

Epidemiology of child deaths due to drowning in Matlab, Bangladesh

M Kapil Ahmed, Mizanur Rahman and Jeroen van Ginneken

Background	Although the recent decline in child mortality in Bangladesh is remarkable, death from causes other than infectious diseases and malnutrition remains an important component of child mortality. Death from drowning of children can be expected to be a problem in Bangladesh given the geographical features of the country.
Objective	The objectives of this study are to determine the trend, pattern, and correlates of drowning deaths.
Methods	Data are presented on deaths of children (1–4 years) due to drowning derived from a longitudinal, population-based surveillance system in operation in a rural area of Bangladesh in 1983–1995. Moreover, a case-control study was carried out to identify the risk factors associated with drowning.
Results	Deaths due to drowning ranged from about 10% to 25% of child deaths during 1983–1995. The absolute risk of dying from drowning remained almost the same over the study period but the proportion of drownings to all causes of death has increased. Drowning is especially prevalent in the second year of life. Age of the mother and parity have a significant impact on drowning. The risk of dying from drowning increases with the age of mother and much more sharply with the number of living children in the family. Two socioeconomic variables did not have an influence on the risk of drowning.
Conclusions	A substantial proportion of child deaths could be averted if parents and other close relatives paid more attention to the safety of children. The Child Health Programme of the Ministry of Health and Family Welfare of Bangladesh should develop health education programmes for villagers alerting them to the dangers of drowning and measures to prevent it.
Keywords	Drowning as cause of death, child mortality, case-control study, risk factors of child mortality
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Child mortality (1–4 years) in rural Bangladesh was over 20 per 1000 population in 1983 and declined to around 8 per 1000 in 1995.^{1,2} This recent decline in child mortality is remarkable given the low level of socioeconomic development. There is a large potential for further reduction through public health interventions. Further improvement in child mortality can be achieved by averting deaths from acute respiratory infection, diarrhoea, malnutrition and other causes. However, deaths from causes other than diseases and malnutrition are also important. For example, a study based on verbal autopsies conducted in a sample of children who died in Bangladesh 1989–1992 shows that about 21% of deaths of children aged 1–4 years were due to drowning.³ This proportion seems to be high and deserves

attention from researchers and policy makers. Moreover, no information is available on the correlates of mortality due to drowning in developing countries.⁴

Deaths from drowning of children can be expected to be a problem in Bangladesh given the geographical features of the country. Villages are usually surrounded and intersected by canals and rivers and there are numerous ponds surrounding households which are used for bathing and washing purposes throughout the year. Children go to these ponds, canals, and rivers for bathing and playing. Most of the villages are inundated for several months in the monsoon. One can expect, therefore, that the peak of these drowning deaths will take place in the monsoon months.⁵

In Bangladesh no data are available on trends in and correlates of child mortality from drowning. The Matlab Demographic Surveillance System (DSS) operated by the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B)

International Centre for Diarrhoeal Disease Research, Bangladesh, GPO Box 128, Dhaka 1000, Bangladesh.

provides a unique opportunity for an exploratory analysis of drowning deaths.

We have developed five hypotheses in this study. First, we hypothesize that the absolute risk of deaths from drowning remains almost similar over time but that the relative proportion increases because of the large reduction of child mortality. The second hypothesis is that as a child becomes more independent and mobile at the end of the first year of life, the risk of dying due to drowning increases. Third, drowning is more likely to occur in the monsoon season. Fourth, drowning is less likely to occur in families with fewer children and the fifth hypothesis is that drowning is less likely to occur among children of educated mothers rather than uneducated mothers.

The objectives of this study are, therefore, to determine the trend, pattern, and correlates of drowning deaths and to test the five hypotheses mentioned above.

