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Use of Indirect Methods for Estimating Childhood Mortality for West Bengal Prior to 1981

Introduction

INFANT and childhood mortality have traditionally been considered as indicators of overall mortality conditions of a country, health progress and, indeed, the overall social and economic wellbeing; an attempt has been made to estimate the infant and childhood mortality in the context of West Bengal, a constituent state of India. It has been increasingly realized, however, that for several reasons given below, child mortality Over age 1 and under age 5 needs to be examined in addition to infant mortality. Unlike developed countries, reliable registration data are not available for countries like India. The estimation of such mortality by analytical methods is thus necessary. In India, civil registration system is more than a century-old, but is totally unacceptable. Using dual record system, the Sample Registration Scheme (SRS) was introduced during mid-1960 as a complementary to civil registration. Despite deficiency in its estimates, the SRS provides the best available source of vital statistics in India and Constituent States.

In this study, we focus on West Bengal because it occupies a special position in the demographic map of India. The then undivided Bengal was divided into two parts at the time of independence in 1947. The eastern part became Pakistan and later Bangladesh. West Bengal, forming one of the small states in India in terms of land area, has become the fourth populous state (about 68 million in 1991) of the country, its density of population being the highest with 766 persons per sq km. West Bengal has absorbed millions of refugees coming across the Indo-Bangladesh border since 1947. The share of its population in achieving higher education levels is quite noteworthy. The overall growth rate of the state has been rising and its natural growth rate is quite moderate. In West Bengal, the health infrastructure at the grass-root level and its management have not been as good as Kerala. The overall literacy, particularly among women, is also much higher in Kerala. As a result of these differences, the demographic measures in West Bengal are not as low as Kerala. A brief demographic scenario for the two states is given below:

Measures	*Year*	*West Bengal*	*Kerala*
Birth rate	1986-88	29.5	21.4
Death rate	1986-88	8.6	6.2
Infant mortality rate	1988	69.0	28.0
Percent under 5-years	1981	11.6	10.7

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Apart from these, the neighbouring country Bangladesh does not. however, present comparable demographic situations as West Bengal. For example, its infant mortality rate was 116 and under five mortality was 184 per thousand births in 1989(Ross e/ a/. 1992).

Direct estimates of mortality from deficient registration of vital statistics and census being often flawed, indirect methods of estimation based on children everborn and surviving is mainly adopted in the study. But SRS age specific death rate-based mortality estimates have also been presented for a comparative study. Using the Brass-Trussell method as ours, the office of the Registrar General (R.G.) of India, has recently (1988) estimated the infant and childhood mortality for West Bengal. The major points of difference with our present estimates are that it uses only Cnale-Demeny South model But West model is often recommended as a first choice to represent mortality in countries where lack of evidence prevents a more appropriate choice of model (United Nations 1983) and it is believed that West model may yield less error in the estimation. So, in the present study both South model and West model have been used and compared. Then logit smoothing of the estimates obtained by using both South model and West model is done. Moreover, the infant and child mortality estimates are classified by both age of mother and duration of marriage. The reporting of 'duration' is believed to be more reliable than that of 'age'. The SRS-based estimates of mortality have shown inconsistency with those of indirect age-based and duration-based estimates. The R. G. estimates, however, use only age classification. Though the information on number of children everbom and number of children surviving are available at the district level, even approximate estimates of model mortality patterns at this disaggregated level do not seem to be feasible, particularly in the presence of considerable inter-district migration. Average number of children everbom may be distorted by the migration of women. The R.G. estimates are, however, given at the district level, but do not make attempt to test their consistency with the state estimate.

The Data Source and the Data Used

In the present study, the data are taken from the Population Census of 1981 and SRS (1981-83). The items of information used are as follows:

A. (i) Children everbom and surviving classified by five-year age groups of mother.

(ii) Women (15-49) classified by five-year age groups. B. (i) Children everbom and surviving by five-year duration groups of marriage of mother.

(ii) Currently married women (15-49) by five-year duration groups of marriage.

