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Vulnerability to fatal drowning among the population in Southern Bangladesh: findings from the baseline survey of the BHASA project

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Manuscripts

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3 **Vulnerability to fatal drowning among the population in Southern Bangladesh: findings from the**
4 **baseline survey of the *BHASA* project**
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ABSTRACT

Objectives: To determine the mortality burden and associated risk factors in Southern Bangladesh.

Settings: The survey was conducted in 39 sub-districts of all six districts of the Barishal division, Southern Bangladesh.

Participants: All residents (over last 6 months) of the Barishal division, Southern Bangladesh.

Intervention/methods: A cross-sectional, regionally representative household survey was conducted in all six districts of the Barishal division between September 2016 and February 2017, covering a population of 386,016. Data was collected by face-to-face interview with adult respondents using handheld electronic tablets. Mortality was determined using the ICD 10 codes for drowning W65 – W74, X36 – X39, V90, V92, X71 or X92.

Results: The overall drowning mortality in Barishal was 37.9/100,000 population per year (95% CI 31.8–43.9). The highest drowning mortality rate was observed among children 1-4 years (262.2/100,000/year). Mortality rates among males exceeded females (48.2/100,000/year). A higher rate of fatal drowning was found in rural (38.9/100,000/year) compared to urban areas (29.3/100,000/year). Results of the multivariable logistic regression identified that the factors significantly associated with fatal drowning were being male (OR 1.7, 95%CI: 1.2, 2.3), aged 1-4 years (OR 3.0, 95% CI 1.4-6.4) and residing in a household with 4 or more children.

Conclusion: The mortality rate for drowning in Bangladesh is known to be one of the highest in the world, in 2016, drowning was the leading cause of death in children 1-4 years. Project *BHASA* was established to implement a coordinated multisectoral program to prevent drowning in the Barishal division of Southern Bangladesh. Prior to the implementation of the programme, a baseline survey was conducted to determine the magnitude of drowning mortality and factors associated with fatal drowning.

Trial Registry: Not applicable

Key words: Drowning, fatal drowning, mortality, injury, risk factor, Bangladesh

ARTICLE SUMMARY

Strengths and limitations of this study

- A key strength of this study was the large regionally-representative sample of Barishal division in Bangladesh, to guide contextual implementation of effective interventions.
- The study used multiple methods for quality control, of significance are the learnings from use of electronic data capture system with low access to internet.
- Limitations included the cross-sectional nature of the study which may have introduced recall bias.
- Under-reporting in overall mortality rates is a concern for children under five years and may have contributed to an under-estimate of the true mortality in this age group

INTRODUCTION

An estimated 322,149 drowning deaths occur globally every year making drowning a major global health problem[1]. Half of all drowning fatalities in the world occur in people under the age of 25 with the most vulnerable being children aged between 1 – 4 years. More than 90% of drowning incidents take place in low- and middle-income countries (LMICs) where men, women and children have a higher exposure to the risks associated with open water[2]. According to the 2012 WHO Global Health Estimates, the overall mortality rate from drowning globally was 5.2 per 100,000 population with the highest rates observed in the African Region (7.9 per 100,000 population) followed by South-East Asia Region (7.4 per 100,000 population)[2].

The first Bangladesh Health and Injury Survey (BHIS) reported in 2005, identified drowning as the leading cause of death among children 1-17 years with approximately 17,000 children dying each year[3]. In 2016, the BHIS was carried out for the second time and again drowning was found to be the main cause of injury deaths among children aged 1-4 and 5-9 years. According to the 2016 BHIS, 40 children (aged between 0-17 years) lost their life every day from drowning in Bangladesh and this was the highest among all injury fatalities. Among adults (aged 18 years or more) however, there were 13 deaths from drowning per day and this was the sixth leading cause of injury death in that age category[4]. The 2011 Bangladesh Demographic Health Survey (BDHS) found that while the risk of dying from other conditions had significantly decreased, fatalities from drowning among children 1-4 years rose alarmingly from 19% in 2004 to 43% in 2011[5].

Bangladesh is one of the most disaster-prone countries in the world, ranked sixth in the 2015 World Risk Report[6]. It is especially vulnerable to cyclones and frequent riverine and coastal flooding which claim many lives each year[7]. As a riverine country, drowning during inland water transport accidents is also common[8].

1
2
3 The 2005 BHIS identified that the highest mortality rate due to drowning occurred in the Pirojpur
4 district of Barishal division in Bangladesh[3]. Geographically, the division is located in the central
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6 district of Barishal division in Bangladesh where several large rivers converge; with a land mass of 13,644.85
7
8 km² and a population of 8,147,000. As a low lying, coastal division, Barishal is vulnerable to disaster
9
10 and climate change. All six districts under this division are affected by water-related hazards[9].
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14
15 Considering these factors, Project *BHASA*, a Comprehensive Drowning Reduction Strategy was
16
17 designed to reduce drowning mortality and morbidity utilizing evidence-based interventions. As part
18
19 of this initiative a baseline survey was conducted to determine the burden and context of fatal
20
21 drowning in the Barishal division of Bangladesh.
22
23

24 25 26 27 **METHODS**

28
29 The *BHASA* baseline survey was a regionally representative population-based cross-sectional survey
30
31 of households in rural and urban areas of all sub-districts in the Barishal Division, one of the
32
33 country's eight divisions. Geographically, the division is located in the central southern region of
34
35 Bangladesh where several large rivers converge. The survey was conducted between September
36
37 2016 and February 2017 in 39 sub-districts of all six districts (Barguna, Barishal, Bhola, Jhalokathi,
38
39 Patuakhali and Pirojpur) of the Barishal division. The survey covered 95,124 households comprising
40
41 of 386, 016 population in the selected sub-districts and used a multi-stage stratified cluster sampling
42
43 method.
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49 **Measures**

