EDITOR'S CHOICE

Analysis of the childhood fatal drowning situation in Bangladesh: exploring prevention measures for low-income countries

A Rahman,[1] S R Mashreky,[1] S M Chowdhury,[1] M S Giashuddin,[1] I J Uhaa,[2] S Shafinaz,[2] M Hossain,[3] M Linnan,[4] F Rahman[1]

[1] Centre for Injury Prevention and Research, Bangladesh (CIPRB), Dhaka, Bangladesh; [2] UNICEF, Dhaka, Bangladesh; [3] UNICEF, Dili, Timor-Leste (Formerly UNICEF, Dhaka, Bangladesh); [4] The Alliance for Safe Children (TASC), Bangkok, Thailand

Correspondence to:
Dr A Rahman, Centre for Injury Prevention and Research, Bangladesh (CIPRB), House 226, Lake Road 15, New DOHS, Mohakhali, Dhaka 1206, Bangladesh; aminur@bdonline.com

Accepted 26 December 2008

ABSTRACT

Objective: To determine the epidemiology of child drowning in order to propose possible interventions for Bangladesh and other similar low-income countries.

Design: Population-based cross-sectional study.

Setting: Rural and urban communities in Bangladesh.

Subjects: About 352 000 children 0–17 years were selected from over 171 000 households, using multistage cluster sampling.

Main outcome measures: Incidence of fatal drowning.

Results: Drowning was the leading cause of death (28.6 per 100 000 child-years) in children aged 1–17 years. The highest incidence (86.3 per 100 000 child-years) was in children aged 1–4 years. More than two-thirds of drownings occurred in ponds and ditches. Most drownings (85%) happened in daylight. In more than one-third of cases of drowning, the child was alone. In the two-thirds of cases in which the child was accompanied, almost half were with children who were 10 years or below. Only 7% of drowned children over 4 years of age knew how to swim.

Conclusions: Drowning is a major cause of childhood mortality in Bangladesh. Creating drowning-safe homes, improving supervision of children, modifying the environment, and developing water safety skills for children and the community may be effective interventions for drowning prevention.

Drowning is a major, but often neglected, public health problem. The first Global Burden of Disease (GBD) Study conducted by the World Bank and WHO in the 1990s showed that, worldwide, drowning is one of the most common causes of death. The study found that death by drowning (504 000) was more common than death through war (502 000) or HIV infection (312 000).[1] The recent GBD Study data show global mortality from drowning to be 6.8 per 100 000 person-years. Drowning affects all age groups, but over half of the global mortality occurs among children less than 15 years of age. Furthermore, 97% of all deaths from drowning occur in low/middle-income countries.[2] In the eastern and south-eastern regions of the world, more children die annually from drowning than from pertussis, measles, diphtheria, plague, cholera, dengue fever and typhoid fever combined.[3]

In high-income countries, various drowning prevention measures including pool fencing,[4–7] pool fencing legislation,[8 9] parent education,[10] close supervision of young children,[11] use of personal flotation devices,[12–14] cardiopulmonary resuscitation[15] and swimming instruction[16 17] have been advocated. However, prevention efforts in low/middle-income countries are almost non-existent, and drowning is not yet recognised by policy makers as a major cause of child mortality. Moreover, there is no successful model for implementing the known, effective interventions from high-income countries in a low-income country such as Bangladesh.

The aim of this study was to determine the epidemiology of child drowning in order to propose possible interventions for Bangladesh as well as other similar low-income countries.

METHODS

The Bangladesh Health and Injury Survey (BHIS)[18] data were analysed to elicit feasible prevention measures for drowning. The BHIS was a population-based survey conducted in 12 randomly selected districts and Dhaka Metropolitan City between January and December 2003. Multistage cluster sampling was used to select 171 366 households: 88 380 from rural areas, 45 183 from district towns (urban areas) and 37 803 households from Dhaka Metropolitan City. In each district, to represent the rural community, one upazlia (sub-district) was randomly chosen, and, in each upazilia, two unions (a union is the lowest administrative unit comprising ~20 000 population) were selected randomly. All households in the union were included in the survey. The district headquarters of the 12 selected districts and Dhaka Metropolitan City constituted the urban areas. In the urban areas, mohallas (a mohalla is the lowest unit in an urban area) served as clusters, and systematic sampling was performed to achieve the required number of households. In the sampled households, 351 651 children aged 0–17 years were identified; of these, 177 985 were male. Data were collected by 48 trained collectors through face-to-face interviews with the respondents. Mothers were preferred as respondents; however, when a mother was not available, the most knowledgeable member of the household present at the time of interview was selected as the respondent. Where possible, it was the head of the household, and as many members of the household as possible were present to corroborate or add detail to the respondent's answers. The respondents were first asked if there had been any deaths of children 0–17 years in the household in the last 2 years in all areas except Dhaka Metropolitan City; in the latter, the recall period was 3 years.