Methods and Procedures

Data and setting

The data in this study came from the DSS operated by the ICDDR,B. The DSS is a longitudinal surveillance system in which data has been collected in Matlab thana for nearly 30 years. Matlab is situated about 50 km southeast of Dhaka, the capital of Bangladesh. The area is entirely rural and surrounded by rivers and canals. Part of it is regularly flooded and part of it is protected from the annual flood by an embankment. The population of the study area was estimated to be 208 000 in 1995 with 88% Muslim and 12% Hindu. Average household size is about six people. Roughly 70% of the male and 6% of the female population is economically active and traditionally agriculture (rice cultivation) is the main occupation of most villagers.

In Matlab, households are visited monthly by Health Assistants (HA) who collect data on vital events. They rely for their information on female Community Health Workers (CHW) who visit a certain number of households every fortnight. Households are revisited quarterly by supervisors who check on the completeness of the vital events collected by the HA and CHW. Death registration includes collection of information on causes of death by means of forms filled out by a HA. A Medical Assistant, who has formal paramedical training checks these forms and assigns the cause of death. The coding was done according to the 9th revision of the International Classification of Diseases, Injuries and Causes of Death.⁶ It is unlikely that the cause-of-death data are entirely free from respondent, interviewer, and classifier biases.⁷ However, deaths from drowning are probably reported fairly accurately due to the fact that in case of the death of a child under 5 the Medical Assistant interviewed the mother or guardian during a home visit and determined the circumstances leading to the death.

Method of analysis

The data analysed in this study are from calendar year 1983 through 1995. There were 661 drowning deaths among children aged 1–4 years. In our study we also identified a few (34) cases of death from drowning below the age of one year. We excluded these children from the analysis since they are not at risk of dying until near the end of their first year of life when they learn to walk. The analysis consists of two parts. In the

first part we will describe various aspects of the available data such as proportion of all deaths due to drowning and trends in mortality due to drowning. In the second part we will focus on determinants of drowning mortality. We decided to adopt a case-control design. The deaths due to drowning will be compared with a sample of 3000 surviving children born during 1979–1991. Maternal age (at the time of death of the children), number of surviving children, mother's education and religion variables were taken from the DSS database. Other variables, such as household space (a proxy for economic condition) were taken from the 1982 Census. In addition, we carried out a case-control study comparing all deaths in children 1–4 years old with surviving children in the same age group. The multivariate technique of analysis chosen in both case-control studies was logistic regression analysis.

Results

The mortality rate from all causes in age group 1–4 years declined dramatically from nearly 30 per 1000 in 1983–1984 to about 5 per 1000 in 1994–1995 (Figure 1). Drowning deaths averaged about 2 per 1000 and have been decreasing slightly since 1983. The proportion of drowning deaths to deaths from all causes has increased from below 10% in 1983–1984 to over 30% in 1995.

The death rate from all causes declined regularly with age, from 18 per 1000 for one year old children to 5 for 4 year olds (Table 1). In contrast, the death rate from drowning was much higher at age one (5 per 1000) than at ages 2, 3 and 4. If we consider 4-year intervals of time, it can be observed that the rates from all causes declined over time for all ages whereas the death rates from drowning were almost steady for one year olds and decreased for the 2, 3 and 4 years olds. Table 1 also shows the percentage of deaths due to drowning. This percentage is particularly high at age one, declines sharply at age 2 and 3, and again increases at age 4 years. These percentages have increased between 1983–1987 and 1991–1995 in most age groups.

To illustrate the impact of seasonality, Figure 2 indicates that drowning peaked between April and September (6 months). About one-third of deaths occurred during the months of April through June (3 months). In Bangladesh April through June are the hottest months of the year and children are likely to play outside their house either near to or in rivers and canals or ponds and ditches. Another peak of drowning deaths occurred between July and October and these are the months when flooding is common in rural Bangladesh.

A differential in mortality due to all causes in the age group 1–4 years old by sex is shown in Table 2. Girls have higher death rates than boys. Such a differential by sex does not exist for drowning. The percentage of drowning to all deaths is, however, nearly double for boys than girls. The risk of mortality due to all causes in the age group 1–4 years old decreases with the increasing maternal education whereas education has no effect on drowning deaths (not shown).

