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Levels, Trends and Causes of Mortality in Children Below 5 Years of Age in Bangladesh: Findings From a National Survey

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ABSTRACT

A nationwide survey, conducted in 1992-93 by the Control of Diarrhoeal Disease Programme, Government of Bangladesh, made national estimates of levels and causes of child mortality. A gradual downward trend in infant and child mortality was observed from the mid 1980s. Current mortality rates among infants and children below 5 years were estimated to be around 100 and 150 per 1,000 live births respectively. More than a quarter of deaths in children below 5 years were found to be associated with diarrhoea. Acute respiratory tract infections were also shown to be a major killer of young children.

Key words: Child mortality; Infant mortality; Causes of death; Diarrhoea; Bangladesh

INTRODUCTION

Although several analyses of levels and causes of child mortality in Bangladesh have been performed, they have, on the whole, been based on data from only one region of the country, namely Matlab, where the International Centre for Diarrhoeal Disease Research, Bangladesh has operated a field station since 1963 (see #1 in appendix). Data collected in Matlab are generally recognized to be of high quality, but how well these represent the experience in the rest of the country is necessarily open to question. At the same time, the majority of large-scale national demographic surveys conducted in Bangladesh has focused more on contraceptive use and fertility than on mortality (2-4). National data on causes of death are particularly limited. For this reason the data generated by a national survey conducted by the National Control of Diarrhoeal Disease Programme in 1992-93 are of great interest. The survey estimated current levels and recent trends in mortality of children below 5 years. The survey also generated information on the main causes of death in children below 5 years.

MATERIALS AND METHODS

The Integrated Multipurpose Sample (IMPS), used by the Bangladesh Bureau of Statistics for a series of surveys since 1980, formed the sampling frame for the present survey. One hundred sixty-four primary sampling units (PSUs), 119 rural and 45 urban, were randomly selected from the total 360 that comprise the IMPS. The PSUs were distributed among the four divisions of the country: Dhaka, Khulna, Rajshahi and Chittagong, in proportion to their population sizes. Households were then randomly selected from within these PSUs, with an average of 60 households being included per PSU.

The primary respondents in the survey were all women aged between 13 and 50 years, who are normally resident in the households selected. In total 8,171 rural and 3,135 urban women were interviewed (see # 2 in appendix). The questionnaires included questions on total number of living and dead children (the "Brass Questions") as well as the dates of birth of the three most recent births of each respondent, together with the dates of death for dead children (a "Short Birth History"). This meant that estimates of mortality could be made using a number of direct and indirect techniques (see # 3 in appendix).

In addition, a structured verbal autopsy questionnaire was administered for each of the 3 most recently-born children who had died. Detailed information on age at death, duration of illness, and symptoms leading to death was collected for children who died in the 5 years prior to the survey, and who

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were below 5 years at the time of death (see # 4 in appendix). Four main groups of symptoms were of interest: diarrhoea, cough, fever, and convulsions. Analysis of the cause of death was performed separately for the rural and urban samples and then weighted national estimates were made. It should be borne in mind that it is extremely difficult to ascertain causes of childhood death and that children often die from a combination of several different factors. Verbal autopsy data can therefore be categorized in any number of ways, producing a range of different results.

In the current analysis both spontaneous and probed reports of symptoms were combined. The frequency and combination of symptoms, duration of illness and the age at death reported, were first examined. Taking these into consideration, as well as previous analyses of cause of death data (11-13), the following procedure for categorizing cause of death was developed.

First, all deaths that occurred in the first 3 days of life were coded as deaths due to prematurity or birth difficulties regardless of the symptoms reported. Next, deaths occurring within 4 to 30 days, where the mother reported convulsions plus stiffness of the body, or convulsions plus the child's inability to take breast-milk or other food, were coded as neonatal tetanus. The period 4 to 30 days was used, rather than the more conventional 4 to 14 days, because data from Bangladesh suggest that tetanus deaths may occur beyond 14 days (14) and also because of concerns over the accuracy of age at death reporting (see # 5 in appendix).