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51 The operational definition of injury mortality used in this study was in accordance with International
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53 Classification of Disease (ICD), Version 10, Chapter XX recording intent and mechanism of injury [10]
54
55 and was defined as, 'any death occurred due to external harm resulting from a fall, burn, cut,
56
57 transportation, suffocation, drowning, machine/tool injury, electrocution, animal injury, blunt object
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3 injury, poisoning, suicide and violence'. Drowning was described as 'the process of experiencing
4 respiratory impairment from submersion or immersion in liquid[11]. Drowning deaths were included
5
6 if the cause was any of the following external cause codes from Chapter XX ICD-10[10, 12]: codes
7
8 W65 – W74 (unintentional drowning), X36 – X39 (exposure to forces of nature –water related, V90
9
10 (drowning or submersion due to accident to watercraft), V92 (drowning and submersion due to
11
12 accident on board watercraft, without accident to watercraft), X71 (intentional self-harm by
13
14 drowning and submersion) or X92 (assault by drowning and submersion while in bath tub).
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17
18 Information on all fatal injuries was collected over a two-year recall period. For all cases of fatal
19
20 drowning additional information was collected on potential risk factors such as socio-demographic
21
22 characteristics, access to water, and risk factors pre-event, event and post-drowning event,
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24 knowledge, attitudes and perceptions/practices related to drowning, drowning prevention and
25
26 disaster preparedness. Information on all mortality, followed by all causes of injury mortality was
27
28 collected.
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35 **Data collection and procedures**

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37 Data was collected using a pre-tested structured questionnaire by 50 trained data collectors.
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39 Information was gathered from household heads, mothers or any adults aged of 18 years or above
40
41 through face-to-face interviews. Each day data collectors visited 25-30 households to collect
42
43 information. Non-participation due to refusal was 2%. To ensure data quality, responsible
44
45 supervisors randomly re-surveyed 2% of the households covered over the previous few days on a
46
47 daily basis. An electronic data capturing system, the REDCap application, was used on tablets for
48
49 data collection[13].
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55 **Statistical analysis**

56
57 In this study, to estimate the rates, weights were created for the survey data to appropriately adjust
58
59 for differences in probability of selection and response rates according to age and sex. The
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1
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3 probability of selection based on sampling information (number of upazilas, number of villages) was
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5 calculated and then adjusted to the age and sex distribution from the 2011 Bangladesh Population
6
7 and Housing Census. All data were analysed using SAS 9.4 with SAS/STAT 14.2.
8
9

10
11
12 While analysing the rates (per 100,000/population) for fatal drowning and percentage for other
13
14 variables Taylor Series method was used. This incorporated the survey weights and the other
15
16 features of survey design (stratification by district, and cluster sampling of villages). Multivariable
17
18 logistic regression was used to examine associations between various socio-demographic factors
19
20 with fatal drowning. Missing data was less than 1% for all variables.
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23 24 25 **Ethical considerations**

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27 This study received ethical approvals from the ethical review committee of the Centre for Injury
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29 Prevention and Research, Bangladesh (CIPRB), Bangladesh and the Human Ethics Committee of the
30
31 University of Sydney, Australia.
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33

34 35 36 **Patient and public involvement statement**

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38 This is a community-based household survey, no patients were involved in the study.
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40

41 42 **RESULTS**

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45 A total of 95,063 households were visited of which 92,616 household representatives (97.4%) were
46
47 available for completing the survey. Males and females were equally represented among the
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49 sampled population (49.1% vs 50.9%) and over one-third (37.2%) of the population were children
50
51 under-18 years. A total of 4,128 deaths were reported in the two-year recall period, giving an
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53 overall mortality rate of 5.3/100,000 population per year (data not shown).
54
55

56 57 *Drowning burden and mortality rates* 58 59 60

Drowning accounted for 6.6% of all deaths across all age group, however among children aged 1-4 years drowning was the cause of almost one-third of all deaths (35.1%). One in ten deaths among infants (<1 year) and children aged 5 to 9 years were a result from drowning (data not shown). In the two-year recall period, there were 285 fatal drownings across all ages giving an overall death rate of 37.9/100,000 population per year (95%CI: 31.8, 43.9). Fatal drowning rates were consistently higher among males compared to females across all ages except among those aged 10-14 years where a higher rate was observed among females.

The highest fatal drowning rates were in children aged 1–4 years at 262.2/100,000 per year (95% CI: 216.4, 308.0) followed by infants (88.6/100,000) then children aged 5-9 years (65.1/100,000). In early adolescence (10-14 years) fatal drowning rates decreased but increased again in early adulthood (18-24 years) and among those aged 60 years and over where higher rates of fatal drownings were observed (Table 1).

Table 1. Drowning deaths and mortality rates by age and sex in the Barishal division, Bangladesh

Sex	Males		Females		Both		National Rate both sex BHIS 2016 ¹	
AGE (years)	Rate (per 100,000/ year)	95% CI (LL, UL)	Rate (per 100,000/ year)	95% CI (LL, UL)	Rate (per 100,000/ year)	95% CI (LL, UL)	Rate (per 100,000/ year)	95% CI (LL, UL)
<1	142.9	22.9, 263.0	34.8	0, 81.9	88.6	25.4, 151.9	53.3	2.8, 345.8
1-4	325.3	252.6, 398.0	199.8	143.1, 256.5	262.2	216.4, 308.0	71.7	31.4, 154.8
5-9	78.7	48.9, 108.4	51.8	25.1, 78.4	65.1	42.4, 87.9	28.1	9.0, 77.3
10-14	9.3	0, 18.8	28.2	6.7, 49.8	18.9	7.2, 30.5	3.2	0.0, 36.2
15-17	21.1	2.8, 39.3	-	-	11.2	1.5, 20.9	5.6	0.0, 63.5
18-24	24.1	0, 52.9	10.8	1.3, 20.4	17.2	2.9, 31.5	-	-
25-39	5.2	0, 10.9	1.2	0, 3.5	3.1	0.1, 6.1	2.5	0.1, 16.2
40 to 59	8.1	0, 18.2	3.1	0, 7.4	5.6	0.1, 11.1	8.6	1.9, 30.3
60+	22.3	3.6, 40.9	3.1	0, 9.1	12.6	2.9, 22.2	8.8	0.5, 56.9
Total	48.2	38.9, 57.4	27.9	21, 34.9	37.9	31.8, 43.9	11.7	7.1, 19.0

¹Rahman A, Chowdhury SM, Mashrekry SR, Linnan M, Rahman AKMF. (2016) Report on Bangladesh Health and Injury Survey, DGHS, CIPRB, Dhaka.

Fatal drowning rates were higher in rural areas compared to urban areas of the sub-district (38.9/100,000 vs 29.3 per 100,000), and across all age groups except in infancy (<1 year) and early adulthood (18-24 years) where drowning fatality rates were higher in urban areas (Table 2).