Table 3 presents results of analysis of circumstances related to child deaths from drowning in Matlab during the study period. The majority (61%) of deaths from drowning occurred before noon when mothers and relatives were busy with the preparation or consumption of meals and/or other household chores.

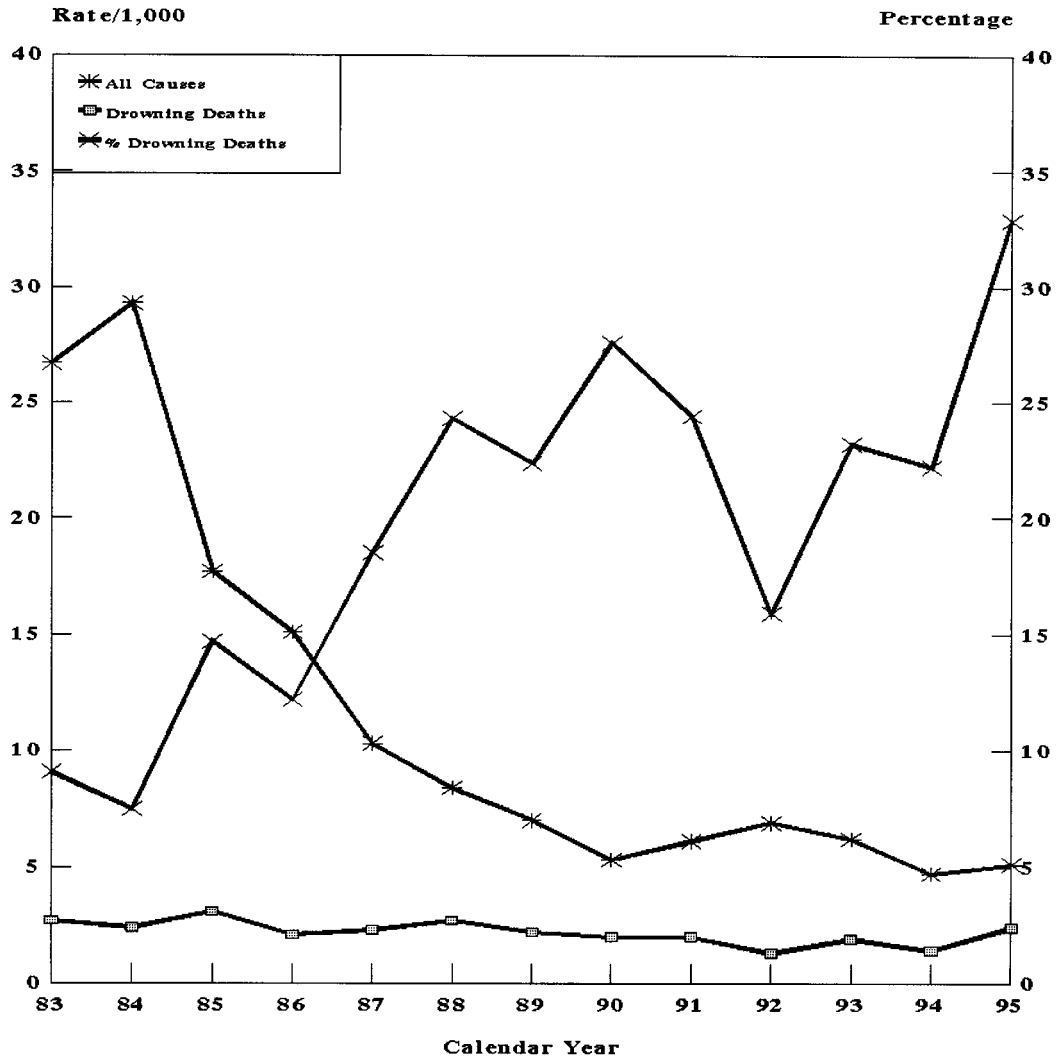


Figure 1 Death rate per 1000 and per cent of drowning deaths due to drowning of children 1-4 years old in Matlab, 1983-1995