Of the remaining deaths, the following causes were identified:

Watery diarrhoea

If the mother reported diarrhoea but no blood in the stool and no symptoms of acute respiratory tract infection (ARI)

Bloody diarrhoea

If diarrhoea and blood in the stool were reported but no symptoms of ARI

Acute respiratory tract infection

If the mother reported cough plus difficult breathing, cough plus fast breathing or cough with chest in-drawing, but no symptoms of diarrhoea

Watery diarrhoea and ARI combined

If the mother reported diarrhoea but no blood in the stools together with cough plus difficult breathing, cough with fast breathing, or cough with chest in-drawing

Bloody diarrhoea and ARI combined

If diarrhoea with blood in the stools was reported together with cough plus difficult breathing, cough with fast breathing, or cough with chest in-drawing.

Cases where both diarrhoea and ARI symptoms were reported were examined closely to see if the duration of each symptom would reveal which the primary cause of death was. However, in the majority of cases it was felt that there was insufficient information and that a combined cause of death should be used.

The remaining deaths were coded as 'other causes.'

RESULTS

Current levels and trends of mortality in infant and children less than 5 years old

Figure 1 shows the estimated trend in mortality of children less than 5 years produced by the Brass technique (see # 3 in appendix) for the 15-year period before the survey. The graph suggests that the probability of dying before 5 years of age remained roughly constant from 1978 to 1984 at a little less than 200 per 1,000. This was followed by a fall to around 155 per 1,000 in 1991 (see # 6 in appendix).

Figure 1 also shows the trend in mortality among children below 5 years, estimated by direct methods from the Matlab Comparison Area (see # 7 in appendix). From 1978 to 982 data from the 2 sources are remarkably consistent, and from 1986 to 1989 the Matlab Comparison Area and CDD survey estimates are similar, though the decline in mortality appears to be somewhat steeper for Matlab than the national average. The figures for the Matlab Comparison Area for 1983 and 1984 diverge significantly from the rest of the trend and may be explained, in part, by an epidemic of dysentery in the Matlab area at that time (16) (see # 8 in appendix). Ignoring these two years, both data series suggest a decline in the probability of dying before age 5 from the mid-80s onward.

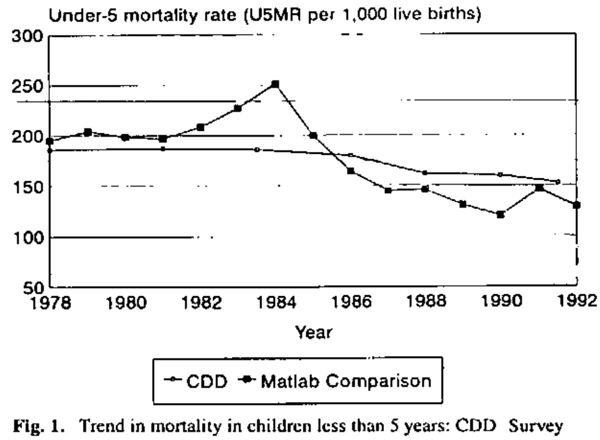

Fig. 1. Trend in mortality in children less than 5 years: CDD Survey and Matlab Comparison Area

Figure 2 shows the trend in infant mortality estimated from the CDD survey (Brass estimates) compared to that for the Matlab Comparison Area. The pattern is similar to that in under-five mortality with the level declining from around 1984 onward. The CDD data suggest a decline in the national infant mortality rate from around 125 per 1,000 live births in 1978 to 105 per 1,000 live births in 1991. The Matlab data show some fluctuations, but on the whole, suggest a slightly steeper decline to around 90 per 1,000 in the early 1990s.

In addition to the Brass technique, current estimates of mortality among infant and children below 5 years were made from the CDD survey data using the Preceding Birth Technique (PBT), and also directly from a life table for births in the 5 years preceding the survey (see # 3 in appendix). The various estimates are shown in Tables I and II alongside the Matlab Comparison Area data and national level estimates from the Bangladesh Bureau of Statistics (BBS), Vital Sample Registration System (17).

