Levels and Patterns of Infant and Child Mortality in Bangladesh

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ABSTRACT: Utilizing the 1974 Retrospective Survey data and registration data by Cholera Research for 1967–68 and by the Population Growth Experiment for 1962–63, this study attempts to measure infant and child mortality levels in Bangladesh and to determine their structure. The child mortality technique is used to convert proportions dead among children ever born to women in the childbearing ages into conventional life table measures of mortality. Shortcomings of present methods of measuring infant and child mortality in developing populations are discussed.

This paper attempts to measure infant and child mortality levels in Bangladesh to determine their structure by utilizing the 1974 Retrospective Survey data, registration data by Cholera Research, and Population Growth Experiment data. Among the major problems encountered in the exercise are the adjustment of the current raw mortality data and the estimation of infant and child mortality from independent source material.

The estimates of infant mortality and childhood mortality are seriously hampered by the lack of reliable and adequate information on infant and child deaths. The existing source of information (Cholera Research Project, Comilla Kotwali Project) are insufficient and can at best give an indication only of the level of rural infant mortality.

The tendency of surveys to miss a substantial proportion of infant deaths imposes a further limitation on the degree to which the infant mortality rate can be reasonably estimated from the available sources. The present study will therefore be concerned with two main problems: (1) the adjustment of raw data on the basis of detected errors as revealed by analytical methods and/or by the fitting of models; and (2) the estimation of infant mortality from independent source meterial, i.e., retrospective information on the number of children ever born and the number surviving.

MATERIALS AND METHODS

The Cholera Research estimates of infant mortality for the periods 1966–67 and 1967–68 were 110 and 125 per thousand live births. These figures seem to be serious underestimates compared to the Population Growth Experiment (PGE) estimate for 1962–63 of 147 per thousand live births, especially considering the fact the latter estimate is based on national data and therefore reflects a more or less true level of infant mortality.

It is evident that infant mortality rates are higher in rural areas than in urban areas, although the magnitude of the differences is small. Males have a higher death rate than females, as reflected in the sex ratios at death. Neonatal mortality accounts for nearly one-half of the infant deaths. Although there is tendency for the proportion of infant deaths to rise during the second half of the period under review, exact times of rise and fall differ slightly from one area to another or from one study to another. The irregular pattern of proportions dead may be largely due to either age misstatements or underregistration of deaths.

It was assumed, however, that a large proportion of the observed discrepancies between the age composition of the infant deaths was due to errors arising from age misreporting. In the following section an attempt was made to adjust the recorded infant deaths by age by an analytical model developed by Bourgeois-Pichat (1952).

RESULTS

APPLICATION OF BOURGEOIS-PICHAT MODEL TO INFANT MORTALITY BY MONTH OF AGE

According to Bourgeois-Pichat's model, P_n, the probability of death from birth to age n days can be expressed (except apparently in the first month of age) in terms of the following function

$$P_n = a + b \log^3 (n + 1),$$

where a measures endogenous mortality and $b \log^3 (n + 1)$, exogenous mortality. The application of the method to both Cholera Research and PGE data is presented in Table 1.

It can be seen from this table that the curve of the adjusted infant mortality rates falls very sharply during the first four weeks and then falls more gradually toward the end of the period. According to the model, the proportion of infant deaths at ages 0 and 1 should be 45.9 and 9.7 respectively. There is therefore a general tendency toward understatements of age of the one-month-olds, resulting in the inflation of the proportion of deaths at age 0 months. However, if the omission of deaths is strongly associated with age, then the distortion of the mortality schedule may be partly attributed to omission errors. This fact is difficult to demonstrate with the available data, but it is commonly known that a fairly sizeable number of deaths of infants who die immediately after birth are missed.

While it is difficult to draw any meaningful inferences from the data presented in Table 1, it is evident from available information that there was underreporting