Table 2. Distribution rates of fatal drowning by age and region of residence in the Barisal Division, Bangladesh

	Rural	Urban*
Age (years)	Rate per 100,000	Rate per 100,000
<1 (infant)*	79.8 (13.6 - 145.9)	160.9 (0.0 - 438.2)
1-4	277.2 (225.7 - 328.6)	135.4 (40.8 - 230.0)
5-9	68.9 (43.4 - 94.3)	31.5 (0.0 - 66.1)
10-14	18.9 (6.4 - 31.3)	18.5 (0.0 - 51.8)
15-17	11.5 (0.7 - 22.3)	8.6 (0.0 - 25.3)
18-24	11.0 (3.3 - 18.6)	65.7 (0.0 - 177.4)
25-39	3.5 (0.2 - 6.9)	0
40-59	6.3 (0.1 - 12.4)	0
60 +	13.9 (3.2 - 24.6)	0
Total	38.9 (32.6 - 45.3)	29.3 (6.5 - 52.1)

*The event rate for infants and urban areas are very small, reporting very wide confidence interval

Drowning by type of water body, activity and seasonality

Across all age categories about three quarters of fatal drowning events occurred within 100 metres of the households. However, among adolescents aged 15-17 years and adults aged 40 years and above over 20% of drowning deaths occurred at a distance of over two kilometres (data not shown). The majority (98%) of drowning deaths took place in the community while less than 1% were related to natural disasters or while using water transportation. Over three-quarters of drowning deaths occurred in ponds and ditches (Figure 1a), and over half were in outdoor water bodies primarily used for bathing and washing (56%) (Figure 1b).

INSERT FIGURE 1

Drowning occurred throughout the year, however fatalities peaked during the monsoon season (between June to October) particularly in the months of June and September which accounted for nearly one quarter (23.7%) of all drowning deaths (Figure 2).

INSERT FIGURE 2

Almost all fatal drownings occurred between the daylight hours of 6 *a.m.* and 6 *p.m.* with two-thirds (63%) taking place between the hours of 9am and 3pm. (Figure 3). Among children aged 1-4 years where most fatal drownings occurred between the hours of 12 *p.m.* and 4 *p.m.* (58%) followed by the morning between 8am to noon (31%) (data not shown).

INSERT FIGURE 3*Individual involved in rescue*

During fatal drownings, neighbours or bystanders (43.0%) were the individuals most often involved in the rescue, followed by mothers (21.2%). Almost two-thirds (62.3%), of drowned individuals were not accompanied by anyone during the drowning incident, while 15% were accompanied by a friend or colleague (data not shown).

Factors associated with fatal drowning

Univariate analyses for fatal drowning showed that children aged 1 to 4 years had almost three times higher odds of drowning deaths compared with those aged under one years. Similarly, households with more than four or more children had almost two times higher odds of experiencing a drowning fatality than households with one child. After adjustment, the factors that remained associated with fatal drowning was age with children aged 1 to 4 years at three times higher odds than those aged less than one year, being male also significantly increased the odds of drowning fatalities by almost 70%. Number of children in the household was also significantly associated with fatal drowning and increased with increasing number of children (Table 3).

Table 3. Socio-demographic factors associated with drowning mortality

Characteristic	Univariate				Multivariable			
	OR	LCL	UCL	p-value	OR	LCL	UCL	p-value
Sex								
Male	1.724	1.281	2.319	0.0004	1.682	1.248	2.265	0.0007
Female	reference				reference			
Age group (years)								
<1	reference				reference			
1-4	2.969	1.398	6.306	<.0001	2.983	1.399	6.358	<.0001
5-9	0.734	0.340	1.585	.	0.696	0.325	1.487	.
10-14	0.212	0.077	0.588	.	0.186	0.070	0.499	.
15-17	0.126	0.039	0.411	.	0.102	0.033	0.321	.
18-24	0.193	0.077	0.489	.	0.097	0.030	0.313	.
25-39	0.035	0.010	0.120	.	0.027	0.008	0.093	.
40-59	0.063	0.019	0.213	.	0.037	0.010	0.133	.
60 +	0.142	0.046	0.434	.	0.067	0.021	0.210	.
Maternal education								
None	1.919	0.447	8.245					
1 -5 years	2.750	0.665	11.374	0.3372	.	.	.	.
6-8 years	2.513	0.595	10.618	.	.	.	.	.
9-12 years	2.084	0.491	8.841	.	.	.	.	.
13-17 years	reference				reference			
Wealth quintile								
Q1 (Lowest)	1.462	0.851	2.514	0.5147	1.279	0.759	2.157	0.8396
Q2	1.179	0.619	2.245	.	1.063	0.571	1.978	.
Q3	1.284	0.770	2.143	.	1.184	0.724	1.937	.
Q4	1.167	0.645	2.111	.	1.132	0.630	2.033	.
Q5 (Highest)	reference				reference			
No. of children in household*								
1 child	reference				reference			
2 children	0.916	0.593	1.415	0.6273	0.943	0.595	1.493	0.0026
3 children	0.963	0.633	1.466	.	1.190	0.782	1.809	.
4 children	1.279	0.767	2.131	.	1.777	1.076	2.935	.
5+ children	1.384	0.790	2.423	.	2.092	1.181	3.705	.

*Number of household with no children were very small to draw plausible inference

95% CI's

DISCUSSION

The mortality and morbidity reporting systems in Bangladesh are poor [14]. To inform a large-scale drowning prevention strategy, we conducted a cross-sectional household survey to provide otherwise unavailable epidemiological data on drowning in the Barishal Division. Our study found a mortality rate from drowning of 37.9 per 100,000 per year across all ages in the Barishal division, which is over three times higher than the national rate reported in 2016 (11.7/100,000/year) [4]. The number of water bodies including rivers, lakes, ponds and ditches in this division is far higher than the other parts of the country. For both males and females fatal drowning rates were high in infancy, and peaked at 1-4 years of age, then fell rapidly through middle childhood and adolescence and remained relatively low throughout adulthood. This pattern of fatal drowning rates across the age groups in this study is consistent with another recent national survey[4].

Previous studies identified nearby ponds, ditches, and canals as the most common location of fatal drowning among children in Bangladesh[3, 14-17]. In the Barishal region, most households are surrounded by water bodies, and similar previous studies, the majority of childhood drowning deaths occurred in ponds, ditches and canals situated within only 100 metres from their residences. Children are often with other siblings (children) or unaccompanied at the time of drowning. Lack of supervision in younger children is a major risk factor. Attentiveness and continuity are essential characteristics of the hierarchical model of supervision,[18] proximity to the water exacerbates risk. However, among adults a considerable proportion of drowning fatalities occurred at a distance of two kilometres from their houses. It is possible that these deaths occurred in rivers where individuals were engaged in aquatic activities such as fishing or boating.