In the present study, the duration of marriage is considered only for currently married women (15-49) of first union because the variants based on the data classified by duration of marriage are, strictly speaking, based on the assumption that woman, once married, stay married until age 50 (the assumed upper limit of the potential reproductive life of a woman). Therefore, the duration-based methods should strictly be applied only to data from currently married women still in their first union. (For details, see United Nations 1983, Chapter III: 75.)

But Indian censuses do not. however, provide order of marriages. As such all current marriages are assumed in the paper as of first order.

C. SRS age-specific death rates (1981-83) by five-year age-groups for each sex.

Limitations of Data and their Adjustment

The information on children everborn, the major input for the estimation of mortality of early ages, are known to suffer from two types of errors. One arises from the under-reporting of children and the other from the misclassification of women in age or duration groups. The children, living elsewhere and those who have died, are often not reported so that proportion of such omission increases with age of mother. In our data, the approximate monotonic increase of average parities with increase of age, at least younger ages, indicates absence of such error of omission. On the other hand, the proportion of wrong inclusion of still births or foetal deaths among liveborn children seems to be insignificant. Another kind of error that may arise is the misclassification of childless women into category 'parity not stated'. This may affect average parity downward. Data given at the end of the paragraph will prove the point.

Average parities by the age of mother in 1981

15-19	20-24	25-29	30-34	35-39	40-44	45-49
0.22	1.20	2.42	3.47	4.34	4.84	5.14

An exercise relating to the estimation of 'true women childless' and 'true women with parity not stated' has been done with the help of El-Badry's adjustment procedure for the present study. According to the model presented by El-Badry in 1961, the true level of non-response is the estimated value of β (here, the value of $\beta = 0.0377$). When the data on children everborn are being used to estimate the childhood mortality indirectly by the methods described in this paper, the average parity of women of age group 'i' should be calculated by using $FP^*(i)$, the estimated number of women with known parity as the denominator instead of using the reported number, $FP(i)$, as suggested by El-Badry. But the average parities $P(i)$'s obtained by using the denominator $FP^*(i)$ give a very negligible variation compared to those of average parities obtained by using the denominator $FP(i)$ on one hand. But on the other hand, the ratio of P_1/P_2 and P_2/P_3 obtained by using $FP^*(i)$ and $FP(i)$ as the denominators, give the same results. So, in the estimation of childhood mortality for West Bengal, $FP(i)$ has been used as the denominator to find out the $P(i)$'s.

Methodology

Direct measures of infant and child mortality being suspect, we use indirect methods for estimating such mortality from information on children everborn (CEB) and children surviving (CS). Most of these are modifications and refinements of a procedure originally developed byBrass (Brass *et al.* 1968: Sullivan 1972: Trussell 1975; Feeney 1976; Preston andPalloni 1977;Palloni 1978;TrussellandPreston 1982). For the present study, the Brass-Sullivan method and the Brass-Trussell method have been used. The methods assume constant fertility and childfiood mortality in the recent past. As evidenced from the following data from SRS (Registrar General, India, 1985, *Sample Registration Bulletin,* Vol, XIX, No.

2), fertility for West Bengal has not changed much during the period under consideration:

	1974-76	*1975-77*	*1976-78*	*1977-79*	*1978-80*
Birth rate (3-year moving average)	29.6	30.9	30.8	31.1	30.9

During 1976-80, infant mortality for India changed from 129 to 114. West Bengal does not have the relevant registration data for the period, but on the basis of current occurrence, childhood mortality is believed to have declined at least as fast as the country as a whole. But the problems created by declining mortality are taken care of by referring the estimates to different time-points before the census.

Brief description of the methods is given in the Appendix. In order to find out the best estimate of the survivorship function $l(x)$ from the Brass-Sullivan and Brass-Trussell preliminary estimates, the logit smoothing technique is adopted. Thus the smoothed value of

$$Y(x) = 0.5 \ln (1 - l(x)/l(x))$$

denoted by $Y(x)$ is derived from the estimated function $l(2)$, $l(3)$ and $l(5)$ as follows :

$$\hat{Y}(x) = Y_s(x) + \frac{1}{3} \sum_x (Y(x) - Y_s(x))$$

where $x = 2$, 3 and 5; $Y_s(x)$ is the logit of the Brass General Standard life table smoothed by Hobcraft (cited in Hill and Trussell 1977). The smoothed $l(x)$ values are given by