TABLE 1

OBSERVED AND ADJUSTED INFANT DEATH RATES BY AGE: BANGLADESH

	Cholera Research 1967–1968			Population Growth Experiment 1962–1963		
Age in Months	Deaths Cumulated	Observed Rates per 1,000 Live Births	Adjusted Rates*	Deaths Cumulated	Observed Rates per 1,000 Live Births	Adjusted Rates*
0	94	18.05	27.01	2,778	91.88	111.05
1	142	27.71	29.65	3,046	102.59	111.97
2	178	34.18	37.73	3,333	112.26	114.46
3	221	42.44	48.36	3,643	122.70	118.46
4	264	50.70	60.52	3,704	124.75	122.68
5	317	60.88	73.16	3,789	127.62	127.06
6	380	72.98	86.19	3,913	131.80	131.59
7	452	86.81	99.13	3,998	134.66	136.11
8	513	98.52	112.16	4,093	137.86	140.60
9	561	107.74	125.41	4,238	142.74	145.47
10	698	114.85	143.04	4,288	144.43	149.44
11	653	125.41	150.18	4,319	145.47	153.78

SOURCES: Derived from data from the 1967–68 Cholera Research annual report, Table B.21, and the 1962–63 Population Growth Experiment report, Table A_2.

* The adjusted rates were obtained by applying Bourgeois-Pichat's model (1952) to the observed rates.

of infant deaths. In addition, since Bourgeois-Pichat's model can not detect omission errors, as noted by Chandrasekar (1959), it is very doubtful that it could provide useful adjustment factors for correcting the distorted infant mortality rates. Further, the model tends to conceal some, if not all, of the basic characteristics of the infant mortality pattern, e.g., an increase in the proportions dead at ages between six and eight months.

Several studies in the developing countries have also shown that the shape of the infant mortality curve beyond age six months is heavily influenced by malnutrition and infectious diseases (Gordon et al., 1967). The Bourgeois-Pichat model offers very little assistance as far as adjustment for underreporting of infant mortality is concerned. It must, however, be noted that it could be a useful tool for distinguishing between endogenous and exogenous mortality.

ESTIMATION OF INFANT MORTALITY FROM CHILD SURVIVORSHIP DATA

Demographic data in many developing countries are still limited to that available from a single census or survey. In such surveys or censuses, the questions ask for retrospective information from women about the number of children ever born and also about the number of these children who had died by the time of the survey. From this information, proportions of dead or surviving children by age of women can be easily calculated. Brass (1968) felt that these proportions reflect in a crude way the level of childhood mortality. He developed a method by which these proportions of dead or surviving children could be translated into conventional life table functions. More specifically, the technique is used to estimate the proportion of children ever born who have died by ages 1, 2, 3, 5, 10, etc., from the proportions reported as dead among children ever born to women 15–19, 20–24, 25–29, 30–34, etc.

In the estimation of childhood mortality by Brass's technique, it is assumed that age-specific fertility and mortality (especially infant and child mortality) have remained approximately stable in the recent past. It is further assumed that the experience of surviving women can be taken as representing that of all women exposed to the risk of births and deaths of children. The underlying ideas on which the method is based can be explained in the following way.

The proportions of children ever born who have died are denoted by the term D_x, so that if standard age groups are used, D_1 refers to the proportion dead in the age group of women 15–19; D_2 the proportion in the age group 20–24; and so on. With the terms used thus defined, the first step in converting D_x values into life table measures is to examine the relationship between D_x and $q(t)$. The D_x values for any age group of women will depend on two factors—the age distribution of all the children ever born to those women, assuming that they all survived, and the mortality to which these children have been subjected.

The age distribution of the children ever born is, of course, a direct reflection of the age-specific fertility rates. However, the explanation of the relationship between D_x and $q(t)$ is rather complex for age groups of women in the childbearing period. Nonetheless, its essence remains the same; that is, for each D_x some time interval (t_x) will equate the values of $q(t_x)$ and D_x. For women aged 20–24, t_x appears surprisingly small, approximately two years, that is, D_2 is roughly equivalent to q_2. This finding reflects the effect of the sharp fall in mortality during the first year of life and the very gradual rise after age 5.

For a fixed location of the fertility curve, alterations in the shape of fertility will also affect t_x. On examination, it was found that for each group the calculated t_x values were approximately equal to a whole number. More precisely, a rough approximation was found between each of D_1 and q_1, D_2 and q_2, D_3 and q_3, D_4 and q_4, and so on. These approximations were closest for locations of the fertility distribution that revealed neither very late nor very early starts to childbearing. In the case of early fertility, the children ever born to a particular age group of women will be on the average older; for instance, D_2 will be somewhat larger than q_2. The reverse situation will hold for late fertility. But the amount of change in the relation of $q(t_x)$ to D_x as the fertility locations varied was found to be small. As a result, only small adjustments were necessary to convert each D_x value into $q(\bar{t}_x)$, the probability of dying by the appropriate exact age (in years).

