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Use of Widowhood Data for Estimating Adult Mortality for West Bengal, 1981

Introduction

THE straightforward way of calculating the mortality rates is by using the information on deaths by age produced by a vital registration system. However, India like many other developing countries possesses such a registration system it is often the case that not all the deaths are registered. As a result, the death rate implied by the reported deaths is usually an underestimate of the true death rate prevalent in the population in question, and some method of adjustment is required to transform the reported death rate into a better estimate of mortality conditions. In India, the most reliable registration system, popularly known as Sample Registration System (SRS) introduced during mid-sixties provides vital rates from the direct estimates, are often underestimated. In case of death rates, the SRS-estimate for 1980-82 was 13.5 for rural and 7.7 for urban population respectively. By weighting rates for rural and urban population to the total population in 1981 Census, the death rate for all sector population for 1980-82 was estimated at 12.2 against the quasi-stable estimate of 14.5. Thus, the death rate was underestimated in the Sample Registration System (SRS) by a margin of 16% for India in 1980-82 (Das, 1992). It may be expected that the death rates provided by SRS for the States in India for 1980-82 were also underestimated. An attempt has therefore been made to estimate the mortality conditions in the adult ages both for males and females on widowhood data by indirect methods adopted in the present study for West Bengal, 1981. The methods as recently revised by Hill (1977) and Hill-Trussell *(loc. cit.)* namely, (i) conditional method and (ii) unconditional method have been adopted in the present study and the estimates are compared. Theoretically, information collected should refer to the survival of the first spouse; in Indian Censuses questions are asked of, to the evermarried respondents

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on their marital status only but the information on the order of marriage is not collected. As a result, bias in the survivorship estimates may arise and the extent of bias may not be quantified. West Bengal is a mosaic of different culture andreligion. In some society, specifically in Muslims the effect on the incidence of remarriage still exists but in case of Hindus, a wide range of results has come up (Malaker, 1981). So, as a first approximation, while estimating survivorship probabilities, it has been assumed that the marriages recorded in Indian Censuses are of first order for each sex. The main assumption underlying the method, is the static conditions for mortality and nuptiality in the recent past. But in a changing mortality condition, Brass-and Bangboye (1981) have relaxed the assumption of constant mortality to estimate the reference time period. Since West Bengal has been experiencing changing mortality conditions (F.W. Year Book, Govt, of India, 1978-85), the procedure adopted by Brass and Bangboye (1981) has been adopted to estimate the time-location to which the estimate refer. Finally another attempt has been made to relate the two distinct sets of mortality estimates, (i)* childhood mortality estimates from children everborn and surviving data by age groups of mother and (ii) adult mortality estimates from widowhood data by age of the evermarried respondents to complete the age pattern of mortality generated by Brass Two-parameter Logit Life Table System for West Bengal, 1981.

The Data Source and the Data Used

The data are collected from the Population Census, 1981 and the information required to estimate the adult mortality are as follows:

(i) Number of evermarried male/female respondents with surviving first spouse alive/ dead, classified by five-year age groups,
(ii) Number of evermarried male/female respondents who did not declare or did not know the survivorship status of the first spouse by five-year age groups,
(iii) Total number of evermarried male/female respondents by five-year age groups,
(iv) Singulate mean age at marriage for male/female,
(v) An independent estimate of l_2 by sex.

Methodology

Two indirect methods as recently revised by Hill (1977) and Hill-Trussell *(loc. cit.)* have been used in the present study. The methods are the following:

(A) Conditional method (Hill, 1977) and
(B) Unconditional method (Hill-Trussell *(loc. cit.)*.

The methods assume constant mortality and nuptiality in the recent past.

* Not shown in detail.

Apart from this, methodology proposed by Brass and Bangboye (1981) to estimate the reference time-period of the mortality estimates to which they refer has also been adopted in the study.

The above mentioned methods have been given in order in the Appendix.