$$\hat{l}(x) + 1/[1 + \exp(2\hat{Y}(x))].$$

Findings

The sex ratios (not shown here separately) of the children everborn by age groups 15-19, 20-24, 25-29 and 30-34 and duration groups 0-4, 5-9, and 10-14 show a value of around 1.07. This sex ratio implies that the birth registration is fairly complete. On the other hand, the average parities, $P(i)$'s are increasing monotonically with the increase in age or marriage duration of mother in Tables 1-3 for both males and females, and the proportions of children dead, $D(i)$'s, are, also increasing. So, as in the case of age-based analysis, the data classified by duration of marriage, appear to be of acceptable quality. The consistency of the final mortality estimates with respect to the estimates obtained from both the age-based and duration-based approaches can be conveniently assessed by finding the mortality levels in the Coale-Demeny West model and South model by linear interpolation. As an illustration for $l(2)$, in Table 1 (where $l(2) = 0.8927$), the interpolation factor θ, is,

$$\theta = (0.8927 - 0.88164)/(0.89790 - 0.88164)$$
$$= 0.70,$$

that is, the values that enclose the preliminary estimate of $l(2)$ are $l_{16}(2) = 0.88164$ and $l_{17}(2) = 0.89790$ (the $l_{(2)}$ values at levels 16 and 17 respectively.) The estimated level is consistent with $q_{(m)}$ (2), being 16.70 ~ 17.0 when rounded. The dates prior to Census, referred by the mortality estimates, have been calculated. Indian census of 1981 was carried out on 1st March of that year, which is equivalent to 1981.16. The decimal equivalent has been obtained (United Nations 1983) as

Number of days from 1, January to 1, March)/365 =

60/365=0.165

The estimated dates are presented in Tables 2 and 3. The reference dates have been subtracted from 1981.16 to get the estimated dates, it may be noted that using the above-mentioned procedure, the estimates of reference dates were found to be very close.

In Table 1, the Brass-Sullivan age-based estimates of *q(x)* values after being converted into mortality levels in the Coale-Demeny West and South model life table system show little

TABLE 1 : BRASS-SULLIVAN ESTIMATES OF CHILDHOOD MORTALITY BY SEX AND AGE GROUP OF MOTHER, WEST BENGAL, 1981

Age group of mother	i	x	*P(i)*	*D(i))*	*q(x)*	*I(x)*	*Mortality level*
' *(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(V*	*(7)*	*(8)*
Males, [$P_{(2)}$ / [$P_{(3)}$ =0.4975]							
			(a) West family of mortality pattern				
20-24	2	2	0.6214	0.1040	0.1073	0.8927	17.0
25-29	3	3	1.2492	0.1125	0.1092	0.8908	17.0
30-34	4	5	1.7891	0.1212	0.1172	0.8829	17.0
			(b) South Family of mortality pattern				
20-24	2	2	0.6214	0.1040	0.1068	0.8932	18.6
25-29	3	3	1.2492	0.1125	0.1104	0.8896	18.9
30-34	4	5	1.7891	0.1212	0.1189	0.8811	18.8
Females, [$P_{(2)}$ / $P_{(3)}$ = 0.4940]							
			(a) West family of mortality pattern				
20-24	2	2	0.5802	0.0959	0.0991	0.9009	16.1
25-29	3	3	1.1747	0.1094	0.1064	0.8936	16.2
30-34	4	5	=1:6767	0.1227	0.1186	0.8814	16.0
			(b) South family of mortality pattern				
20-24	2	2	0.5802	0.0959	0.0987	0.9013	18.5
25-29	3	3	1.1747	0.1094	0.1105	0.8895	18.3
30-34	4	5	1.6767	0.1227	0.1190	0.8810	18.2