Brass developed a set of multiplying factors to convert the proportion dying into the life table functions. The choice of multiplying factors depends on four parameters: (1) the ratio of total children ever born per women in the age group 15–19 to that for the age group 20–24 (P_1/P_2); (2) the ratio of children ever born per women in the age group 20–24 to that for the age group 25–29 (P_2/P_3); (3) the mean age of the fertility distribution ($\bar{m}$); (4) the median age of the fertility distribution ($\bar{m}'$).

If more than one of these measures is available from the population in question, then the factors obtained by use of the different measures will agree if the fertility distribution of the population is exactly the same as model. The first two indices (P_1/P_2 and P_2/P_3) indicate the shape of the fertility curve toward the beginning of the reproductive period and thus are particularly relevant to the younger women. The last two indices ($\bar{m}$ and $\bar{m}'$) are measures of the age around which most children are born and are therefore more important for the older women. Extensive investigations have shown that the multiplying factors give satisfactory estimates of child mortality despite differences between true and model fertility and mortality patterns.

With regard to fertility, the small range of multiplying factors, even with quite different values of P_1/P_2 and other indices, suggests that the factors are insensitive to the detailed shape of the fertility function, and this feeling has been confirmed by the application of the method to a wide range of populations. The only case in which sizeable differences occur is in the 15–19 age group of women, which is because of the great variability of the fertility patterns possible at the younger ages (even for a given P_1/P_2 value). Thus, the estimates of q_1 are subject to considerable error.

Although the mortality model used was a fixed one, it is important to realize that exactly the same results would have been obtained from any other life table in which the level of mortality differed but the pattern remained the same. More specifically, this comment applies to any life table in which the q_x values are some constant times the corresponding q_x values in the standard. Thus, using a single fixed mortality model is less rigid than it at first appears, and only variations in the age pattern of mortality will affect the accuracy of the estimates. To examine this latter effect, numerous comparisons have been made both with observed mortality schedules and with other model life tables showing a variety of patterns of mortality, for example, the four mortality patterns of the Coale-Demeny model life tables (Coale-Demeny, 1966). The results have shown that although estimates where the age pattern of mortality differs from that of the model will not be completely accurate, errors are small and unimportant when compared with those arising from other sources.

The assumptions made are that fertility

and mortality have not changed recently and that the experience of surviving women is not markedly different from that of those who have died. Changes in fertility are unlikely to have an effect in the estimation. However, shifts in the age pattern of fertility might have an effect in the estimation.

Table 2 reveals that errors in reporting the proportions dead are fully reflected in xq_0 values obtained by Brass's technique. Both a priori reasoning and general experience suggest that such errors, consisting chiefly in failures to report past events, do commonly affect such data (Brass, 1968). If dead children and children still alive were underreported by the same percentage, the proportion reported dead would not be affected. However, it is more common to fail to report the births and deaths of the children who have died, particularly if the event took place long before the time of the survey.

It follows that reports of older women might be particularly subject to bias, an expectation that appears to be confirmed by the figures of Table 2, which show proportions dead reported by older women that are somewhat higher than the proportions reported by younger women in the same locations. It should be noted that, whatever their reliability, older women's reports are heavily influenced by the mortality conditions that prevailed long before the time of the survey. And as noted above, the implausibly low infant mortality rates shown in Table 1 are indicative of incompleteness of reporting on infant deaths. A comparison between the computed l_2 values and those estimated from l_3 and l_5 (Table 3, Cols. 10 and 11) would seem at first sight to indicate an improvement in mortality over time and a slow decline in child mortality.

One would have expected that with the substantial improvements in the health services and medical facilities that have occurred since World War II, the mortality rate should have been declining. It appears therefore that the l_3 and l_5 values have been inflated by the omission of dead children. This omission could be more frequent among the older than the younger women. The l_2 values, as implied by observed l_3 and l_5 values, were calculated on the basis of the comparable l_3 and l_5 values in the Coale-Demeny West model life tables (Coale and Demeny, 1966). The low expectation of life at birth as implied by the l_2 values in the Coale-Demeny West model life tables suggests that mortality level did not improve significantly over the period 1961–74.