Table 1 Death rate per 1000 and percentage of deaths due to drowning of children 1-4 years in Matlab, 1983-1995

Age (years)	Rate/1000											
	All deaths				Drowning deaths				% Drowning			
	1983-1986	1987-1990	1991-1995	Total	1983-1986	1987-1990	1991-1995	Total	1983-1986	1987-1990	1991-1995	Total
1	31.9	13.6	9.1	17.8	4.9	5.0	4.4	4.8	15	37	48	27
2	28.5	8.6	7.5	14.4	1.9	1.4	1.1	1.4	7	16	15	10
3	17.7	4.9	4.4	8.7	1.8	1.2	1.2	1.4	10	24	27	16
4	10.0	3.3	2.7	5.0	1.5	1.3	0.5	1.1	15	30	19	22
Total	22.3	7.7	5.9	13.8	2.6	2.3	2.8	2.2	12	30	47	16

Our results show that the highest percentage of drowning deaths (88%) occurred when parents were in the house and 75% of the mothers were engaged with 'household chores'.

Table 4 shows logistic regression results of factors related to drowning. This analysis is based on a case-control study in which 661 children who drowned in 1983-1995 were compared with a sample of 3000 children who survived. We included

all independent variables against the dependent variable (after controlling for the others) in the model and we found, first of all, that sex of the child is not related to risk of drowning which is consistent with the results of Table 2. The risk of dying from drowning increases with the age of the mother as shown by the significance of the maternal age variable. The risk of dying from drowning increases sharply with the number of surviving