TABLE 2: BRASS-TRUSSELL ESTIMATES OF INFANT AND CHILDHOOD MORTALITY BY SEX AND AGE GROUP OF MOTHER, WEST BENGAL, 1981

Age group of mother	*i*	*x*	*P(i)*	*D(i)*	*K(i)*	*q(x)*	*l(x)*	*Estimated date*	*Mortality level*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(S)	(9)	(10)
Males, ([$P_{(1)}/P_{(2)}$ = 0.1793; [$P_{(2)}/P_{(3)}$] = 0.4975])									
(a) West family of mortality pattern									
15-19	1	1	0.1114	0.1060	1.0374	0.1100	0.8900	Jan., 1980	15.1
20-24	2	2	0.6214	0.1040	1.0286	0.1070	0.8930	Sep., 1978	16.7
25-29	3	3	1.2492	0.1125	0.9886	0.1112	0.8888	Sep.. 1976	16.9
30-34	4	5	1.7891	0.1212	1.0014	0.1214	0.8786	May, 1974	16.8
(b) South family of mortality pattern									
15-19	1	1	0.1114	0.1060	0.9762	0.1035	0.8965	Jan., 1980	17.3
20-24	2	2	0.6214	0.1040	1.0233	0.1064	0.8936	Oct., 1978	18.7
25-29	3	3	1.2492	0.1125	1.0035	0.1129	0.8871	Oct., 1976	18.8
30-34	4	5	1.7891	0.1212	1.0144	0.1229	0.8771	June, 1974	18.6
Females ([$P_{(1)}/P_{(2)}$] = 0.1798; [$P_{(2)}/P_{(3)}$] = 0.4940])									
(a) West family of mortality pattern									
15-19	1	1	0.1043	0.0892	1.0333	0.0922	0.9078	Jan., 1980	15.1
20-24	2	2	0.5802	0.0959	1.0293	0.0987	0.9013	Sept, 1978	16.1
25-29	3	3	1.1747	0.1094	0.9901	0.1083	0.8917	Sept., 1976	16.1
30-34	4	5	1.6767	0.1227	1.0030	0.1231	0.8769	June, 1974	15.8
(b) South family of mortality pattern									
15-19	1	1	0.1043	0.0892	0.9716	0.0867	0.9133	Jan., 1980	18.0
20-24	2	2	0.5802	0.0959	1.0241	0.0982	0.9018	Sept., 1978	18.5
25-29	3	3	1.1747	0.1094	1.0052	0.1100	0.8900	Oct., 1976	18.3
30-34	4	5	1.6767	0.1227	1.0161	0.1247	0.8753	June. 1974	17.9

general trend, suggesting that the childhood mortality has remained more or less constant over the past years for both males and females. However, the model levels of childhood mortality among females are lower than those among males, indicating higher child mortality among females in both the models used.

In Table 2, the preliminary Brass-Trussell age-based estimates *ofq(* 1) with the use of West and South models show high infant mortality as indicated by the low mortality levels for both males and females in West Bengal. The *q(* 1) values for males are 110 and 103 per thousand male live births, and for females 92 and 87 per thousand female live births in West and South models respectively. The *q(\)* values for males and females in South model are identical to the estimates provided by the Registrar General of India (1988). In the West model, the estimated value *ofq(l)is* higher than the value of *q(2)* for males, which is improbable because the mortality estimates should obviously be progressive. The estimates of 17(2), *q(3)* and *q(5)* for both males and females have remained more or less constant over the past years in West and South model respectively. The estimates *ofq(2)*, *q(3)* and *q(5)* have shown the same pattern over the past years, though the estimates shown in Table 1 vary slightly with those of Table 2. The estimated values *ofq(l)* for males and females for both the models, shown in Table 2. are relatively high, which may indicate inaccurate reporting or omission of large number of children everborn and surviving and other factors peculiar to West Bengal. Brass, in his presentation had mentioned that the estimates *ofq(l)* could not be relied upon because of the smaller number of children everborn and surviving to women in the age-group 15-19, leading to large sampling errors. But the data in the age-group 15-19 in West Bengal are not at all small in size. One explanation leading to high infant mortality is that the women (15-19) marrying young are from low socio-economic and cultural status. According to 1991 census, 72.61 % of the total West Bengal population live in rural areas. Women amongst the rural population are mostly agricultural labourers or in jobs which are low paid. So, in the absence of child care facilities in the unorganised sector, such women are not able to look after their children while they are at work. Thus the children are deprived of their maternal care. The infant mortality for rural male and female children in West Bengal is 112 and 93 respectively, and, for urban male and female children is only 62 and 56 respectively (R.G., India, 1988). So, the infant mortality for the state as a whole is shared mostly by the rural children. In Tables 1-2, South model shows mostly higher *q(x)* values than those of West model in age-based estimates followed by Brass-Sullivan and Brass-Trussell methods respectively. So in West Bengal. South model gives lower estimates of survival probabilities for males and females respectively. Brass-Sullivan age-based estimates of survivorship probabilities provide better estimates than those of Brass-Trussell age-based estimates.