Nevertheless, with the exception of $1q_0$ which is highly unreliable for several reasons (Brass et al., 1968), $2q_0$, $3q_0$ and $5q_0$ give reasonable and plausible indications of at least the lower limits of recent levels

TABLE 2

ESTIMATING CHILD MORTALITY FROM 1974 RETROSPECTIVE SURVEY DATA: BANGLADESH

Age Group of Mothers	Proportion Deaths (D_i)	Multiplying Factors* (W_i)	Proportions of Dying (xq_0)	Exact Age of Children	Proportion Surviving (l_x)
15–19	0.1856	0.911	0.1691	1	0.8309
20–24	0.2035	0.973	0.1980	2	0.8020
25–29	0.2132	0.971	0.2070	3	0.7930
30–34	0.2282	0.982	0.2241	5	0.7757
35–39	0.2398	1.026	0.2460	10	0.7540
40–44	0.2635	1.004	0.2646	15	0.7354
45–49	0.2835	1.003	0.2847	20	0.7153

* The parameter for finding the multiplying factor is $P_2/P_3 = 0.5506$, $\bar{m} = 28.7$.

TABLE 3

ESTIMATED CHILD MORTALITY (q_x) AND THE PROBABILITY OF SURVIVING FROM BIRTH TO AGE x (l_x) DERIVED FROM REPORTED PROPORTIONS OF CHILDREN DEAD AMONG CHILDREN EVER BORN TO WOMEN AGED 20–35

	Proportions Dead Among Children Ever Born to Women Aged			Child Mortality (Derived from Cols. 1, 2, & 3)			Corresponding l_x Values Derived from Cols. 4, 5, & 6			Corresponding l_x Values Derived from Cols. 8 & 9		Ratio of Col. 7 to Col. 10	Ratio of Col. 7 to Col. 11
	20–24	25–29	30–34										
	1	2	3	4	5	6	7	8	9	10	11	12	13
Region				($_2q_0$)	($_3q_0$)	($_5q_0$)	(l_2)	(l_3)	(l_5)	(l_2)	(l_2)		
National ...	0.204	0.213	0.228	0.198	0.207	0.224	0.802	0.793	0.776	0.810	0.812	0.990	0.998
Rural	0.204	0.216	0.230	0.199	0.211	0.226	0.801	0.789	0.774	0.806	0.810	0.994	0.989
Urban	0.189	0.157	0.192	0.191	0.156	0.192	0.809	0.844	0.808	0.856	0.839	0.945	0.964
Dacca	0.201	0.211	0.237	0.203	0.209	0.237	0.797	0.791	0.763	0.808	0.800	0.986	0.996
Chittagong .	0.206	0.214	0.228	0.211	0.215	0.230	0.789	0.785	0.770	0.802	0.807	0.984	0.978
Rajshahi ...	0.203	0.219	0.216	0.202	0.216	0.215	0.798	0.784	0.785	0.802	0.819	0.995	0.974
Khulna	0.205	0.209	0.231	0.206	0.207	0.231	0.794	0.793	0.769	0.810	0.806	0.980	0.985

SOURCE: Estimated from the 1974 Retrospective Survey data.

of infant and child mortality. Furthermore, general experience has shown that $_2q_0$ is the most reliable of the estimated probabilities of dying (Brass et al. 1968).

Accepting the estimated $_2q_0$ as fairly plausible and also assuming that the relationship between it and the $_1q_0$ in the model life tables is the same as that prevailing in the actual population, we estimated a new set of infant mortality rates which is given in Table 4. The basis was the Coale-Demeny West model life tables. Estimates from the North model life tables are also presented. The estimates from the North family models show low infant mortality relative to child mortality, apparently a notable feature of the African and Asian mortality pattern (Brass et al., 1968). The $_1q_0$ does not differ significantly, and in some cases the latter exceeds the infant mortality, although some of the differences may be explained in terms of omission errors and chance fluctuations affecting mortality rates.

Estimates based on the West models are higher than those derived from the North models. The estimates for males in the Dacca and Chittagong regions are too high to be plausible. Similarly, the estimate for urban females is too low to be taken into consideration. This finding is due to the fact that the estimated l_2 values are probably not only biased by omission errors but also by chance fluctuation largely due to the small number of cases. In general, however, the highest infant death rates are found in the Chittagong and Khulna regions with relatively lower rates prevailing in the other regions, except the urban area

TABLE 4

ESTIMATED INFANT MORTALITY RATES BASED ON THE COALE-DEMENY WEST AND NORTH MODEL LIFE TABLES BY REGION AND BY SEX

Region	Both Sexes	Male	Female
National			
West	158	167	149
North	154	162	146
Rural			
West	159	168	150
North	155	163	147
Urban			
West	153	165	138
North	148	161	134
Dacca			
West	162	176	146
North	157	171	143
Chittagong			
West	168	175	160
North	164	170	157
Rajshahi			
West	161	171	153
North	159	168	151
Khulna			
West	164	172	159
North	162	167	156

which enjoys the lowest infant death rate. The rural infant death rates are generally higher than that of the urban area.