Finally to get better estimates of the two independent sets of $l_{(x)}$ values: one from childhood mortality and another from adulthood mortality, Brass (1975 : 91-6) Two-Parameter Logit Life Table System has been adopted. Logit transformation of the estimated survivorship probabilities $l_{(x)}$ is given by,

$$
\begin{aligned}
Y_{(x)} &= \text{logit}\,(1.0 - l_{(x)}) \\
&= 0.5\; l_n\,(1.0 - l_{(x)})/l_{(x)}
\end{aligned}
$$

Selecting suitably, the two most reliable sets of points representing survivorship probabilities for childhood and adulthood ages, a line is fitted to them by group of childhood points (l_2, l_3 and l_5) for both males and females; and adulthood points (l_{40}, l_{45}, l_{50}, l_{55} and l_{60}) for males and (l_{35}, l_{40}, l_{45}, l_{50} and l_{55}) for females respectively. For estimating the two parameters α and β by group mean method, the notations, (Y_c and Y_a) and (X_c and X_a) representing the group means of the logit transformation of the childhood and adulthood points of the estimated and standard survivorship probabilities have been used respectively. Hence, the value of β is given by,

$$
\begin{aligned}
\beta &= \frac{Y_a - Y_c}{X_a - X_c}, \text{ and} \\
\alpha &= Y_c - \beta \cdot X_c
\end{aligned}
$$

Having estimated the values of α and β, the fitted logits $Y_{fit}\,(x)$ are then obtained by using the equation below

$Y_{fit}\,(x) = \alpha + \beta \cdot Y_s\,(x)$, where $Y_s\,(x)$ is the logit transformation of the Standard (Brass) and the fitted l_x is obtained by taking the inverse of the logit transformation as,

$$
\text{Fitted } l_{(x)} = \frac{1}{1 + e^{2Y_{fit}(x)}}\,.
$$

Findings

Table 1, presents the data on proportion not widowed by sex and age. The table shows that the proportion not widowed by sex has been decreasing as their age increases. The decreases in females upto the age 35 is slow and very fast afterwards. This suggests that male mortality is increasing very fast after the females reaching the age 35. On the other hand the proportion of male not widowered is seen constant upto the age 40 and afterwards they are declining but very slowly. These data exhibit that proportionately of widows are much more higher than those of the widowers.

TABLE 1: DATA ON PROPORTION NOT WIDOWED BY AGE AND SEX FOR WEST BENGAL, 1981

Age Group	*Proportion not widowed*	
	Female	*Male*
	(2)	*(3)*
20 - 24	0.98754	0.99562
25 -29	0.97720	0.9951
30 - 34	0.95782	7
35 - 39	0.92563	0.99348
40 - 44	0.85180	0.9902
45 - 49	0.76878	4
50 - 54	0.61827	0.9817
55 - 59	0.51894	3

TABLE 2: ESTIMATION OF CONDITIONAL MALE AND FEMALE SURVIVORSHIP PROBABILITIES, WEST BENGAL, 1981

Age		*Male survivorship*			*Female survivorship*	
n	$l_m(n)/l_m(20)$	*West survival level*	*Reference date*	$l_f(n)/l_f(20)$	*West survival level*	*Reference date*
(/)	. *(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
25	0.98848	20.17	1979.73	0.99407	21.15	*
30	0.97950	20.74	1977.44	0.99274	22.56	1978.18
35	0.96309	20.11	1975.17	0.99100	23.19	1975.96
40	0.93475	19.06	1973.05	0.98153	22.66	1973.74
45	0.86731	16.46	1971.08	0.97029	22.54	1971.72
50	0.79636	15.21	1969.29	0.94740	22.09	1970.02
55	0.66306	12.36	1967.22	0.92854	22.47	1968.77
60	0.58318	12.59	1965.70			

Average level = 17.09
$SMAM_m$ = 25.73

Average level = 22.38
* out of line.
$SMAM_f$ = 19.86 years.

In Table 2, the conditional survivorship probability estimates for each sex associated with the estimated mortality levels that are consistent with the Coale-Demeny West model and the reference dates to which the mortality estimates refer, have been presented. Table 2 shows that the estimates of the male survivorship probabilities are not, very different from the proportion surviving reported by the females upto the age 40 in Table 1 and afterwards the male survivors are much more compared to those of the proportion surviving reported by the female respondents in Table 1. This implies an upward bias, possibly arising out of the underreporting by older women about their marital orders. At the very young ages of 25 and 30, male survivorship probabilities as indicated by mortality levels have shown an unbelievable picture. At age 25, the survivors are less than those at age 30 suggesting a simple case of age misreporting, that is, a certain proportion of the respondents has been shifted to the next higher age 30. This yields error in the estimation and produces a downward bias at age 25. Older male survivors have been observed low in Table 2.