Drowning deaths in Barishal occurred year-round but most frequently during the monsoon season (June to October); this is similar to findings reported in prior studies[15, 19-21]. It is also notable that

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2
3 in the dry season (November-December) the fatal drowning rates remained relatively high in
4
5 Barishal. This is likely because most natural water bodies including those close to households are
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7 connected to the rivers and given much of the division is subject to semidiurnal tides where
8
9 waterbodies are filled twice a day by sea water including the dry season, this can increase the risk of
10
11 exposure especially among children playing in these water bodies. Previous studies, have also
12
13 reported over 90% of fatal drowning events occurred in daylight hours [14, 22].
14
15

16
17 Fatal drowning was strongly and significantly associated with sex with males having over 1.5 times
18
19 the odds of death from drowning. This may be related to males greater engagement in risk taking
20
21 behaviours and exposure to high risk situations[23] or to existing traditional gender roles in
22
23 Bangladesh with young boys more likely to be out playing unsupervised whereas girls would be at
24
25 home helping with household activities. This points to the need to place specific emphasis on
26
27 targeting boys within drowning prevention programs. Age was also significantly related to fatal
28
29 drowning with those in the age group of 1-4 years having the greatest risk of drowning. This age
30
31 group has consistently been found to be at greater risk of drowning in Bangladesh and other South-
32
33 East Asian and Western Pacific countries[2, 15, 24] and may be related to lack of adult supervision,
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35 the lack of swimming ability in this age group and other behavioural factors[15]. We did not find any
36
37 significant association between mother's education and fatal drowning risk. Socio-economic status
38
39 of our study population was fairly homogenous and no associations were reported across the socio-
40
41 economic groups. Increased number of children in the household, increased the risk of drowning
42
43 events. With some families having often four or five children in the household parents may find it
44
45 difficult to adequately supervise all of them. These findings support the need for programmes that
46
47 can assist families with supervision.
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52 53 **STRENGTHS AND LIMITATIONS OF THE STUDY**

54
55 The strength of this study was that to ensure the quality of data, trained supervisors were recruited,
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57 and they observed 10% of interviews conducted by the data collectors, checked 10% of the collected
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1
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3 data, and re-interviewed 2% of the households. In addition, field level research officers and
4
5 managers were appointed to re-check all data for inconsistencies. If inconsistency was detected, the
6
7 respective data collector was asked to revisit the household to collect correct information.
8
9

10 Given that the mortality burden is highest in children aged under five years, it should be noted that
11
12 under-reporting in overall mortality rates is an issue in this age group because of poor birth /vital
13
14 registration systems, so our results may have under-estimated the true burden. This is likely to affect
15
16 data on children aged under-one year to a larger extent. However, given that a two-year recall
17
18 period was used in this survey, the fatal drowning rates are likely to be conservative.
19
20

21 The survey was purposively conducted in Barishal division which is one of the eight divisions of
22
23 Bangladesh. In previous national injury surveys the highest drowning mortality rate among children
24
25 was observed in the Pirojpur district of Barishal division[3]. Considering this high rate the Barishal
26
27 division was selected for Project Bhasa.
28
29

30
31 The study findings highlight the very high magnitude of drowning deaths in the Barishal division.
32
33 Socio-demographic factors including being male, aged 1-4 years and having five or more children in
34
35 households was associated with increased risk of fatal drowning. The findings further demonstrate
36
37 that drowning is predominantly a problem that affects children in Bangladesh. The Barishal division
38
39 demands urgent interventions targeted at high risk groups identified here. Project Bhasa aims to
40
41 provide evidence-based interventions, including community day-care for under-five children to
42
43 ensure adult supervision during day time and providing swimming instruction and school water
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45 safety education to children aged five years and over, to reduce drowning. It is expected that the
46
47 project will generate knowledge to assist with drowning reduction efforts both nationally and in
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49 other similar settings.
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CONTRIBUTORS

AR participated in the design, implementation and supervision of field work and analysis and wrote the paper. JJ contributed on project design, data analysis and writing of the paper. KB and MJH contributed on project design, implementation, Data management and supervision of field work and writing of the paper. DR contributed on project design and writing of the paper. TA and KR were involved in data management and analysis and contributed to write the paper. RI and FR conceived the study and supervised throughout and contributed to the writing of the paper. RI and FR are the guarantors.

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COMPETING INTERESTS

Authors declare no conflict of interest.

ETHICAL APPROVAL

Obtained

PROVENANCE AND PEER REVIEW

Not commissioned; externally peer reviewed.

DATA SHARING STATEMENT

Additional de-identified data is available on request to the study steering committee.

Figure 1: *Distribution of fatal drowning by type of water bodies (1a) and their use (1b)*

Figure 2: *Distribution of fatal drowning by time of the year in Barishal Division, Bangladesh*

Figure 3: *Distribution of fatal drowning by time of the day in Barishal Division, Bangladesh*

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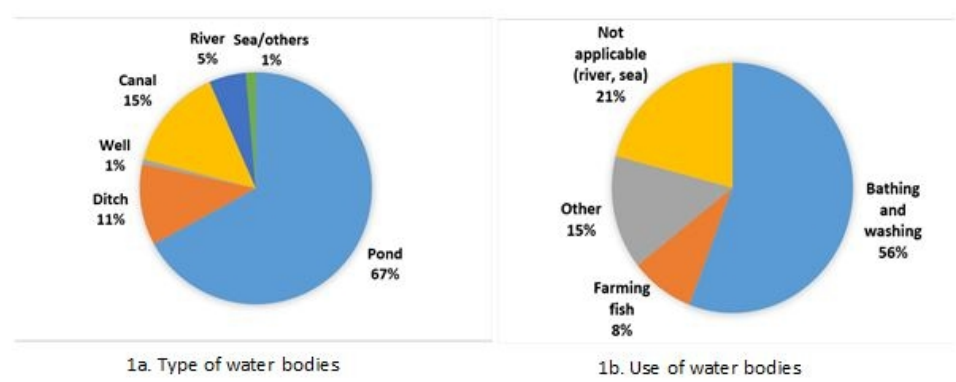