Table 5 shows both recorded and estimated child mortality rates defined as the proportion dying between ages 1 and 4. The estimates derived from both the West and North models are higher than the recorded $4q_1$ values, and in view of the general underreporting of deaths by both the survey and the registration system, the West models appear to be inappropriate for the determination of the levels of child mortality for the population in question. In all the regions, the child mortality rates (based on the 1974 Retrospective Survey data) are remarkably lower than the corresponding North models estimates. It is quite possible that mortality rates of the magnitude recorded in the North family model life tables would indeed operate in areas where the high infant mortality rate is sustained through the second year of life, and even beyond, as a result of malnutrition and infectious diseases. It can be seen from the estimated infant and child mortalities that Bangladesh's mortality pattern is characterized by high child mortality relative to infant mortality, a feature which has also been observed in a number of other developing countries.

The regional child mortality differentials follow the same pattern as revealed by the infant mortality rates and, in general, rural areas are experiencing the highest child mortality levels, while relatively moderate rates operate in the other regions. The survival rates are higher among females than among males.

TABLE 5

RECORDED AND ESTIMATED CHILD MORTALITY ($4q_1$) BY REGION AND BY SEX

Region	1974 Retrospective Survey			Cholera Research 1967–1968			Population Growth Experiment 1962–1963			Coale-Demeny West Model			Coale-Demeny North Model		
	Both Sexes	M	F	Both Sexes	M	F	Both Sexes	M	F	Both Sexes	M	F	Both Sexes	M	F
National	0.051	0.051	0.050	...	...	...	0.094	0.081	0.101	0.093	0.091	0.096	0.124	0.123	0.126
Rural	0.052	0.052	0.051	0.109	0.093	0.122	...	...	...	0.094	0.092	0.097	0.125	0.125	0.127
Urban	0.036	0.042	0.030	...	...	...	...	...	...	0.089	0.090	0.087	0.119	0.122	0.115
Dacca	0.052	0.057	0.048	...	...	...	...	...	...	0.095	0.097	0.094	0.128	0.132	0.124
Chittagong	0.050	0.051	0.048	...	...	...	...	...	...	0.100	0.097	0.105	0.134	0.132	0.136
Rajshahi	0.044	0.043	0.046	...	...	...	...	...	...	0.096	0.092	0.099	0.127	0.124	0.130
Khulna	0.059	0.055	0.063	...	...	...	...	...	...	0.099	0.094	0.103	0.126	0.128	0.125

SUMMARY AND CONCLUSIONS

The child mortality technique is used to convert proportions dead among children ever born to women in the childbearing ages into conventional life table measures of mortality. This conversion is made by the use of a table of multiplying factors specifically devised for the purpose and by taking into account the location of the fertility distribution in the population. The most reliable estimates are those derived from the reports of the younger women, usually q_2, q_3 and q_5. Therefore, it is primarily a method for estimating early childhood mortality, and it follows that its major drawback is that it does not provide reliable estimates of adult mortality.

The method was designed originally for populations where demographic data are limited to those available from a single census or survey. It has been very widely used in such populations and has given very reasonable results of child mortality. Its application has also been extended to populations where data is available from two or more censuses.

Recently, various shortcomings of the method have been noted, particularly in its application to the population where infant and child mortality are declining since Brass (1968) developed the technique on the assumption of constant mortality and fertility in the recent past. There is evidence that mortality has been declining sharply in many countries of the developing world for which estimates are most needed. Finally, the multipliers with which Brass mortality estimates are usually made are based on a special model life table developed for African populations. The question is whether these multipliers are appropriate in applications to, for instance, Asian populations and, for that matter, to any other population. To what extent, indeed, do Asian or African populations share a particular pattern of mortality? How much difference does the choice of model life table make? In order to answer these questions, exhaustive research seems in order.

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