Table 1 Ranking of top 10 causes of child mortality in Bangladesh

	0–17 years (n = 351 651)		1–17 years (n = 335 458)		1–4 years (n = 74 164)		5–9 years (n = 106 916)	
Rank	**Cause**	**Number**	**Cause**	**Number**	**Cause**	**Number**	**Cause**	**Number**
1	Pneumonia	271 (77.1)	**Drowning**	96 (28.6)	**Drowning**	64 (86.3)	**Drowning**	28 (26.2)
2	LBW/preterm	211 (60.0)	Pneumonia	69 (20.6)	Pneumonia	56 (75.5)	Diarrhoea	16 (15.0)
3	Birth asphyxia	156 (44.4)	Malnutrition	46 (13.7)	Malnutrition	40 (53.9)	Pneumonia	7 (6.5)
4	Diarrhoea	113 (32.1)	Diarrhoea	44 (13.1)	Diarrhoea	25 (33.7)	Transport injuries	7 (6.5)
5	**Drowning**	96 (27.3)	Meningitis	23 (6.9)	Meningitis	17 (22.9)	Chicken pox	5 (4.7)
6	Malnutrition	75 (21.3)	Transport injuries	20 (6.0)	Diarrhoea + pneumonia	11 (14.8)	Animal bite	5 (4.7)
7	Septicaemia	67 (19.1)	Diarrhoea + pneumonia	15 (4.5)	Septicaemia	5 (6.7)	Meningitis	4 (3.7)
8	Meningitis	55 (15.6)	Suicide	12 (3.6)	Transport injuries	2 (2.7)	Electrocution	4 (3.7)
9	Diarrhoea + pneumonia	50 (14.2)	Animal bite	12 (3.6)	Dengue	1 (1.3)	Malnutrition	3 (2.8)
10	Transport injuries	18 (5.1)	Chicken pox	5 (1.5)	–	–	Diarrhoea + pneumonia	2 (1.9)

Values in parentheses are rates per 100 000/year.
LBW, low birth weight.

To elicit cause of death, a verbal autopsy module, adapted from the WHO standard for verbal autopsy was used. Major revisions involved asking specific questions about each type of injury, and extending the age groups to include children from 5 to 17 years of age. After the verbal autopsy forms had been entered, the cause of death was determined by two independent panels of paediatricians in a blinded, two-stage procedure that required consensus on the final cause of death.

In cases where no respondent was found at the first visit, a repeat visit was made. If no respondents were available on the repeat visit, the household was excluded from the study. The detailed methodology of the survey has been published elsewhere.[18]

A screening form was used to collect information from households, including number of child deaths in the household. If any deaths were identified, a standard verbal autopsy form was administered to determine the cause of death. If the death was due to drowning, a specific form was used to obtain detailed information on the drowning event.

Drowning deaths were annualised, and urban–rural adjustments were made. Rates were calculated per 100 000 child-years. The incidence of drowning among children was calculated with exact binomial 95% CIs. In addition, frequency distributions of different variables related to drowning were calculated.

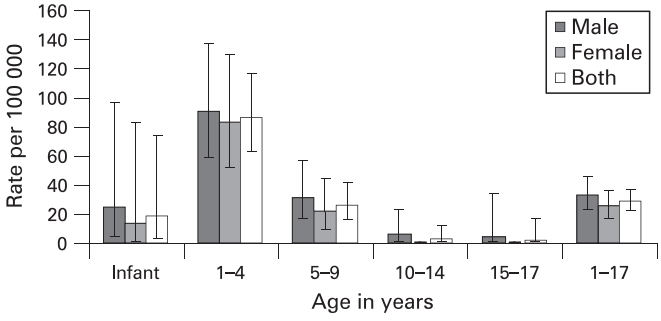

Figure 1 Drowning mortality among children by age and sex in Bangladesh.

RESULTS

Ranking of drowning in child mortality

For all children under 18 years of age, communicable diseases and neonatal causes predominate child deaths. Drowning is the fifth leading cause among the top 10 killers of children (27.3 per 100 000 children-year).

However, when infants are excluded, drowning becomes the leading cause of death among children 1–17 years of age (28.6 per 100 000 per year; 95% CI 22.2 to 36.8). In children 1–4 years of age and 5–9 years of age also, drowning is the leading cause of death (86.3 per 100 000 and 26.2 per 100 000, respectively) (table 1).