The Brass-Trussell duration-based preliminary estimates *ofq(x)* values in Table 3 show that the childhood mortality by sex is likely to show the pattern shown in Tables 1 and 2. But the Brass-Trussell estimates in Table 3 provide better estimates than those of Brass-Sullivan and Brass-Trussell age-based estimates *ofq(x)* values in Tables 1-2 as indicated by the mortality levels. Also, the reference periods or the estimated dates are shown more recently by Table 3 than those of Tables 1 and 2. In duration-based estimate. South model also shows higher mortality levels for males and females, indicating inconsistency with the mortality levels of West Bengal. The *e0* both for males and females, is 55.45 and 54.65 respectively in 1981 in West Bengal. The females may have conformity with the level 15 of West model but males have not. The estimates ofq'(l), *q(2). q(3)* and *q(5) are* much lower than the national average valuesof 122,125,130,and 147formalesand 108,120,134and 157forfemales. The estimates *ofq(x)* values by R.G. and the present estimates, one from SRS-based (1981-83)

TABLE 3: BRASS-TRUSSELL ESTIMATES OF CHILDHOOD MORTALITY BY SEX AND MARRIAGE DURATION OF MOTHER, WEST BENGAL, 1981

Age group of mother	*i*	*x*	*P(i)*	*D(i)*	*K(i)*	*q(x)*	*l(x)*	*Estimated rate*	*Mortality level*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Males, [$P_{(1)}/P_{(2)}$ = 0.3354; $P_{(2)}/P_{(3)}$ = 0.6172]									
(a) West family of mortality pattern									
0-4	1	2	0.3220	0.0872	1.1680	0.1018	0.8982	Nov., 1979	17.0
5-9	2	3	0.9600	0.0993	1.0282	0.1021	0.8979	Dec.. 1977	17.4
10-14	3	5	1.5554	0.1129	1.0296	0.1162	0.8838	Aug., 1975	17.1
(b) South family of mortality pattern									
0-4	1	2	0.3220	0.0872	1.1983	0.1045	0.8955	Nov., 1979	18.8
5-9	2	3	0.9600	0.9930	1.0485	0.1041	0.8959	Jan., 1978	19.3
10-14	3	5	1.5554	0.1129	1.0426	0.1177	0.8823	Sept., 1975	18.9
Females. [$P_{(1)}/P_{(2)}$ = 0.3321; $P_{(2)}/P_{(3)}$ = 0.6125]									
(a) West family of mortality pattern									
0-4	1	2	0.2981	0.0739	1.1690	0.0864	0.9136	Nov., 1979	17.0
5-9	2	3	0.8975	0.0930	1.0296	0.0957	0.9043	Dec., 1977	16.8
10-14	3	5	1.4654	0.1097	1.0312	0.1131	0.8869	Sep., 1975	16.4
(b) South family of mortality pattern									
0-4	1	2	0.2981	0.0739	1.1996	0.0886	0.9114	Nov., 1979	19.3
5-9	2	3	0.8975	0.0930	1.0502	0.0977	0.9023	Jan., 1978	19.1
10-14	3	5	1.4654	0.1097	1.0444	0.1146	0.8854	Oct., 1975	18.4