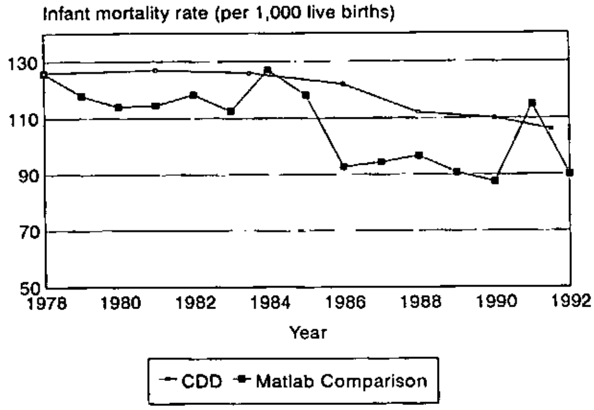

Fig. 2. Trend in infant mortality estimates: CDD Survey and Matlab Comparison Area compared

Table I shows that estimates made by the Brass and PBT techniques in the CDD survey agree very well with the national estimates from the Vital Sample Registration System of the BBS. The CDD life table estimate is somewhat lower and probably underestimates mortality (5) to some extent (see # 3 in appendix). The Matlab Comparison Area figures are somewhat lower than those for the national level, which may reflect the impact of the diarrhoeal hospital located in the nearby treatment area. The pattern in Table II is similar with estimates of infant mortality derived from the Brass and PBT, agreeing well with those from the VSRS and from the Matlab Comparison Area. Again, the life table figure appears to be an underestimate.

The CDD results thus suggest that mortality among both infants (IMR) and children below 5 years (U5MR) had fallen in Bangladesh since the mid-80s, and that the levels stood at around 100 and 150 per 1,000 live births respectively, in the early 1990s.

Causes of death among children less than 5 years

A total of 806 (654 rural and 152 urban) deaths had occurred in the 5 years preceding the survey among children aged below 5 years (excluding accident deaths; see # 4 in appendix). Table III gives the frequencies of symptoms reported in both urban and rural samples. It can be seen that in both samples, the most commonly reported symptom in the two weeks prior to death was fever, followed by the child's inability to take breast-milk or other foods. Diarrhoea was also very commonly reported. In the rural sample 25% of all mothers reported that their child suffered from diarrhoea in the two weeks preceding death; in the urban sample, this figure was about the same (27%). Cough, difficult breathing and convulsions were also commonly reported symptoms.

Table I. Recent estimates of mortality in children below 5 years in Bangladesh (U5MR)

Data source	Estimation method	1988	1990	1992
CDD 92/93	Brass	162	160	153
CDD 92/93	PBT	-	155	-
CDD 92/93	5 year life table	-	118	-
Vital sample registration system (BBS)	Deaths/mid-yr pop converted to probability	-	151	-
Matlab comparison area	Deaths/mid-yr pop converted to probability	146	121	129*

* Provisional figures

Despite the fact that several different symptoms were commonly reported together, there were a few deaths that could be classified under more than one cause on the basis of the algorithm described above. Thus, application of this hierarchical scheme, where deaths in the first 3 days were first coded, followed by neonatal tetanus deaths, followed by diarrhoea and ARI deaths, and finally leaving a group of deaths due to other causes, was felt to be a satisfactory approach. Use of a different hierarchy would not have produced greatly differing results.

Table II. Recent estimates of infant mortality in Bangladesh

Data source	Estimation method	1990	1991	1992
CDD 92/93	Brass	110	106	-
CDD 92/93	PBT	90	-	-
CDD 92/93	5-year life table	77	-	-
Vital Sample Registration System (BBS)	Deaths/births in year	94	91	-
Matlab comparison area	Deaths/mid-yr pop converted to probability	88	115*	90*

* Provisional figures

Table IV shows the percentage distribution of causes of death (excluding accidents) for children below 5 years, who died in the 5 years preceding the survey.

Diarrhoeal deaths

Overall, diarrhoea alone accounted for 18.4% of all the deaths. When deaths due to diarrhoea plus ARI were included, 25.8% of all deaths were associated with diarrhoea, 95% confidence intervals were 21.9-29.7% (see # 9 in appendix). This figure did not differ significantly between the rural and urban samples. Diarrhoea-related deaths thus accounted for the largest share of deaths to children below 5 years (except 'other causes'). It is interesting to note that 22% of rural mothers and 27% of urban mothers directly reported diarrhoea or dysentery as the cause of their child's death when asked the question: *'In your opinion what was the reason for the death?'*

Of all diarrhoea-related deaths, 66% were associated with watery diarrhoea and 34% with bloody diarrhoea. Aside from the common concurrent occurrence of symptoms of diarrhoea and ARI, the other most frequently mentioned symptom among the diarrhoeal deaths was 'fever' which was mentioned in more than half of the cases (see # 10 in appendix).