Figure 1: Distribution of fatal drowning by type of water bodies (1a) and their use (1b)

Figure 1: Distribution of fatal drowning by type of water bodies (1a) and their use (1b)

166x94mm (96 x 96 DPI)

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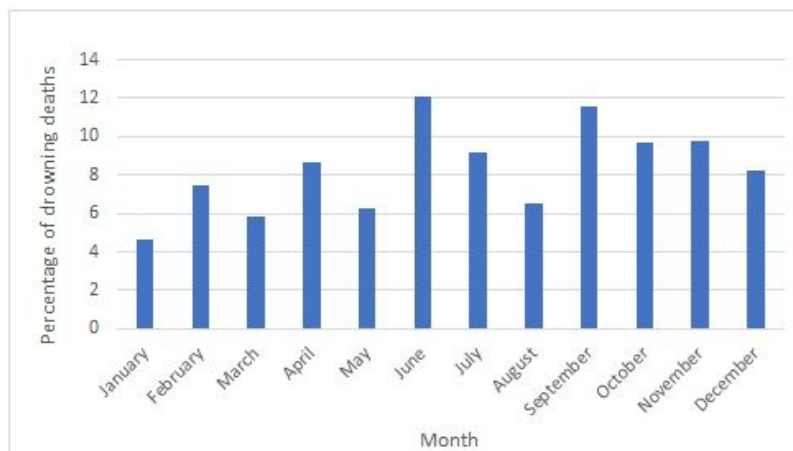


Figure 2. Distribution of fatal drowning by time of the year in Barishal Division, Bangladesh

Figure 2. Distribution of fatal drowning by time of the year in Barishal Division, Bangladesh

160x97mm (96 x 96 DPI)

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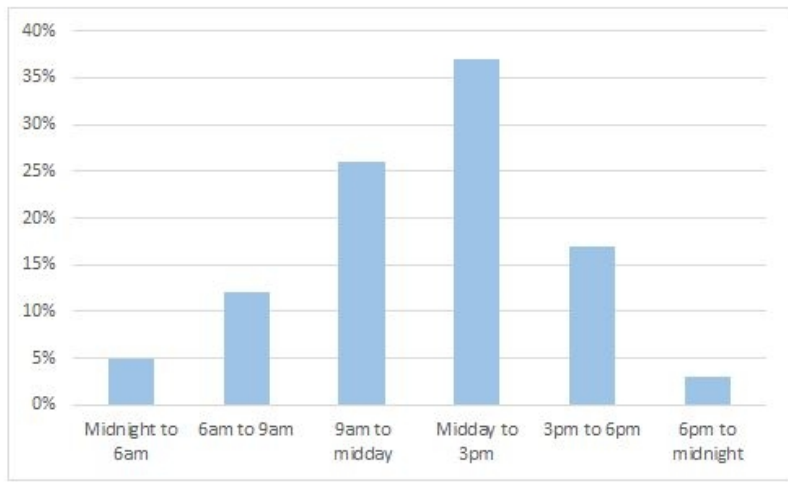


Figure 3. Distribution of fatal drowning by time of the day in Barishal Division, Bangladesh

Figure 3. Distribution of fatal drowning by time of the day in Barishal Division, Bangladesh
162x97mm (96 x 96 DPI)

BMJ Open

Vulnerability to fatal drowning among the population in Southern Bangladesh: findings from a cross-sectional household survey

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Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology
Keywords:	drowning, Fatal drowning, mortality, injury, risk factor, Bangladesh

SCHOLARONE™
Manuscripts

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3 **Vulnerability to fatal drowning among the population in Southern Bangladesh: findings**
4 **from a cross-sectional household survey**
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ABSTRACT

Objectives: To determine the drowning mortality burden and associated risk factors in Southern Bangladesh.

Settings: The survey was conducted in 39 sub-districts of all six districts of the Barishal division, Southern Bangladesh.

Participants: All residents (residing over last 6 months) of the Barishal division, Southern Bangladesh.

Intervention/methods: A cross-sectional, divisionally representative household survey was conducted in all six districts of the Barishal division between September 2016 and February 2017, covering a population of 386,016. Data was collected by face-to-face interview with adult respondents using handheld electronic tablets. Mortality was determined using the ICD 10 codes for drowning W65 – W74, X36 – X39, V90, V92, X71 or X92.

Results: The overall drowning mortality in Barishal was 37.9/100,000 population per year (95% CI 31.8–43.9). The highest drowning mortality rate was observed among children 1-4 years (262.2/100,000/year). Mortality rates among males (48.2/100,000/year) exceeded females. A higher rate of fatal drowning was found in rural (38.9/100,000/year) compared to urban areas (29.3/100,000/year). Results of the multivariable logistic regression identified that the factors significantly associated with fatal drowning were being male (OR 1.7, 95% CI: 1.2 - 2.3), aged 1-4 years (OR 3.0, 95% CI 1.4 - 6.4) and residing in a household with 4 or more children (4 year old children OR 1.8, 1.1 – 2.9; and 5 year old children OR 2.1, 1.2 – 3.7).

Conclusion: Drowning is a public health problem, especially for children, in the Barishal division of Southern Bangladesh. Male gender, children 1-4 years of age and residing in a household with 4 or more children were associated with increased risk of fatal drowning events. The Barishal division demands urgent interventions targeted at high risk groups identified in the survey.

Trial Registry: Not applicable

Key words: Drowning, fatal drowning, mortality, injury, risk factor, Bangladesh

ARTICLE SUMMARY**Strengths and limitations of this study**

- A key strength of this study was the large divisionally-representative sample of Barishal division in Bangladesh, to guide contextual implementation of effective interventions.
- The study used multiple methods for quality control, of significance are the learnings from use of electronic data capture system with low access to internet.
- Limitations included the cross-sectional nature of the study which may have introduced recall bias.
- Under-reporting in overall mortality rates is a concern for children under five years and may have contributed to an under-estimate of the true mortality in this age group.

INTRODUCTION

An estimated 322,149 drowning deaths occur globally every year making drowning a major global health problem[1]. Half of all drowning fatalities occur in people under the age of 25 with children aged between 1 – 4 years most vulnerable. More than 90% of drowning incidents take place in low- and middle-income countries (LMICs) where men, women and children have a higher exposure to the risks associated with open water[2]. According to the 2012 WHO Global Health Estimates, the overall mortality rate from drowning globally was 5.2 per 100,000 population with the highest rates observed in the African Region (7.9 per 100,000 population) followed by South-East Asia Region (7.4 per 100,000 population)[2].