TABLE 4: COMPARISON OF $_1q_0$, $_2q_0$, $_3q_0$ and $_5q_0$ ESTIMATES FOR WEST BENGAL

		Male				*Female*			
		$_1q_0$	$_2q_0$	$_3q_0$	$_5q_0$	$_1q_0$	$_2q_0$	$_3q_0$	$_5q_0$
SRS* (1981-83)		70	105	122	143	63	97	113	133
R.G. Estimates		103	106	113	123	87	98	110	125
Indirect estimates									
Brass-	South model	–	107	110	119	–	99	110	119
Sullivan	West model	–	107	109	117	–	99	106	119
Brass-	South model	103	106	113	123	87	98	110	125
Trussell	West model	110	107	111	121	92	99	108	123

* Since for some years prior to 1981. SRs age-specific death rates are not available and SRS provides only >/0 for West Bengal, the values of ^ and //, are derived from Coale and Demeny West model by taking the ratio of the

closest values of ${}_5M_{10}$ (SRS) and ${}_5M_{10}$ (West model), assuming the age pattern of mortality under age 5 is the same as that of Coale and Demeny West model, ${}_1q_0$ and ${}_5q_0$ are calculated by usual life table procedures. Values of ${}_2q_0$ and ${}_3q_0$ are calculated from the compliments of the ${}_1q_0$ and ${}_5q_0$ values (l_1 and l_5) using the interpolation coefficients of Coale and Demeny West model. The values of ${}_5M_0$ from SRS (1981-83) are 0.03307 and 0.03244 for males and females respectively.

TABLE 5: LOGIT SMOOTHING OF BRASS-SULLIVAN AND BRASS-TRUSSELL ESTIMATES OF SURVIVORSHIP RATIOS, MALES, WEST BENGAL, 1981

Age x	Standard logit $Y_s(x)$	Estimated $l(x)$	Logit. $l(x)$ $Y(x)$	$Y(x) - Y_s(x)$	$\hat{Y}(x)$	Smoothed estimated $\hat{l}(x)$	Survival level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			(a) Brass-Sullivan : West Model				
2	–0.7152	0.8927	–1.0593	–0.3440	–1.0975	0.8998	17.1
3	–0.6552	0.8908	–1.0495	–0.3942	–1.0375	0.8884	16.9
5	–0.6015	0.8829	–1.0101	–0.4085	–0.9838	0.8774	16.8
			(b) Brass-Trussell : West Model				
2	–0.7152	0.8930	–1.0609	–0.3456	–1.0878	0.8980	17.0
3	–0.6552	0.8888	–1.0393	–0.3840	–1.0278	0.8865	16.8
5	–0.6015	0.8786	–0.9896	–0.3880	–0.9741	0.8752	16.6
			(a) Brass-Sullivan : South Model				
2	–0.7152	0.8932	–1.0619	–0.3466	–1.0934	0.8991	19.0
3	–0.6552	0.8896	–1.0433	–0.3880	–1.0334	0.8876	18.8
5	–0.6015	0.8811	–1.0014	–0.3998	–0.9797	0.8765	18.6
			(b) Brass-Trussell : South Model				
2	–0.7152	0.8936	–1.0640	–0.3487	–1.0837	0.8973	18.9
3	–0.6552	0.8871	–1.0307	–0.3754	–1.0237	0.8857	18.7
5	–0.6015	0.8771	–0.9826	–0.3810	–0.9700	0.8743	18.5

age-specific death rates and the other based on children everborn and surviving data, is presented for West Bengal in Table 4. Here Table 4 shows that the infant mortality estimates based on SRS (1981-83) age-specific death rate for each sex are much lower compared to the. infant mortality estimates provided by the indirect methods. These may be due to under-reporting of infant deaths. On the other hand, Table 4 shows that the childhood mortality estimates specifically q_3 and $\#_5$ for each sex based on SRS (1981-83) age-specific death rates are much higher compared to other indirect estimates. This shows an upward bias in the estimation which may be due to age misreporting in those ages. The SRS-based estimates are inconsistent with those of the indirect estimates for West Bengal. Therefore, it may be assumed that the indirect estimates are much better compared to SRS-based estimates for West Bengal.