Table III. Percentage of mothers reporting symptoms in two weeks preceding the death of their child (spontaneous and probed responses combined)

Symptom	Rural (%)	Urban (%)
Diarrhoea	25.2	27.0
Diarrhoea with blood	10.2	3.3
Cough	22.6	21.1
Difficult breathing	24.0	20.4
Very fast breathing	16.5	11.8
Chest in-drawing with breathing	19.4	15.8
Fever	42.7	44.7
Very high fever	18.7	21.1
Shivering	10.7	18.4
Sweating	10.9	14.5
Convulsions	28.4	19.7
Stiff body	20.0	15.1
Unable to take breast-milk or other food	38.1	30.3

Acute respiratory tract infection

As mentioned above, a large proportion of deaths (7.4%) was assigned to the combined cause diarrhoea (watery or bloody) plus ARI. However, in addition to this, 15.5% of all deaths to children under-5 were associated with ARI. In total, around 23% of the deaths were ARI-related. ARI thus clearly represents an important cause of childhood death in this population. Fever was very commonly reported as a symptom among these cases (more than 60%).

Other causes of death

A large fraction, 21%, of all deaths occurred in the first 3 days of life. Many of these deaths are likely to have been due to a combination of causes, and it is difficult to disentangle the effects of the complex of neonatal factors (prematurity, intra-uterine growth retardation, hypoxia and so on). In around half of these cases, respondents reported that the child was born premature, and in one-third of cases that the child was smaller than normal at delivery. The symptoms prior to death most commonly reported were convulsions, and the child's inability to suck or feed.

Neonatal tetanus was identified as the cause of death in 10% of all deaths to children below 5 years.

Finally, since the focus of the CDD survey was on identifying the contribution of a few main causes of death, in particular diarrhoea-related deaths, in children below 5 years, the category 'other causes' is large (28%). No information was available to further divide this category into causes, though the most common symptom reported was fever.

Table IV. Percentage distribution of causes of death among children below 5 years in the 5 years preceding the survey

Cause of death	Rural	Urban	Weighted national
Diarrhoea:			
Watery diarrhoea	10.7	15.8	11.5
Bloody diarrhoea	7.6	3.3	6.9
Watery diarrhoea and ARI	5.2	5.9	5.4
Bloody diarrhoea and ARI	2.5	0.0	2.0
(Total)	(26.0)	(25.0)	(25.8)
Acute respiratory tract infection	15.2	17.1	15.5
Neonatal tetanus			
4-15 days	7.8	5.9	7.5
16-30 days	2.0	2.0	2.0
Prematurity/birth difficulties	20.9	23.7	21.3
Other causes	28.0	26.3	27.9
	100.0	100.0	100.0
	N=654	N=152	

Note: Accident deaths are not included (see # 4 in appendix).

DISCUSSION

The national CDD survey made useful estimates of both recent trends and current levels of infant and child mortality in the population of Bangladesh. In addition, important information on the causes of death among children below 5 years was gathered.

The picture is one of slowly declining mortality from the mid-80s onward. It can be concluded that in the early 1990s, a little less than 100 out of every 1,000 children born alive died before age 1, and around 150 before their 5th birthday.

Given the observed decline it is pertinent to look for possible causal factors, and for this, information on causes of death is important. Kamal *et al.* (13), in their analysis of the 1989 Bangladesh Fertility Survey (BFS) data, note that there is very little consistency in the results from the few cause of death analyses that have been carried out in Bangladesh. A large part of this discrepancy undoubtedly arises from the use of different questioning procedures and different algorithms for the assignment of causes.

