These countries were specially chosen, because it is possible to compare the moitality estimates derived from orphanhood data with alternative estimates of adult mortality derived fiom other sources. His results were highly plausible, internally consistent, and showed very *reasonable* agreement with alternative estimates of adult mortality. However, the agreement with alternative methods, all of which have serious defects is not a very good way of justifying a new method. It is quite possible for the mortality estimates to appear both plausible and consistent, and at the same time to be seriously biased. Perhaps all the estimates may have been biased in the same diiection.

The method has become popular. For example, orphanhood questions were included on a sampling basis in the censues of Kenya and Uganda (1969), Botswana (1961), the Gambia (1973), Sudan (1973) and Sierra Leone (1974), and in demographic sample surveys in Lesotho (1967—68 and 1971—72) Malawi (1970—72) and Tanzania (1973)

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