Incidence of drowning in Bangladesh

Drowning incidence peaked in the 1–4-year age group (86.3 per 100 000; 95% CI 63.1 to 117.5), and then rapidly declined as age increased. There were no significant differences in incidence between males and females in any age groups (fig 1).

Place of drowning

More than 80% of drowning occurred in natural bodies of water as opposed to man-made containers such as buckets, drums or tubs. Ponds (43%) and ditches (26%) were the most common places of drowning (table 2).

Distance of place of drowning from home

About 80% of drowning incidents took place within 20 m of the house (table 2).

Time of drowning

Most (85%) drownings in children 0–17 years occurred in daylight between 0900 and 1700 (table 2). However, in 1–4-year-olds, about half occurred between 0900 and 1300 (data not shown).

Person accompanying

More than one-third of children who drowned were unaccompanied (table 2). However, about one-fifth were accompanied by mothers/care givers or fathers.

For the two-thirds of drowning incidents in which the child was accompanied, over 40% were accompanied by children

Table 2 Details of fatal drowning of children in Bangladesh

Factor	Percentage
Place of drowning	
Pond	42.5
Ditch	26.2
Lake	6.8
River	5.2
Bucket	7.2
Drum	3.6
Tub	2.3
Other	6.1
Distance of place of drowning from home (m)	
⩽5	19.2
6–10	30.7
11–20	27.8
21–50	7.4
51–100	7.5
100+	7.3
Time of drowning	
0001–0900	9.9
0901–1100	19.8
1101–1300	25.8
1301–1500	21.3
1501–1700	18.9
1701–1900	4.2
Accompanying person	
Mother/care giver	13.1
Father	6.1
Elder sibling	12.5
Other relative	5.4
Friend/peer	15.7
None	35.6
Other	3.8
Not known	7.7
Age of the accompanying person (years)	
<5	17.5
5–9	22.6
10–14	11.8
15–17	4.2
⩾18	43.9
Swimming ability (4–17 years)	
Can swim	7.0
Cannot swim	93.0

under 10 years. However, about 44% were accompanied by an adult.

Swimming ability

Most of the drowned children could not swim. Almost half (46%) were under 4 years of age and too young to know how to swim. Among those over 4 years old, only 7% of drowned children knew how to swim (table 2). Swimming ability was defined by reference to "survival swimming" skills.[19] In children 4–9 years of age, there were 34 fatal drownings; only one of these children could swim (3%). Of the 10–14-year-olds, only three drowned, and one of them (33%) could swim.

DISCUSSION

As in other developing countries, health management information systems and other vital registration systems are inadequate in Bangladesh. Therefore, it is challenging to ascertain accurately the magnitude of health events with routinely collected information. This survey was designed and conducted to meet this challenge and to obtain more accurate estimates of the magnitude and distribution of drowning in Bangladesh.

Table 3 Possible drowning prevention measures

Issues	Prevention measures
Common place of drowning: ponds and ditches situated close to house	*Environmental modification*: creating barrier to prevent access to the water bodies, especially for younger children 1–4 years old *Awareness development*: parents should be aware about the hazards of open water bodies
Time of drowning: half of the drowning events in 1–4 year-old children occur between 0900 and 1300	*Institutional supervision*: community day care centre or crèche should be established to supervise children
Person accompanying before drowning: half of child drowning incidents occurred when the child was accompanied by an adult	*Improved supervision*: supervision of children to be improved by raising awareness
Swimming ability: only 7% of drowned children over 4 years of age could swim	*Swimming teaching*: at the community settings using local resources, teaching of survival swimming should be provided to children 4 years and above

Verbal autopsy, which was used in this study, is considered a useful tool for ascertaining causes of death in settings where the proportion of people who die under medical care is low and there is no routine registration.[20 21]

This survey revealed that drowning is the leading cause of death in children older than infants. A similar finding was obtained in the Vietnam Multi-center Injury Survey.[22]

Drowning rates are known to vary greatly with age.[23] This is also applicable for Bangladesh. In this study, the highest rate of drowning was in children aged 1–4 years, and the rate decreased with increasing age. Similar to the situation in Bangladesh, a high incidence (49.1 per 100 000) of drowning was found in the under 5 age group in the countries of the Western Pacific Region.[24]

Villages or communities in Bangladesh are usually surrounded and intersected by canals and rivers, and there are numerous ponds in close proximity to households, which are used for bathing and washing purposes throughout the year. Children usually go to these bodies of water, unaccompanied or unsupervised by adults, for bathing and playing.[25] This study reveals that ~80% of the drowning deaths occurred in water bodies within 20 m of residences. Some environmental modification of water reservoirs, at least those that are within 20 m of residences, may prevent access by younger children (1–4 years). At the same time, parents and the community at large should be educated about water hazards and the need for increased supervision of children, especially those in this high-risk group (table 3).