The contribution of diarrhoea related deaths shows some consistency across studies. Diarrhoea appears to account for around 20%-30% of the deaths in children below 5 years in Bangladesh. The present CDD survey estimated 26%, the 1989 BFS 21% (13) and a 1983 survey put the figure at 29% (20). Although the persistent percentage contribution to the falling total mortality suggests that diarrhoeal deaths are declining to some extent (see # 11 in appendix), diarrhoea clearly remains a very important killer of children in Bangladesh. It seems unlikely, then, that the overall decline in mortality has been due to a decline in diarrhoea mortality.

The persistently large contribution of diarrhoea-related deaths to mortality in children below 5 years is a cause for concern. Fauveau *et al.* (21) concluded that in the Matlab MCH-FP area, the oral rehydration therapy programme has had no significant effect on diarrhoea-related mortality. This is, in part, explained by the fact that many diarrhoea deaths are associated with malnutrition or dysentery, and thus require more than ORT for prevention. In the present survey, 34% of diarrhoea-related deaths were found to be associated with bloody diarrhoea. An emphasis on improved case management, which remains the principal strategy of the national CDD programme (20), is thus appropriate. However, it seems clear that broader, preventative interventions deserve more attention. Access to safe drinking water has improved to some extent in Bangladesh in recent years, but the provision and use of sanitary latrines has lagged noticeably behind. It seems likely that diarrhoea will persist as an important cause of death until access to and utilization of safe water and good sanitation is increased, and hygiene behaviour is improved (22). Research in Bangladesh shows a strong association between diarrhoeal mortality and water use and sanitation practices (see # 12 in appendix). It is also apparent that positive changes in behaviour do not automatically follow provision of facilities, and that effective interventions will be those that are tailored to the specific socio-cultural setting (23).

Like diarrhoea, acute respiratory tract infections persist as an important cause of death among young children. The past ten years have seen little in the way of interventions aimed at combatting this. A unit of the Government of Bangladesh was established in 1993 to address the issue of ARI. Future strategies will concentrate heavily on case management, in particular increased recognition of danger signs in young children.

If deaths from diarrhoea and ARI remain high, where has improvement been made? A large part of the observed mortality decline may be attributable to the rapid increase in immunization coverage among both children and women of reproductive age. The WHO Coverage Evaluation Survey of 1991 showed that 62% of children aged 12-17 months were fully immunized and 74% of mothers had received two TT immunizations during pregnancy or the last 3 years (24). Declining neonatal tetanus and deaths related to measles may thus account for a large part of the overall decline in mortality levels (25). The present survey showed far fewer neonatal tetanus deaths than some earlier studies, though caution is needed in making comparisons because of different methodologies.

Limitations of the survey

In any large scale survey, there are concerns about quality of the data collected. This is particularly so when respondents are expected to recall events that occurred some time in the past. In the present survey, before making estimates, a detailed examination of the data was performed. This investigation suggested that the data are generally of high quality. Nevertheless, as noted above, the life-table data appeared to underestimate mortality to some extent. This has been found in many large-scale surveys worldwide (5), and the results of the CDD survey illustrate the usefulness of including questions that allow the use of both direct and indirect mortality estimation techniques. Although data inadequacies mean that estimates should always be treated with caution, the findings from the survey, together with those presented from other data sources, support the suggestion that child mortality has declined over the past 5 to 10 years in Bangladesh.

There were also a number of limitations in the cause-of-death analysis. Examination of the data suggested that some questions could have been better designed, and illustrated the need for careful wording and instructions to interviewers. Inconsistencies in methodology between studies make it difficult to compare results and to draw any firm conclusions about changes in cause-specific mortality over time. Refinement and standardization of the procedures for collection of cause-of-death information are needed.

Despite many limitations, the survey appears to have been carried out well and has produced useful national estimates of both the levels and main causes of mortality in children below 5 years. As such, it represents an important addition to our knowledge of the mortality experience in children of Bangladesh.

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APPENDIX

1. See Annotated Bibliography of ICDDR,B Studies in Matlab, Bangladesh (1), for details of this research work.

2. Urban women were 'oversampled' and weighting factors were applied to make national representative estimates.

3. Experience in various parts of the world has shown that estimates of mortality derived from direct questions on timing of births and deaths often tend to be inaccurate. Retrospective questions on deaths during the 12 or 24 months preceding the survey and birth histories that include the dates of birth and death for all children, are often subject to large errors. This may be caused by some combination of recall lapse, age misreporting, reference period error, and misunderstanding of the questions (5). Indirect estimation techniques were developed in order to overcome these problems. However, it should be remembered that the indirect techniques are based on a number of assumptions and may also, in some circumstances, be subject to important bias. Blacker (5) reminds us that none of the methods available for estimating mortality in countries lacking reliable vital registration can be guaranteed to give accurate results every time they are used.