The results that obtained from the female respondents on male survivorship probabilities exhibit a declining trend in the years prior to Census. This trend may be acceptable moderately especially in view of having the good mortality level (Overall level is 17.10 in the Princeton West model life tables) which is slightly higher but close to the mortality level 16.56 estimated by linear interpolation corresponding to e°_0 for males (55.45) in West Bengal, 1981, provided by the Report on the Expert Committee on Population Projections in the light of 1981 Census (Department of Family Welfare, Ministry of Health, Govt. of India, New Delhi, 1986-87). The mortality estimates refer to period of 15 years prior to Census.

On the other hand, the Table 2, shows that the female survivorship estimates are different but not so much from the female proportion surviving as reported by the male respondents even in the old ages presented in Table 1. But the results that obtained from the female survivorship estimates in Table 2 show an irregularity as indicated by the mortality levels. The Table 2 shows that the overall female mortality level is much more higher than overall male mortality level which is quite insignificant and unacceptable for West Bengal because in West Bengal, female mortality is higher than male mortality. The mortality level estimated for female by conditional method is very far from that of the mortality level prevailing in West Bengal. The mortality estimates refer to a period of around 12 years prior to Census.

Table 3 presents the estimates of survivorship probabilities from birth to adult ages by age and sex based on the reported proportion surviving presented in Table 1. Table 3, shows that estimated survivorship probabilities by sex and age compared to those of the reported proportion surviving presented in Table 1, are much lower. The immediate interpretation of these low values of the estimates is the effect of using the independent estimate of /,. The /„ may be slightly overestimated due to which the adult mortality estimates by sex are lower than those of the estimates presented in Table 2. Overall mortality levels for males and females are 16.39 and 18.42 respectively (in the Princeton Westmodellifetables). Overall male mortality level (16.39) conforms close to that of the level 16.56 estimated corresponding to e°. So, from this cofornity, the effect of using $l(m)_2$ is virtually very-negligible. But the use l_{2} may have some effect on the estimation of high survivorship probabilities, nonetheless the estimates obtained by the unconditional method may be acceptable. The estimates obtained by conditional method are higher than those obtained by the unconditional method.

TABLE 3: ESTIMATION OF CONDITIONAL MALE AND FEMALE SURVIVORSHIP PROBABILITIES. WEST BENGAL, 1981

Age	Male survivorship			Female survivorship		
n	$l_m(n)$	West survival level	Reference date	$l_f(n)$	West survival level	Reference date
(/)	(2)	(3)	W	(5)	(6)	(7)
25	0.84081	17.54	1979.73	—	—	*
30	0.83486	17.66	1977.44	0.86101	17.82	1978.18
35	0.81897	17.73	1975.17	0.85532	18.20	1975.96
40	0.79217	17.55	1973.05	0.84130	18.33	1973.74
45	0.72971	16.50	1971.08	0.82626	18.52	1971.72
50	0.67523	16.05	1969.29	0.80203	18.58	1970.02
55	0.55280	14.06	1967.22	0.78310	19.05	1968.77
60	0.48623	14.02	1965.70			

Average level = 16.39

Average level = 18.42
*out of line.
— Impossible to estimate.

Comparative Study of the Methods Used

A Comparison of the mortality levels presented in Table 2 with those presented in Table 3 indicated that the estimates of male survivorship probabilities associated with the former imply slightly lower mortality (that is, higher mortality levels) than those implied by $l_{m(n)}$ values presented in Table 3, by taking child mortality (extrapolated) into consideration. The immediate reason for these differences are that the child mortality estimates employed, imply slightly higher mortality and hence, their use in the estimation of $l_{m(n)}$ values reduces the overall mortality levels associated with the latter. So, this suggests that child mortality is overestimated to some extent. But in case of female, the mortality levels that are presented in Table 2 are much higher than those in Table 3. This implies that the male respondents have under-reported the order of marriage. The weakness of the widowhood data in this particular case is also suggested by the fact that the mortality levels in Table 2 fail to increase as age of the respondents decreases (that is one moves towards the present in terms of reference date). Taken at face value, these estimates would imply that female adult mortality in West Bengal has increased over time. The small likelihood of such an event immediately makes their accuracy questionable, but it is the comparison between these levels and those implied by the estimates of child mortality that best illustrates the inconsistencies in the data. Hence, the case of West Bengal is a good example of how the application of a variety of estimation methods allows the assessment of data quality.

