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Estimation of Adult Mortality from Widowhood Information

DEMOGRAPHIC estimation has traditionally been a hazardous undertaking in most of the developing countries. Vital registration, where it exists, is not usually considered reliable. The data collected from the population censuses in these countries are defective. Thus, for most underdeveloped countries of the world to day, mortality and fertility analyses present special problems because of the inadequacy of the basic data. Over the past few years much of the focus of demographic methodology has turned to the development of methods for estimating demographic events from limited and defective data. Although the demographic data available in the developing countries have been less than satisfactory, their collection and analysis have been improving rapidly in recent years. Vital statistics data have also been improved greatly, particularly since the widespread introduction of sample surveys.

Many indirect techniques have been developed *to* make use of existing inadequate data to estimate fertility and mortality. A widely known indirect method of estimating adult mortality is the orphanhood method developed by Brass and Hill (Brass and Hill, 1973). Various shortcomings of the method have been noted. The orphanhood method raises a number of difficulties namely, the multiple counting of parents according to surviving children, the adoption effect for mothers, the widespread of ages at births of children for fathers, the biases due to rapid changes in mortality. Recently, Hill has devised another method to estimate adult mortality from widowhood information (Hill, 1975, 1977).

The aim of this paper is to apply the widowhood technique to the 1974 Census data of Bangladesh and determine whether the method yields a plausible level Of adult mortality. In a population where marriage is clearly defined and takes place almost universally during a limited span of age, the age specific proportions of ever widowed provide such a set of measures. In monogamous societies there is one-to-one correspondence of partners; even where polygamy is socially permitted the incidence of multiple counting would appear to be quite small. Widowhood method thus seems to be a particularly valuable measure for the estimation of the mortality of adult males.

Widowhood Method

Information is collected on the survival of the first spouse by asking a simple question, such as, "Is your first husband (wife) still alive?" Responses by females about their first husbands give information about male adult mortality, and responses by males about their first wives, about female adult mortality. The analysis of information on widowhood to estimate adult mortality has an apparent advantage over the analysis of information on orphanhood; the marriage function is much more close, having a minimum variance, thus reducing the possible deviations from model assumptions. Remarriages may affect the estimate, but it is possible to derive estimates from reports of young adults, who "will not have been married long, whose exposure to risk of widowhood is short, and whose widowhood experience thus reflects very recent mortality levels (Hill, 1975, 1977). In the orphanhood method, much less reliance can be placed on respondents under age 20, on account especially of bias arising from adoption of orphans by related families. There are no doubt some problems in the analysis of widowhood information. The information may be affected by widow remarriages. To minimise this difficulty, data must be collected on the survival of first spouse.

In the case of widowhood, neither commencing age nor the length of exposure are known. Implicitly, they can be arrived at from the ages of men and women at marriage in relation to the age of the respondents at the time of the survey. In practice, the results will depend on the bivariate distribution of ages at marriage of men and women. Applying the same mortality model as for orphanhood and simple functions for the distribution of ages at marriage, Hill was able to develop a convenient estimation procedure. The form it takes is the same as orphanhood. Weights W_N are calculated from the models for insertion into an appropriate equation which combines proportions never widowed in the successive'age groups.[1] For simplicity, the estimation of male mortality from female responses will be described first. The estimating equations used are:

$$l_{(N+5)}/l_{22\frac{1}{2}} = W_N \cdot 5\,P_{N-5} + (1 - W_N)\,5\,P_N\text{; and}$$
$$l_{(N+5)}/l_{27\frac{1}{2}} = W_N \cdot 5\,P_{N-5} + (1 - W_N)\,5\,P_N,$$

where W_N is the weighting factors, $5P_N$ is the proportion never widowed in the age group of women N to $N + 5$, and N is the central point of the adjacent age groups. For respondents aged 15 to 19 and 20 to 24, N will be 20, so the survivorship ratio estimated be $l_{25}/l_{22\frac{1}{2}}$, a survivorship of $2\frac{1}{2}$ years from an age of $22\frac{1}{2}$. If males marry on an average five years later than females, the exposure to risk will run from around $22\frac{1}{2}$ if females marry at $17\frac{1}{2}$. Thus for wives aged 30 will have husbands who survived from $22\frac{1}{2}$ to 35.

The first equation is used where the average age of the female marriage is below 20 years and the second, where it is higher. On the left-hand side of the equation the ages of exposure are made 5 years older than those of the women to allow for the fact that on average, husbands are about so much older than their wives. Deviations from this average are adjusted by the weights W_N. The weights W_N are located by two characteristics, the mean age of marriage of the cohort of women and the period mean age of marriage of men. The length of exposure is fixed by the difference between the current age of a group of respondents, centred at N and their mean age of marriage as a cohort moving through time. On the other hand, the mean ages of the husbands at the start of exposure will be a period measure that is dependent on the number of men in different age groups in the population at the time of marriage. In a growing population the number of men at younger ages will be relatively higher than if they had been a cohort moving through time. The period mean age of marriage is, therefore, normally lower than the cohort mean age. It should be noted here that the estimates made from the proportions of older persons widowed may, therefore, be biased if ages of marriage are changing. Allowance can be made for this if data on marriage at earlier periods are available. However, experience suggests that these biases are relatively small.