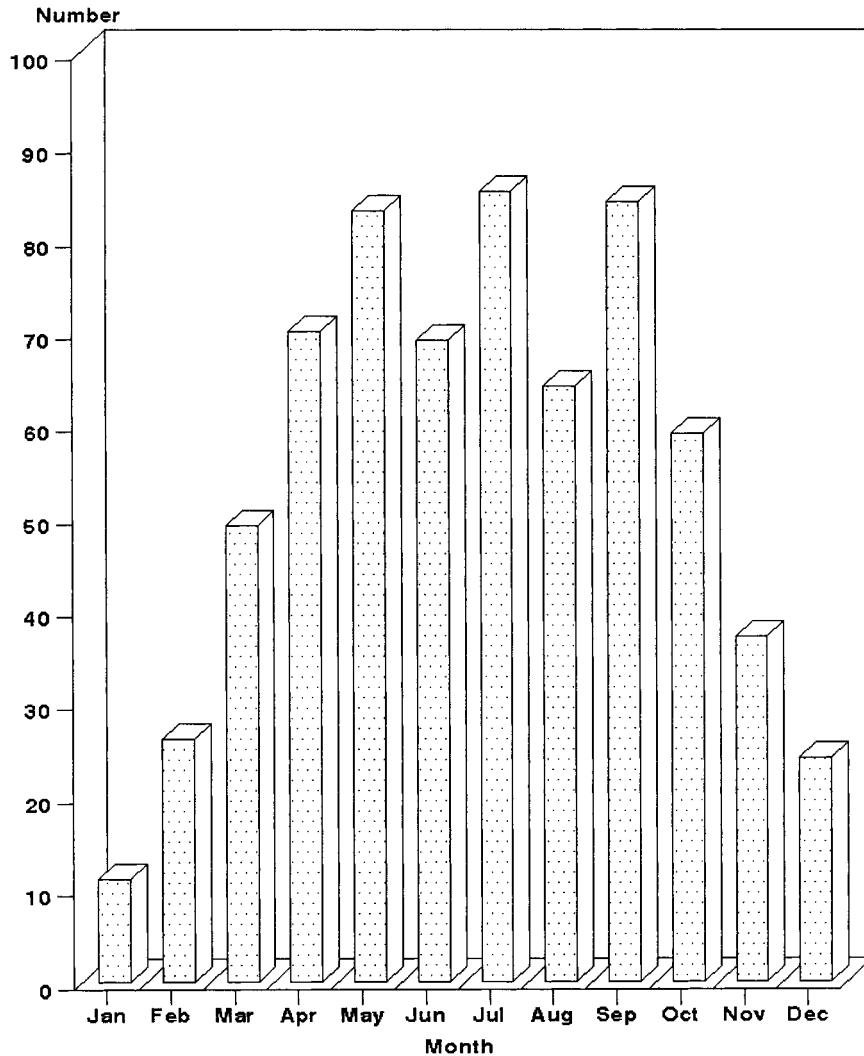


Figure 2 Seasonality of drowning deaths of children 1-4 years old in Matlab, 1983-1995

Table 2 Death rate per 1000 and percentage of deaths due to drowning of children 1-4 years old by sex in Matlab, 1983-1995

Sex	Rate/1000		% Drowning
	All deaths	Drowning deaths	
Male	10.7	2.2	21
Female	17.1	2.1	12
Both sexes	13.8	2.2	16

children in the family. Maternal education and dwelling space are not associated with drowning deaths. Muslim children have a 28% higher risk of drowning than Hindus. The Matlab study area was divided into two parts; the MCH-FP area where an intensive maternal and child health and family planning (MCH-FP) programme took place and a Comparison area without such a programme. In our study, we observed a significant difference in drowning mortality between the two areas. Children living in the MCH-FP area have a 21% higher chance of drowning than children in the Comparison area. This may be due to the protection of Matlab embankment which covers most of the

villages of the Comparison area. Another study conducted in Matlab found that the percentage of drowning was significantly lower in the embankment area than elsewhere.⁸

We also did a case-control analysis of total child mortality (excluding drowning deaths) (Table 4). The results of logistic regression show that male children have a much lower risk of dying than female children. Child mortality increases sharply with maternal age and to some extent with the number of surviving children in the family. Mother's education and another indicator of socioeconomic status, the size of the dwelling space of the household, were negatively associated with child mortality. There was lower child mortality among Hindus than among Muslims. Area variation is pronounced; there was higher child mortality in the Comparison area than in the MCH-FP area.

Discussion and Conclusions

The proportion of deaths from drowning to all deaths in children 1-4 years old is about 19% in Matlab for 1983-1995; this figure is very close to the nationwide figure of 21% found in

Table 3 Details of child deaths (1–4 years) from drowning in Matlab, 1987–1995

Factors	No.	Percentage
Total	470	100
Time of death		
Before noon	196	61
Afternoon	83	26
Evening	42	13
Unknown	149	–
Place of drowning		
River/canal	82	22
Pond/ditch	242	66
Others	43	12
Unknown	103	–
Activities prior to death		
Playing	150	44
Bathing	44	13
Others	144	43
Unknown	132	–
Presence of father or mother		
At home	322	88
Outside home	43	12
Unknown	105	–
Activities of mother at the time of death		
Household chores	242	75
Talking/sleeping	39	12
Others	40	13
Unknown	149	–

the verbal autopsy study in Bangladesh during 1989 and 1992. In general, the results of our study support our hypotheses. The proportion of deaths from drowning to all deaths increased over time. The risk of death due to drowning is especially large during the second year of life. It is at this age that children become more independent and are moving around freely. Our study shows that April through September are the high-risk months of drowning. This period is divided into two parts; April through June are the hottest months of the year and July through October almost completely cover the monsoon season of Bangladesh. The monsoon seasonal peak is due to Matlab topology which is riverine and low-lying. Flooding is common at the time of the annual monsoon in Bangladesh. This pattern of seasonality of mortality is in accordance with another study conducted in Matlab which also found a strong association between drowning in children 1–4 years old and monsoon season.⁹ There is no differential in drowning deaths by sex in the 1–4 years old age group while for all causes girls have a higher risk of mortality than boys. It has been shown in other studies that important sex differentials exist in mortality for children under 5 years old.¹⁰ Discrimination against girls is the main cause for the existence of those sex differentials in mortality and it shows in aspects of life such as allocation of food and access to health care.¹¹