The time of drowning is another important point of consideration for prevention measures. We found that most drowning incidents in children aged 0–17 years occurred in daylight. In children 1–4 years of age, almost half of the drowning incidents took place between 0900 and 1300 when mothers and other care givers are busy with their household chores. This suggests that children are not properly supervised during this time. Improved supervision is crucial for the survival of children in this age group. Some sort of institutional supervision, such as day care centres or crèches, could be considered where children would remain under direct supervision of a skilled care giver.

What is already known on this topic

- Drowning is one of the major causes of death in children aged 1–4 years in rural areas.
- Ponds and ditches are the most common places where drowning occurs.
- Drownings mostly occur during daylight hours.

What this study adds

- Drowning is the leading cause of death in children 1–17 years of age in Bangladesh, in both rural and urban areas.
- The incidence of drowning is highest in children 1–4 years of age, followed by children 5–9 years of age.
- Only 7% of the drowned children over 4 years of age knew how to swim. The proportions with swimming ability in the 4–9-year and 10–14-year groups were 3% and 33%, respectively.
- Lack of adequate supervision is strongly associated with drowning.

The study shows that before drowning, more than one-third of the children were unaccompanied, and, of the remainder, almost half were accompanied by children too young to rescue them. Other studies have also found that most childhood drownings occur in 1–4-year-old children when they were not supervised by adults.[10 26] However, half were with adults who failed to supervise properly. This provides us with two thoughts for prevention. One is that a child should be supervised by an adult and not by a younger child[11]; however, adolescents could also be trained in the supervision, and rescue if necessary, of younger children. The second is that being accompanied by an adult does not necessarily mean adult supervision. A child near water should be constantly watched. An awareness-raising component of supervision should be incorporated in any drowning prevention programme.

The rate of drowning was lower in children 10–14 years of age than in children 4–9 years of age. The proportion who could swim was higher in the older age group. We therefore suggest that swimming skills may reduce the incidence of drowning in children 4 years and above. The role of equipping children with swimming ability to reduce the risk of drowning has been a focus of Asher *et al*[16] and Brenner *et al*[27]; both groups highlight that children should receive swimming lessons from instructors.

During the last decade, efforts have been made to prevent and control communicable and nutritional problems. Notable among these efforts are the Expanded Programme on Immunisation (EPI), Control of Diarrhoeal Diseases (CDD), the Acute Respiratory Infection (ARI) Project and breastfeeding and nutrition programmes. All these efforts have contributed to a significant decline in infant and child mortality and morbidity in Bangladesh. However, as there was no, or a lack of, information on the relative contribution of drowning and other injuries, prevention efforts have been practically non-existent in Bangladesh. As shown by the history of drowning statistics in many high-income countries, the impact of drowning on public health can be greatly reduced through effective interventions.[1] If Bangladesh is to achieve the Millennium Development Goal on child mortality, injury—including drowning—must be addressed. Environmental modifications, improved child supervision, and teaching children older than 4 how to swim should be included in the intervention programme.

This study shows that drowning is the leading killer of children after infancy. Children 1–4 years old are the most vulnerable to drowning. Rural children are more at risk of drowning in Bangladesh. Considering the geographic, socio-cultural, economic and demographic characteristics, it can be assumed that the situation is similar in other low-income countries, especially those neighbouring Bangladesh. Supervision, teaching swimming skills, environmental modification and awareness programmes are possible interventions for preventing childhood drowning in low-income countries such as Bangladesh.

Acknowledgements: This research was a part of Bangladesh Health and Injury Survey, which was supported by Institute of Child and Mother Health (ICMH), Dhaka, Bangladesh, UNICEF-Bangladesh and The Alliance for Safe Children (TASC), Thailand. We thank the ICMH, UNICEF and TASC personnel for their support.

Contributors: AR participated in the design, implementation and supervision of field work and analysis and wrote the paper. SS and MH advised on project design and implementation and contributed to the writing of the paper. IJU helped in designing and developing the paper. ML and FR conceived the study and supervised throughout and contributed to the writing of the paper. SRM and SMC were responsible for implementation and supervision of field activities and contributed to the writing of the paper. MSG assisted in data management and analysis and contributed to the writing of the paper. IJU, ML and FR are guarantors.

Funding: UNICEF-Bangladesh and TASC.

Competing interests: None.

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