The weights W_N have to be determined by three measures, namely the two mean ages of marriage and N. The derivations of adult female mortality from responses of men about the proportion of first wives that have died is identical, apart from the range of measures. The two estimating equations are:

$$l_{(N-5)}/l_{17\frac{1}{2}} = W_N\,5P_{N-5} + (1 - W_N)\,5P_N\text{; and}$$
$$l_{(N-5)}/l_{22\frac{1}{2}} = W_N\,5P_{N-5} + (1 - W_N)\,5P_N$$

for male mean ages of marriage of under 25 and over 25 respectively.

The 1974 Bangladesh Census Data

From the data on the marital status in the 1974 Census of Bangladesh, widowhood can be easily calculated and translated into life table functions with the help of weighting factors. However, these census data are distorted by widow remarriages. So, it is not possible to use census information widowhood without taking into consideration the proportion of widow remarried.

Estimation of Proportion Remarried

The 1974 survey data on ever married, ever widowed and widowed of the first spouse are available. Brass has recently devised a formula for estimating P (i.e., the proportion remarried in an age group) from these data. If W_{Ex} is the proportion of ever widowed of the first spouse and W_x is the reported proportion of widowed, then P can be determined as follows:

$$P = (W_{Ex} - W_x)/(1 - W_{Ex}). \quad (1)$$

The detailed procedure of estimating P values from the 1974 Census data is given in Appendix. The value of P is around 0.08 from age group 35-39 onwards, but for younger age groups, it is not very consistent. In this case, we take the value of P to be 0.08 from age group 35-39 onwards, 0.03 for the age group 25-29 and 0.05 for the age group 30-34. By applying the value of P we can find the proportion remarried by the Brass's formula

$$W_{Ex} = (W_x + P)/(1 + P). \quad (2)$$

Life Table Construction

To establish a link between child mortality and adult mortality from widowhood technique for the construction of life table, we use the method suggested by Brass and Hill (1973). Taking an estimate of child mortality (l_2), as a starting point, a first value of $l_{22\frac{1}{2}}$ is derived from the Brass one-parameter model life tables (assuming $\beta = 1$). Thus value of l_{N+5} can be estimated from $l_{N+5}/l_{22\frac{1}{2}}$. Using Brass logit model a series of estimates of β, one for each value of N can be estimated as

$$\beta = Y_{(N+5)} - Y_{(2)}/Y_{s(N+5)} - Y_{s(2)}, \quad (3)$$

where $Y_{(2)}$ is the observed logit of l_2 and $Y_{s(2)}$ is the standard logit. N is the central age of the respondents. A first estimate of β is then taken as the average of range of estimates based on reports from the most reliable group of respondents. This range will depend upon individual circumstances. From this first estimate of β, a new value of $l_{22\frac{1}{2}}$ is calculated. The results are displayed in Appendix Table 2.

The β parameter was estimated as 0.93 from the average of the logits for N equal to 25 to 50, that is from reports on widowed by women in the age range 25-50 years. The fitted $l_{(N+5)}$ and the resulting survivorship ratios $l_{(N+5)}/l_{22\frac{1}{2}}$ are given in columns (3) and (6) of the Table 2. The first estimate of average β yields a value of β = 0.93; the range being from β = 0.85 for a central age of 30 to β = 1.03 for a central age of 50. The estimates of β are rather erratic. The fitted survivorship ratios are a little higher throughout ages.

It is impossible to make any positive assertion as to whether male adult mortality should be relatively higher than that of females. In most western populations male adult mortality is relatively higher than females, but this is not true in some populations of the developing countries, particularly in Asia. However, the expectation of life at birth for males which was estimated from the widowhood information (female respondents) seems to be reasonable.

Conclusion

The development of techniques for estimating demographic information from limited sources of data has been attracting increasing attention during over the last two decades or so. In this field, the orphanhood method for estimation of adult mortality has proved disappointing, both theoretically and practically (Hill, 1975). The widowhood method, however, shows distinct promise; it is more robust in the underlying assumptions than the original orphanhood method and less affected by the multiple reporting of the same event. The application of the method to the Bangladesh census data on widowhood information (female respondents) yields an expectation of life at birth 46 years. Although, the method has yielded a reasonable level of adult male mortality, question still remains about the reliability of the Bangladesh data, which has not been explored here. In order to prove the method a success, further research regarding the applicability of the Bangladesh data seems to be in order. Hill himself claimed that it is too early to assert that widowhood technique is an important advance. Many more applications are required, in wide range of cultures, before any such claim can be made.