   The indirect techniques of mortality estimation employed in the CDD survey were:

   The Brass Technique: In this analysis the proportions of children born that have since died are calculated for women in each of the five year age-groups (15-19 to 45-49). These proportions are then transformed under a set of assumptions into risks of dying in different time periods over the 15 years prior to the survey. The calculations involve the use of demographic life table models, and in this case, the Coale-Demeny West pattern of mortality was considered appropriate. Details of how the calculations are performed and the assumptions which underlie the method can be found in Brass (6), Feeney (7) and United Nations (8). The United Nations computer program 'Q-FIVE' was used for the necessary calculations. In order to make comparisons between mortality levels for different time periods, the estimates are presented in a common format, usually the risk of dying before age 5 years.

   Preceding Birth Analysis: This method of mortality estimation uses information on women who have had a live birth in the two years preceding the survey, and for whom this was the second or higher order birth. The proportion of preceding births that have died by the time of the survey is transformed into an estimate of early age mortality. The calculations are described by Hill and Aguirre (9) and Hill and Macrae (10).

   The direct technique of mortality estimation employed in the CDD survey was:

   Life table estimate: This method uses information on the dates of birth and death for all children born in the 5 years preceding the survey. Living children are included in the life table as censored cases at the time of interview.

4. Unfortunately, the way the survey instruments were designed meant that no information on age at death or symptoms leading to death was collected for deaths resulting from an accident rather than illness. This was subsequently recognized to be a limitation and future surveys should modify this methodological flaw.

5. A great deal of heaping of reported age at death was found on 15 and 30 days. This heaping may be explained by the common use of the Bangla expressions 'ten to fifteen days' and 'one month' to refer to periods of time of approximately these durations. It should be noted that the number of deaths coded as neonatal tetanus in the latter period (16 to 30 days) was small. Had this procedure not been followed half of these deaths would have fallen into the category 'other causes', one quarter into watery diarrhoea, and one quarter into ARI.

6. Throughout the paper we refer to 'under-5 mortality rate (U5MR)' which is calculated as the proportion of children born who die before their fifth birthday, and 'infant mortality' which is the proportion of children born who die before their first birthday.

7. The International Centre for Diarrhoeal Disease Research Bangladesh (ICDDR,B) has maintained a vital registration system, known as the Demographic Surveillance System (DSS) in Matlab Thana since 1966. Data are collected in two areas; the Treatment Area where an MCH-FP programme is in operation and the Comparison Area where only normal government services are available. The quality of this data is generally recognized to be very high. Although there are likely to be differences between mortality levels and patterns in Matlab and the national population, the Comparison Area in particular can be regarded as a useful source of data with which to compare survey estimates for validity. The figures quoted in this report come from the DSS Registration of Demographic Events (15).

8. It should be remembered that the Brass estimates reflect the experience of a series of cohorts of children and thus show a 'smoothed' picture of the changes in mortality over time. They are less subject to short-term fluctuations than direct estimates calculated from deaths in each particular year.

9. The confidence intervals were calculated using sampling errors based on a cluster sampling approach (18,19). The design effect was calculated to be 1.57.

10. Several studies suggest that measles may be an important contributory factor to many early childhood deaths in Bangladesh (14). Though the present survey did not aim to explore measles mortality in detail, mothers were asked whether their child had experienced measles in the three months preceding death. Among all the diarrhoea-related deaths 14.1% of cases were reported to have suffered a measles infection in the 3 months prior to death.

11. Clearly, if the diarrhoea-related death rate had remained constant, we would see an increasing percentage of the total deaths assigned to diarrhoea as the overall mortality level fell.

12. Bilqis Amin Hoque: Personal communication of results from a recently completed study by ICDDRB in Matlab, Bangladesh.