The majority of drowning deaths occurred before noon. This is the time when mothers and relatives are busy with household work and it is likely to separate them from their children. The

risk of dying from drowning is higher among children of older rather than younger mothers and in families with many rather than few children. The main reason for this is probably that mothers and other family members in households with many children pay less attention to the safety of the children and become more careless than in small households. Our study did not find an association of risk of drowning with socioeconomic variables such as mother's education. This means that our results do not support our fifth hypothesis formulated at the beginning of this paper.

If we compare the logistic regression results of drowning with those of all deaths, we see that the nature and strength of the relationships of the various independent variables with drowning are quite different from those with total mortality. For instance, the impact of the number of children in the family on drowning is much stronger than for total mortality. In contrast, there is no relation of mother's education with drowning while there is a negative relationship with total mortality. The results on determinants of all causes of death presented here are in accordance with others conducted in Bangladesh dealing with the role of maternal education and religion and other variables.^{10,12}

The World Summit on Child Survival and Development was held in November 1990 in New York. World leaders made a promise to meet specific goals for children by the year 2000. Bangladesh has still a high infant and under 5 mortality rate as is the case in a number of other developing countries.¹³ The findings of our study suggest that it is desirable to set targets and to formulate policies with respect to drowning since it is an important component of this high mortality. Death due to drowning is in principle avoidable and can be decreased by raising awareness about the dangers of drowning through use of mass media, aimed in particular at the rural people of Bangladesh. The Bangladesh child health programme, part of the national MCH-FP programme, can help to reduce deaths from drowning by raising awareness of parents and relatives about the dangers of drowning and its prevention. It is hoped that our study will guide policy makers in the government and in non-governmental organizations to make plans for such a programme. In formulating these policies one should not lose sight of the role of parents who have, of course, the final responsibility for the safety of their children.

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Table 4 Odd ratios of determinants of drowning and mortality of children 1–4 years old after controlling for other variables in Matlab, 1983–1995

Independent variables	Drowning deaths (n = 661 versus 3000)		Other deaths (n = 3228 versus 3000)	
	Odds ratio	95% CI ^a	Odds ratio	95% CI ^a
Sex				
Female	1.00		1.00	
Male	1.01	(0.84–1.18)	0.53***	(0.47–0.59)
Maternal age				
<20	1.00		1.00	
20–29	1.80**	(1.21–2.67)	3.54***	(2.67–4.27)
30+	1.64*	(1.04–2.59)	3.42***	(2.67–4.43)
No. of surviving children				
None	1.00		1.00	
1–2	1.72**	(1.20–2.47)	0.66***	(0.57–0.82)
3–4	2.51***	(1.71–3.70)	1.21*	(1.01–1.46)
5+	2.84***	(1.81–4.45)	1.62***	(1.31–2.01)
Maternal education				
None	1.00		1.00	
Primary	0.90	(0.72–1.11)	0.68***	(0.59–0.78)
Above primary	1.09	(0.75–1.58)	0.70**	(0.54–0.92)
Dwelling space (sq.ft.)				
<170	1.00		1.00	
170–349	1.24*	(1.00–1.54)	0.78***	(0.69–0.89)
350+	1.04	(0.80–1.35)	0.63***	(0.54–0.74)
Religion				
Hindu	1.00		1.00	
Muslim	1.28+	(0.95–1.74)	1.26**	(1.06–1.51)
Area				
Comparison area	1.00		1.00	
MCH-FP area	1.21*	(1.02–1.45)	0.66***	(0.60–0.74)

^a Confidence interval of odds ratios.

+ $P < 0.10$, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

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