In 2005, the first Bangladesh Health and Injury Survey (BHIS), identified drowning as the leading cause of death among children 1-17 years with approximately 17,000 children dying each year[3]. In 2016, the BHIS was carried out for the second time and again drowning was found to be the main cause of injury deaths among children aged 1-4 and 5-9 years. According to the 2016 BHIS, every day 40 children (aged between 0-17 years) lost their life every day due to drowning and this was the highest among all injury fatalities. Among adults (aged 18 years or more) there were 13 deaths from drowning per day and this was the sixth leading cause of injury death in that age category[4]. The 2011 Bangladesh Demographic Health Survey (BDHS) found that while the risk of dying from other conditions, such as vaccine preventable communicable diseases, had significantly decreased, fatalities from drowning among children aged 1-4 years rose alarmingly from 19.0% in 2004 to 43.0% in 2011[5].

Bangladesh is a highly disaster prone country, ranked sixth in the 2015 World Risk Report[6]. It is especially vulnerable to cyclones and frequent flooding which claim many lives each year[7]. The country is intersected by many rivers, drowning during inland water transport accidents is also common[8].

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3 The 2005 BHIS identified that the highest mortality rate due to drowning occurred in the Pirojpur
4 district of Barishal division in Bangladesh[3]. Geographically, the Barishal division is located in the
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6 central southern region of Bangladesh where several large rivers converge; with a land mass of
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8 13,644.85 km² and a population of 8,147,000. As a low lying, coastal division, Barishal is vulnerable
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10 to natural hazards and the effects of climate change. All six districts under this division are affected
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12 by water-related hazards[9].
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17 Considering these factors, Project *Bhasa*, a Comprehensive Drowning Reduction Strategy was
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19 designed to reduce drowning mortality and morbidity utilizing evidence-based interventions. As part
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21 of this initiative a baseline survey was conducted to determine the burden and context of drowning
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23 in the Barishal division of Southern Bangladesh.
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29 **METHODS**

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31 The *Bhasa* baseline survey was a population-based cross-sectional survey representative to the
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33 Barishal Division, one of the country's eight divisions. Geographically, the division is located in the
34
35 central southern region of Bangladesh where several large rivers converge. The survey was
36
37 conducted between September 2016 and February 2017 in 39 sub-districts of all six districts
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39 (Barguna, Barishal, Bhola, Jhalokathi, Patuakhali and Pirojpur) of the division (Fig. 1). The survey
40
41 covered 95,124 households comprising 386, 016 population in the selected sub-districts and used a
42
43 multi-stage stratified cluster sampling method.
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49 **INSERT Figure 1: Map of the Barishal division – the study area**

50 51 52 53 **Measures**

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55 The operational definition of injury mortality used in this study was in accordance with International
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57 Classification of Disease (ICD), Version 10, Chapter XX recording intent and mechanism of injury [10]
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3 and was defined as, 'any death occurred due to external harm resulting from a fall, burn, cut,
4 transportation, suffocation, drowning, machine/tool injury, electrocution, animal injury, blunt object
5 injury, poisoning, suicide and violence'. Drowning was described as 'the process of experiencing
6 respiratory impairment from submersion or immersion in liquid'[11]. Drowning deaths were
7 included if the cause was any of the following external cause codes from Chapter XX ICD-10[10, 12]:
8 codes W65 – W74 (unintentional drowning), X36 – X39 (exposure to forces of nature –water related,
9 V90 (drowning or submersion due to accident to watercraft), V92 (drowning and submersion due to
10 accident on board watercraft, without accident to watercraft), X71 (intentional self-harm by
11 drowning and submersion) or X92 (assault by drowning and submersion while in bath tub).
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24 Information on all fatal injuries was collected over a two-year recall period. For all cases of fatal
25 drowning additional information was collected on potential risk factors such as socio-demographic
26 characteristics, access to water, and risk factors pre-event (e.g. location and type of water body,
27 activity of the person prior to drowning, person accompanying prior to drowning, accompanying
28 person's age) , event (e.g. time and season of drowning) and post-drowning event (e.g. time of
29 rescue, person rescued, action taken after rescue), knowledge, attitudes and practices related to
30 drowning, drowning prevention and disaster preparedness. Information on all mortality, followed by
31 all causes of injury mortality was collected.
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46 **Data collection and procedures**

47 Data was collected using a pre-tested structured questionnaire by 50 trained data collectors.
48 Information was gathered from household heads, mothers or any residing adults aged 18 years or
49 older through face-to-face interviews after obtaining written informed consent. Each selected
50 respondent provided information of all household members including children. Each day data
51 collectors visited 25-30 households to collect information. Non-participation due to refusal was
52 2.0%. To ensure data quality, responsible supervisors randomly re-surveyed 2.0% of the households.
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3 An electronic data capturing tool using the REDCap application, was used on tablets for data
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5 collection[13].
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10 **Statistical analysis**

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12 In this study, to estimate the rates, weights were created for the survey data to appropriately adjust
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14 for differences in probability of selection and response rates according to age and sex. The
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16 probability of selection based on sampling information (number of upazilas, number of villages) was
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18 calculated and then adjusted to the age and sex distribution from the 2011 Bangladesh Population
19
20 and Housing Census. All data were analysed using SAS 9.4 with SAS/STAT 14.2.
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25 While analysing the rates (per 100,000/population) for fatal drowning and percentage for other
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27 variables Taylor Series method was used. This incorporated the survey weights and the other
28
29 features of survey design (stratification by district, and cluster sampling of villages). Multivariable
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31 logistic regression was used to examine associations between various socio-demographic factors
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33 with fatal drowning. Less than 1.0% of variables had missing data.
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39 **Ethical considerations**

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41 This study received ethical approvals from the ethical review committee of the Centre for Injury
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43 Prevention and Research, Bangladesh (CIPRB), Bangladesh and the Human Ethics Committee of the
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45 University of Sydney, Australia. The ethics approval numbers were CIPRB/ERC/2016/12 and USyd
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47 HREC - 2016/606 respectively.
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52 **Patient and public involvement statement**

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55 This is a community-based household survey, no patients were involved in the study.
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RESULTS

A total of 95,063 households were visited of which 92,616 household representatives (97.4%) completed the survey. Males and females were equally represented among the sampled population (49.1% vs 50.9%) and over one-third (37.2%) of the population were children under-18 years. A total of 4,128 deaths were reported in the two-year recall period, giving an overall mortality rate of 5.3/100,000 population per year (data not shown).