Finally, when the estimated 1 values are smoothed with the use of logit smoothing, the smoothed values of $l_{(x|}$ as indicated by the survival level are shown to be constant over the

TABLE 6 : LOGIT SMOOTHING OF BRASS-SULLIVAN AND BRASS-TRUSSELL ESTIMATES OF SURVIVORSHIP RATIOS, FEMALES. WEST BENGAL. 1981

(Age-Based)

Age x	Standard logit $Y_s(x)$	Estimated $l(x)$	Logit, $l(x)$ $Y(x)$	$Y(x) - Y_s(x)$	$\hat{Y}(x)$	Smoothed estimate $\hat{l}(x)$	Survival level
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			(a) Brass-Sullivan : West Model				
2	–0.7152	0.9009	–1.1036	–0.3883	–1.1125	0.9025	16.2
3	–0.6552	0.8936	–1.0572	–0.4019	–1.0525	0.8914	16.0
5	–0.6015	0.8714	–1.0029	–0.4013	–0.9988	0.8805	16.0
			(b) Brass-Trussell : West Model				
2	–0.7152	0.9013	–1.1059	–0.3906	–1.1051	0.9012	16.1
3	–0.6552	0.8917	–1.0541	–0.3988	–1.0451	0.8899	16.0
5	–0.6015	0.8769	–0.9817	–0.3801	–0.9914	0.8790	15.9
			(a) Brass-Sullivan : South Model				
2	–0.7152	0.9013	–1.1059	–0.3906	–1.1084	0.9017	18.5
3	–0.6552	0.8895	–1.0428	–0.3875	–1.0484	0.8906	18.3
5	-0.6015	0.8814	–1.0029	–0.4013	–0.9947	–0.8797	18.1
			(b) Brass-Trussell : South Model				
2	–0.7152	0.9018	–1.1087	–0.3934	–1.1007	0.9004	18.4
3	–0.6552	0.8900	–1.0454	–0.3901	–1.0407	0.8891	18.2
5	–0.6015	0.8753	–0.9743	–0.3727	–0.9870	0.8780	18.0

past years. The Brass-Sullivan age-based estimates of smoothed *l(x)* values (West model) have shown higher number of survivors compared to Brass-Trussell age-based estimates for males and females respectively in Tables 4 and 5. The value of each smoothed l(x) in South model is lower compared to West model either in Brass-Sullivan or Brass-Trussell estimates, as shown in Tables 5 and 6. But in Table 7. the duration-based smoothed *l(x)* values (West model) for males show bigher values than South model. In case of females, these values of smoothed *l(x)* in West model show lower values compared to that of South model values, which are not true in the context of West Bengal. The preliminary estimates of l(x) values obtained in Table 3 do not agree with that of smoothed *l(x)* values (South model) obtained in Table 7.

In India and some other parts of South Asia, female mortality is higher than male mortality; but in the Coale-Demeny models, female mortality is lower than male mortality at every level. However, with more prosaic and sharp acumen, it may be pronounced that the real mortality situation of West Bengal does not conform to the South family of mortality pattem. The West model conforms better to those age-based estimates of smoothed *\(x)* values estimated by Brass-Sullivan method than that of Brass-Trussell.

TABLE 7: LOGIT SMOOTHING OF BRASS-TRUSSELL ESTIMATES OF SURVIVORSHIP RATIOS FOR EACH SEX BY MARRIAGE DURATION OF MOTHER, WEST BENGAL, 1981

Age x	*Standard logit $Y_s(x)$*	*Estimated l(x)*	*Logit. l(x) Y(x)*	*$Y(x) - Y_s(x)$*	*$\hat{Y}(x)$*	*Smoothed estimate $\hat{l}(x)$*	*Survival level*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
			(a) Males : West Model				
2	–0.7152	0.8982	–1.0887	–0.3735	–1.1392	0.9071	17.6
3	–0.6552	0.8979	–1.0870	–0.4855	–1.0792	0.8964	17.3
5	–0.6015	0.8838	–1.0145	–0.4130	–1.0255	0.8860	17.2
			(b) Males : South Model				
2	–0.7152	0.8955	–1.0741	–0.3589	–1.1104	0.9021	19.2
3	–0.6552	0.8959	–1.0762	–0.4210	–1.0504	0.8910	19.0
5	–0.6015	0.8823	–1.0072	–0.4057	–0.9967	0.8801	18.7
			(a) Females :West Model				
2	–0.7152	0.9136	–1.1792	–0.4640	–1.1685	0.9119	16.8
3	–0.6552	0.9043	–1.1230	–0.4678	–1.1085	0.9018	16.7
5	–0.6015	0.8869	–1.0297	–0.4283	–1.0548	0.8918	16.6
			(b) Females : South Model				
2	–0.7152	0.9114	–1.1654	–0.4502	–1.1748	0.9129	19.4
3	–0.6552	0.9023	–1.1629	–0.5077	–1.1148	0.9029	19.1
5	–0.6015	0.8854	–1.0223	–0.4208	–1.0011	0.8930	18.9