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Appendix

TABLE 1—ESTIMATION OF ADULT MORTALITY FROM WIDOWHOOD INFORMATION (FEMALE RESPONDENTS) BANGLADESH : 1974

Age Groups	*Reported proportion of widowhood*	*P*	*Expected proportion of widowhood*	*Proportion never widowed*	*Weights*[1] W_N	$l_{N+5}/l_{22\frac{1}{2}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
20-24	0.019	0.02	0.038	0.962	0.8344	0.9590
25-29	0.028	0.03	0.056	0.944	0.9006	0.9394
30-34	0.057	0 05	0.102	0.898	0.9731	0.8963
35-39	0.101	0.08	0,167	0.833	1,0447	0.8374
40-44	0.217	0.08	0.266	0.734	1.1015	0.7465
45-49	0.320	0.08	0.389	0.611	1.1303	0.6480
50-54	0.647	0.08	0.673	0.327	1.1504	—

1. The weighting factors are based on the mean age at marriage of male and female, taken as 24 years and 16 years repectively.

TABLE 2—ESTIMATION OF ADULT MORTALITY FROM WIDOWHOOD INFORMATION (FEMALE RESPONDENTS) BANGLADESH : 1974

Central age (N)	$\frac{l_{N+5}}{l_{22\frac{1}{2}}}$	l_{N+5}* β	*Estimate of*** *implied* β	*Average*† β	*Fitted* $\frac{l_{N+5}}{l_{22\frac{1}{2}}}$
(1)	(2)	(3)	(4)	(5)	(6)
25	0.9590	0.6823	0.91		0.9476
30	0.9394	0.6684	0.85		0.9283
35	0.8963	0.6377	0.87	0.93	0.8857
40	0.8374	0.5958	0.91		0.8275
45	0.7465	0.5311	0.99		0.7376
50	0.6480	0.4610	1.03		0.6403

*The estimates in column (3) have been derived by multiplying values under column (2) with $l_{22\frac{1}{2}}$; $l_{22\frac{1}{2}} = 0.7115$ has been estimated from the Brass logit model $Y_{(x)} = \alpha + \beta Y_{s(x)}$, assuming $\beta = 1$ and having a child mortality l_2 (0.817). The child mortality has been estimated from the child survivorship data by Brass technique.

**Implied β has been calculated from the following formula

$$\beta = Y_{(2)} - Y_{(N+5)}/Y_{s(2)} - Y_{s(N+5)},$$

where $Y_{(2)}$ is the logit of l_2 (child mortality), $Y_{s(2)}$ is the logit of Brass general standard life table and N is the central age.

†Average β has been calculated from the reports on widowhood by women in the age range 25 to 50 years.

TABLE 3—CONSTRUCTION OF BRASS TWO-PARAMETER ABRIDGED LIFE TABLE (FOR MALES) HAVING $\alpha = -0.0830$ AND $\beta = 0.93$

Age	$Y_{s(x)}$	$\alpha + \beta Y_{s(x)}$	l_x	L_x	T_x	e_x^0
0	—	—	10000	8989[1]	461504	46.2
1	−0.8670	−0.8893	8555	32343[2]	452515	52.9
5	−0.6015	−0 6424	7833	38745	420172	53.6
10	−0.5498	−0.5943	7665	38015	381427	49.8
15	−0.5131	−0.5602	7541	37190	343412	45.5
20	−0.4551	−0.5062	7335	36006	306222	41.7
25	−0.3829	−0.4391	7065	34653	270216	38.2
30	−0.3150	−0.3760	6796	33305	235563	34.7
35	−0.2496	−0.3151	6526	31900	202258	31.0
40	−0.1817	−0.2520	6234	30318	170358	27.3
45	−0.1073	−0.1806	5893	28510	140040	23.8
50	−0.0212	−0.1027	5511	26348	111530	20.2
55	+0.0832	−0.0056	5028	23673	85182	16.9
60	+0.2100	+0.1123	4441	20360	61509	13.8
65	+0.3746	+0.2654	3703	16400	41149	11.1
70	+0.5818	+0.4581	2857	11948	24749	8.7
75	+0.8611	+0.7178	1922	7423	12801	6.7
80	+1.2433	+1.0733	1047	3735	5378	5.1
85+	+1.7355	+1.5310	447	1643[3]	1643	3.7

1. $L_0 = 0.3\ l_0 + 0.7\ l_1$.
2. $L_1 = 1.4\ l_1 + 2.6\ l_5$.
3. Assuming $e_0^0 = 45$ years and also assuming every one dies after age 85+. The $_\infty L_{85}$ can be estimated from the Brass one-parameter model life table as $_\infty L_{85}/l_{85} = y/l_{85}$, $y/447 = 1103/300$, therefore, $y = 1643$.