Drowning burden and mortality rates

Drowning accounted for 6.6% of deaths across all age group, however among children aged 1-4 years drowning was the cause of almost one-third of all deaths (35.1%). One in ten deaths among infants (<1 year) and children aged 5 to 9 years were a result from drowning (data not shown). In the two-year recall period, there were 285 fatal drownings across all ages giving an all-age drowning mortality rate of 37.9/100,000 population per year (95%CI: 31.8 - 43.9). All fatal drownings were found unintentional. Fatal drowning rates were consistently higher among males compared to females across all ages except among those aged 10-14 years where a higher rate was observed among females. However, this higher rate among 10-14 year girls was not statistically significant.

The highest fatal drowning rates were in children aged 1-4 years at 262.2/100,000 per year (95% CI: 216.4 - 308.0) followed by infants (88.6/100,000) then children aged 5-9 years (65.1/100,000). In early adolescence (10-14 years) fatal drowning rates decreased but increased again in early adulthood (18-24 years) and among those aged 60 years and over where higher rates of fatal drownings were observed (Table 1).

Table 1. Drowning deaths and mortality rates by age and sex in the Barishal division, Bangladesh

Sex	Males		Females		Both		National Rate both sex BHIS 2016 ¹	
AGE (years)	Rate (per 100,000/ year)	95% CI (LL - UL)	Rate (per 100,000/ year)	95% CI (LL - UL)	Rate (per 100,000/ year)	95% CI (LL - UL)	Rate (per 100,000/ year)	95% CI (LL - UL)
<1	142.9	22.9 - 263.0	34.8	0 - 81.9	88.6	25.4 - 151.9	53.3	2.8 - 345.8
1-4	325.3	252.6 - 398.0	199.8	143.1 - 256.5	262.2	216.4 - 308.0	71.7	31.4 - 154.8
5-9	78.7	48.9 - 108.4	51.8	25.1 - 78.4	65.1	42.4 - 87.9	28.1	9.0 - 77.3
10-14	9.3	0 - 18.8	28.2	6.7 - 49.8	18.9	7.2 - 30.5	3.2	0.0 - 36.2
15- 17	21.1	2.8 - 39.3	-	-	11.2	1.5 - 20.9	5.6	0.0 - 63.5
18-24	24.1	0 - 52.9	10.8	1.3 - 20.4	17.2	2.9 - 31.5	-	
25-39	5.2	0 - 10.9	1.2	0 - 3.5	3.1	0.1 - 6.1	2.5	0.1 - 16.2
40 to 59	8.1	0 - 18.2	3.1	0 - 7.4	5.6	0.1 - 11.1	8.6	1.9 - 30.3
60+	22.3	3.6 - 40.9	3.1	0 - 9.1	12.6	2.9 - 22.2	8.8	0.5 - 56.9
Total	48.2	38.9 - 57.4	27.9	21 - 34.9	37.9	31.8 - 43.9	11.7	7.1 - 19.0

¹Rahman A, Chowdhury SM, Mashreky SR, Linnan M, Rahman AKMF. (2016) Report on Bangladesh Health and Injury Survey, DGHS, CIPRB, Dhaka.

Fatal drowning rates were higher in rural areas compared to urban areas of the sub-district (38.9/100,000 vs 29.3 per 100,000), and across all age groups except in infancy (<1 year) and early adulthood (18-24 years) where drowning fatality rates were higher in urban areas (Table 2).

Table 2. Distribution rates of fatal drowning by age and region of residence in the Barisal Division, Bangladesh

	Rural	Urban*
Age (years)	Rate per 100,000 (95% CI)	Rate per 100,000 (95% CI)
<1 (infant)*	79.8 (13.6 - 145.9)	160.9 (0.0 - 438.2)
1-4	277.2 (225.7 - 328.6)	135.4 (40.8 - 230.0)
5-9	68.9 (43.4 - 94.3)	31.5 (0.0 - 66.1)
10-14	18.9 (6.4 - 31.3)	18.5 (0.0 - 51.8)
15-17	11.5 (0.7 - 22.3)	8.6 (0.0 - 25.3)
18-24	11.0 (3.3 - 18.6)	65.7 (0.0 - 177.4)
25-39	3.5 (0.2 - 6.9)	0
40-59	6.3 (0.1 - 12.4)	0
60 +	13.9 (3.2 - 24.6)	0
Total	38.9 (32.6 - 45.3)	29.3 (6.5 - 52.1)

*The event rate for infants and urban areas are very small, reporting very wide confidence interval

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3 ***Drowning by distance of water body from households, type of water body, activity, seasonality and***
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5 ***time of the day***
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8 Across all age categories about three quarters of fatal drowning events occurred within 100 metres
9 of the households. However, among adolescents aged 15-17 years and adults aged 40 years and
10 above over 20.0% of drowning deaths occurred at a distance of over two kilometres (data not
11 shown).
12

13 The majority (98.0%) of drowning deaths took place in the community while less than 1.0% were
14 related to disasters or while using water transportation. Over three-quarters of drowning deaths
15 occurred in ponds and ditches (Figure 2a), and over half were in outdoor water bodies primarily used
16 for bathing and washing (56.0%) (Figure 2b).
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27 **INSERT FIGURE 2**
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29 Drowning occurred throughout the year, however fatalities peaked during the monsoon season
30 particularly in the months of June and September which accounted for nearly one quarter (23.7%) of
31 all drowning deaths (Figure 3).
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37 **INSERT FIGURE 3**
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39 Almost all fatal drownings occurred between the daylight hours of 6 *a.m.* and 6 *p.m.* with two-thirds
40 (63.0%) taking place between the hours of 9 *a.m.* and 3 *p.m.* (Figure 4). Among children aged 1-4
41 years most fatal drownings occurred between the hours of 12 *p.m.* and 4 *p.m.* (58.0%) which was
42 followed by 8 *a.m.* to 12 *p.m.* (31.0%) (data not shown).
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49
50 **INSERT FIGURE 4**
51

52 ***Person accompanying prior to drowning event***
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54 Almost two-thirds (62.3%) of drowned individuals were not accompanied by anyone during the
55 drowning incident, while 15.0% were accompanied by a friend or colleague (data not shown).
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Individual involved in rescue

During fatal drownings, neighbours or bystanders (43.0%) were the individuals most often involved in the rescue, followed by mothers (21.2%).