Conclusions

On the basis of the findings of the study it may be concluded that -

(1) A reasonable distribution of average parity or the proportion of deceased children, is not an indicator of good reporting.

(2) The age-based estimates of smoothed l(x) values show a coherent trend and reasonable consistency by sex.

(3) The duration-based mortality levels are somewhat higher than those of the age-based.

(4) The duration-based estimates of reference period are more recent than those of age-based estimates for any given value of *x*.

(5) The duration-based estimates indicate lower mortality than do the age-based estimates.

(6) The smoothed l(x) values both for males and females in West model fit better than those of the smoothed l(x) values in South model in the context of West Bengal.

(7) SRS (1981 -83) based mortality estimates are not better than indirect estimates.

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APPENDIX

The Brass-Sullivan Method

The proportions of children dead among those everborn to mothers in standard 5-year age groups yield life table $q(x)$ values when multiplied by factors derived by Brass (1975) from a fertility polynominal of age and a scale factor. Sullivan (1972) showed that multiplying factors based on simple linear regression models, fitted to several empirical fertility schedules, yield much more improved results than the factors developed by Brass. Thus, the probability of dying from birth to age x, $q(x)$, is given by the equation,

$$q(x)/d(i) = a(i) + b\ (i)\ [P_{(2)}/P_{(3)}]$$

where $D(i)$ denotes the proportion of children dead in the ith age-group of mother (where i = 1, 2, 3 and 4 for 15-19, 20-24, 25-29 and 30-34), $P_{(2)}/P_{(3)}$ is the ratio of the average parity of mothers aged 20-24 to the mothers aged 25-29 and $a(i)$ and $b(i)$ are the regression coefficients.

The main assumption underlying the method is the static conditions for age-specific fertility and child mortality in the recent past.

This method is only applied to age-based data—

Brass-Trussell Method

Trussell's (1975) procedure converts the proportion of children dead (CD) among the children everborn (CEB) reported by women in successive five-year age groups or duration groups into probabilities of dying before attaining certain exact childhood ages. Thus, if $D(i)$ denotes the proportion of children dead among the children everborn to women in the ith age group or duration group and $q(x) = 1 - l(x)$, the probability of dying between birth and exact age x, the basic relation is of the form

$$q\ (x) = K\ (i) \cdot D\ (i) \qquad \text{(i)}$$

for x = 1, 2, 3 and 5 for age-based: x = 2, 3 and 5 for duration-based.

$$K\ (i) = a(i) + b(i)\ [P_{(1)}/P_{(2)}] + c(i)\ [P_{(2)}/P_{(3)}] \qquad \text{(ii)}$$

for i = 1, 2, 3 and 4 for age-based; i = 1, 2, and 3 for duration-based

Here $K(i)$ is a multiplier, and $a(i)$, $b(i)$, and $c(i)$ are the Trussell's regression coefficients.

$$P(i) = CEB\ (i)/\ FP\ (i)$$
$$D(i) = 1 - CS\ (i)/CEB\ (i) \text{ or, } CD\ (i)/CEB\ (i)$$

where $P(i)$ is the average parity among the women of ith age-group or duration group and $FP\ (i)$ is the female population and the currently married women by five-year age groups and duration-groups.

The main assumption underlying the method is the static conditions for age-specific or duration-specific fertility, and infant and child mortality in the recent past.