Smoothing Two Sequences of l_x Values

Survivorship function, I_X by unconditional method has been considered te relate the survivorship function I_x estimated separately from children everbom and surviving data to learn about the age pattern of mortality for West Bengal, 1981. Therefore, an attempt has been made to smooth two sequences of I_X values, one for the childhood ages and another for the adult ages and suitably blending these two series at the junction.

Table 4, presents the values of smoothed survivorship function 1(x) for males. The smoothed *l(x)* values show conformity to those of preliminary estimates of I_X values in the childhood ages but on the other hand it differs in the adult ages for males. The smoothed I_X values are lower compared to those of estimated I_X values in the adult ages. The values of α the intercept and β, the slope or the gradient of the straight line are α = -0.3177 and β = 1.0836. A low (i.e., negative) value of α the level parameter, indicates low mortality relative to the standard and a high positive value of β implies low infant and child mortality and high

TABLE 4: ESTIMATED SMOOTHED SURVIVORSHIP PROBABILITIES FOR MALES GENERATED BY BRASS TWO-PARAMETER LOGIT LIFE TABLE SYSTEM FOR WEST BENGAL, 1*981

Age x	*Logit (Standard* / $_{(x)}$) $Y_S(X)$	*Logit estimated* $1_{(X)}$, $Y_{(X)}$	$Y_{fit}(X)$	*Fitted,* $1_{(x)}$	*Estimated* $1_{(x)}$
2	-0.7152	-1.0609	-1.0927	0.8989	0.8930
3	-0.6552	-1.0393	-1.0277	0.8865	0.8888
5	-0.6015	-0.9896	-0.9695	0.8742	0.8786
10	-0.5498	-0.9283	-0.9135	0.8614	0.8649
15	-0.5131	-0.8888	-0.8737	0.8516	0.8554
20	-0.4551	-0.8583	-0.8108	0.8350	0.8477
25	-0.3829	-0.8321	-0.7326	0.8123	0.8408
30	-0.3150	-0.8100	-0.6590	0.7888	0.8348
35	-0.2496	-0.7548	-0.5882	0.7643	0.8190
40	-0.1817	-0.6667	-0.5146	0.7368	0.7914
45	-0.1073	-0.4966	-0.4340	0.7043	0.7297
50	-0.0212	-0.3659	-0.3407	0.6640	0.6752
55	0.0832	-0.1058	-0.2275	0.6118	0.5527
60	0.2100	0.0278	-0.0901	0.5449	0.4861

β= 1.0836, α= -0.3177

adult mortality for males relative to the standard. Table 5 presents the smoothed survivorship function I_X for females. The smoothed I_X values show close conformity to those of the I_X values both in the childhood and adulthood ages. From this closeness it can be claimed that the estimates obtained by using Hill-TrusselL's *(loc. cit.)* unconditional method in Table 3, are better than the estimates obtained by Hill's (1977) conditional method. In case of female the values of α and β are -0.7214 and 0.4956 respectively. The negative value of α indicates very low mortality and a low positive value of β indicates high infant and child mortality and low adult mortality relative to the standard.

TABLE 5: ESTIMATED SMOOTHED SURVIVORSHIP PROBABILITIES FOR FEMALES GENERATED BY BRASS TWO-PARAMETER LOGIT LIFE TABLE SYSTEM FOR WEST BENGAL, 1981

Age n	*Logit (Standard $I_{(x)}$) $Y_s(x)$*	*Logit estimated $I_{(x)}$ $Y_{(x)}$*	*$Y_{(Fit)}(x)$*	*Fitted, $I_{(x)}$*	*Estimated $I_{(x)}$*
2	-0.7152	-1.1059	-1.0758	0.8958 .	0.9013
3	-0.6552	-1.0541	-1.0461	0.8901	0.8917
5	-0.6015	-0.9817	-0.0195	0.8848	0.8769
10	-0.5498.	-0.8986	-0.9939	0.8795	0.8578
15	-0.5131	-0.8457	-0.9757	0.8756	0.8444
20	-0.4551	-0.7830	-0.9469	0.8692	0.8272
25	-0.3829	*	-0.9112	0.8608	*
30	-0.3150	-0.9118	-0.8775	0,8526	0.8610
35	-0.2496	-0.8884	-0.8451	0.8442	0.8553
40	-0.1817	-0.8340	-0.8114	0.8352	0.8413
45	-0.1073	-0.7798	-0.7746	0.8248	0.8263
50	-0.0212	-0.6994	-0.7319	0.8121	0.8020
55	0.0832	-0.6419	-0.6802	0.7958	0.7831

β = 0.4956, α = -0.7214, * Refers to Table 3.

This evidence suggests that the age pattern of mortality for both males and females in West Bengal might be quite different from the standard used in the estimation procedure, the estimate of β gives a general impression of the way in which the population differs. But this does not provide a detailed picture of how the standard and the population differs but does provide evidence of the overall pattern of adult mortality.

Concluding Remarks

From the original reports, it has been noticed that the proportion of widows is higher than the widowers. Use of conditional method provides believable estimates for adult male mortality as indicated by mortality level, on the other hand for female, does not. But the unconditional method provides slightly lower adult male mortality level and virtually the variations in overall mortality level is negligible. Hence any of the two methods may be considered for estimating male adult mortality. The overall mortality level for adult female is much lower than that exhibited by use of unconditional method but nearly close to e°_0 for females in West Bengal, 1981. In view of this evidence, it may be concluded that reporting made by female is much better than that made by male. Older males have misreported their marriage orders. The smoothed $1_{(x)}$ values for females conform to those of $1_{(x)}$ values estimated by unconditional method. This concludes that the use of $1_{f(2)}$ has advantages on the estimation of adult female mortality and the child mortality estimates for female may be acceptable.

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Appendix

A. 1: Conditional Survivorship Method

For male,

$$l_m(n)/l_m(20) = a(n) + b(n)\,SMAM_f + c(n)\,SMAM_m + d(n)\,NW_f(n-5) \qquad \text{(i)}$$

and , for female,

$$l_f(n)/l_f(20) = a(n) + b(n)\,SMAM_f + c(n)\,SMAM_m + d(n)\,NW_m(n) \qquad \text{(ii)}$$

where the co-efficients $a(n)$, $b(n)$, $c(n)$ and $d(n)$ are different for males and females in respect of each value of 'n'. $SMAM$'s (Hajnal 1953) are the singulate mean age at marriage for males and females. $NW_f(n)$ and $NW_m(n)$ are the proportion not widowed females and not widowered males respectively from age 'n' to '$n+4$' whose spouse was alive at the time of survey. $NW_f(n-5)$ has been considered in (i) because it has been assumed that wives are five years younger to husbands.

A. 2: Unconditional Survivorship Method

For male,

$$l_m(n) = a(n) + b(n)SMAM_f + c(n)\,SMAM_m + d(n)\,NW_f(n-5) + e(n)\,l_m(2) + f(n)\,RSW \qquad \text{(iii)}$$

and, for female,

$$l_f(n) = a(n) + b(n)\,SMAM_f + c(n)\,SMAM_m + d(n)\,NW_m(n) + e(n)\,l_f(2) + f(n)\,RSW \qquad \text{(iv)}$$

where, besides the additional co-efficients of $e(n)$ and $f(n)$, the co-efficients $a(n)$, $b(n)$, $c(n)$ and $d(n)$ are different from those appearing in equations (i) and (ii). $l_{(2)}$ are the extrapolated childhood survivorship probabilities. RSW, is the ratio of $l_{(20)}$ and $l_{(2)}$ in the standard (that is, at level 16 for female in West model of Coale-Demeny model life tables).

The above mentioned methods are based on the assumption of constant mortality and nuptiality in the recent past.

B: Methods of Estimating Reference-Period

In case of changing mortality, Brass and Bangboye (1981) proposed a method of estimating reference time-period to which the mortality estimates refer. The methods for

males and females are as follows:
For male,

$$t_m(n) = (n - 2.5 - SMAM_f)\,(1.0 - U_m(n))/2.0 \qquad \text{(a)}$$

where,

$$U_m(n) = 0.3333\ I_n\ NW_f(n-5) + Z\,(SWAM_m + n - 2.5 - SMAM_f) + 0.0037\,(27.0 - SMAM_m)$$

and , for female,

$$t_f(n) = (n + 2.5 - SMAM_m)\,(1.0 - U_f(n))/2.0 \qquad \text{(b)}$$

where,

$$U_f(n) = 0.3333\ I_n\ NW_m(n) + Z\,(SMAM_f + n + 2.5 - SMAM_m) + 0.0037\,(27.0 - SMAM_f),$$

the quantity $n + 2.5 - SMAM$ is used as an indicator of the mean duration of first marriage of the respondents aged from 'n' to '$n+4$' and the values of the Standard function 'z' are taken from U.N. Manual, X, 1983).