Factors associated with fatal drowning

Univariate analyses for fatal drowning showed that children aged 1 to 4 years had three times higher odds of fatal drowning compared with those aged under one years. Similarly, households with more than four or more children had almost two times higher odds of experiencing a drowning fatality than households with one child. After adjustment, the factors that remained associated with fatal drowning were age, with children aged 1 to 4 years at three times higher odds than those aged less than one year, being male also significantly increased the odds of drowning fatalities by almost 70.0%. Number of children in the household was also significantly associated with fatal drowning and increased with increasing number of children (Table 3).

Table 3. Socio-demographic factors associated with drowning mortality

Characteristic	Univariate				Multivariable			
	OR	LCL	UCL	p-value	OR	LCL	UCL	p-value
Sex								
Male	1.7	1.3	2.3	0.0004	1.7	1.2	2.3	0.0007
Female	reference				reference			
Age group (years)								
<1	reference				reference			
1-4	3.0	1.4	6.3	<.0001	3.0	1.4	6.4	<.0001
5-9	0.7	0.3	1.6	.	0.7	0.3	1.5	.
10-14	0.2	0.1	0.6	.	0.2	0.1	0.5	.
15-17	0.1	0.04	0.4	.	0.1	0.03	0.3	.
18-24	0.2	0.08	0.5	.	0.097	0.030	0.313	.
25-39	0.0	0.0	0.1	.	0.0	0.0	0.09	.
40-59	0.1	0.0	0.2	.	0.0	0.0	0.13	.
60 +	0.1	0.0	0.4	.	0.1	0.0	0.2	.
Maternal education								
None	1.9	0.4	8.2					
1 -5 years	2.8	0.7	11.4	0.3372	.	.	.	.
6-8 years	2.5	0.6	10.6	.	.	.	.	.
9-12 years	2.1	0.5	8.8	.	.	.	.	.
13-17 years	reference				reference			
Wealth quintile								
Q1 (Lowest)	1.5	0.9	2.5	0.5147	1.3	0.8	2.2	0.8396

Characteristic	Univariate				Multivariable			
	OR	LCL	UCL	p-value	OR	LCL	UCL	p-value
Q2	1.2	0.6	2.2	.	1.1	0.6	2.0	.
Q3	1.3	0.8	2.1	.	1.2	0.7	1.9	.
Q4	1.2	0.6	2.1	.	1.1	0.6	2.0	.
Q5 (Highest)	reference				reference			
No. of children in household*								
1 child	reference				reference			
2 children	0.9	0.6	1.4	0.6273	0.9	0.6	1.5	0.0026
3 children	1.0	0.6	1.5	.	1.2	0.8	1.8	.
4 children	1.3	0.8	2.1	.	1.8	1.1	2.9	.
5+ children	1.4	0.8	2.4	.	2.1	1.2	3.7	.

*Number of household with no children were very small to draw plausible inference

95% CI's

DISCUSSION

The mortality and morbidity reporting systems in Bangladesh are poor [14]. To inform a large-scale drowning prevention strategy, we conducted a cross-sectional household survey to provide otherwise unavailable epidemiological data on drowning in the Barishal Division. Our study found a mortality rate from drowning of 37.9 per 100,000 per year across all ages in the Barishal division, which is over three times higher than the national rate reported in 2016 (11.7/100,000/year) [4]. The number of water bodies including rivers, lakes, ponds and ditches in this division is far higher than the other parts of the country. For both males and females fatal drowning rates were high in infancy, and peaked at 1-4 years of age, then fell rapidly through middle childhood and adolescence and remained relatively low throughout adulthood. This pattern of fatal drowning rates across the age groups in this study is consistent with another recent national survey[4].

Previous studies identified nearby ponds, ditches, and canals as the most common location of fatal drowning among children in Bangladesh[3, 14-17]. In the Barishal region, most households are surrounded by water bodies. Similar to previous studies, this study revealed that the majority of childhood drowning deaths occurred in ponds, ditches and canals situated within only 100 metres from their residences. Children are often with other siblings (children) or unaccompanied at the time

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3 of drowning. Lack of supervision in younger children is a major risk factor. Attentiveness and
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5 continuity are essential characteristics of the hierarchical model of supervision,[18] proximity to the
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7 water exacerbates risk. However, among adults a considerable proportion of drowning fatalities
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9 occurred at a distance of two kilometres from their houses. It is possible that these deaths occurred
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11 in rivers where individuals were engaged in activities such as fishing or boating.
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15 Drowning deaths in Barishal occurred year-round but most frequently during the monsoon season
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17 (June to October); this is similar to findings reported in prior studies[15, 19-21]. It is also notable that
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19 in the dry season (November-December) the fatal drowning rates remained relatively high in
20
21 Barishal. This is likely because most natural water bodies including those close to households are
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23 connected to the rivers and given much of the division is subject to two high tides where
24
25 waterbodies are filled twice a day by sea water including the dry season, this can increase the risk of
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27 exposure especially among children playing in water bodies. Previous studies, have also reported
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29 over 90% of fatal drowning events occurred in daylight hours [14, 22].
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33 Fatal drowning was strongly and significantly associated with sex with males having over 1.5 times
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35 the odds of death from drowning. This may be a related to males greater engagement in risk taking
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37 behaviours and exposure to high risk situations[23] or to existing traditional gender roles in
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39 Bangladesh with young boys more likely to be out playing unsupervised whereas girls would be at
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41 home helping with household activities. This points to the need to place specific emphasis on
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43 targeting boys within drowning prevention programs. Age was also significantly related to fatal
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45 drowning with those in the age group of 1-4 years having the greatest risk of drowning. This age
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47 group has consistently been found to be at greater risk of drowning in Bangladesh and other South-
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49 East Asian and Western Pacific countries[2, 15, 24] and may be related to challenges to achieve adult
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51 supervision, the lack of swimming ability in this age group and other behavioural factors[15]. We did
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53 not find any significant association between mother's education and fatal drowning risk. The socio-
54
55 economic status of our study population was fairly homogenous and no associations were reported
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3 across the socio-economic groups. Increased number of children in the household, increased the risk
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5 of drowning events. Households with four or five children in the family were common place. In these
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7 circumstances parents may find it difficult to adequately supervise all of them. These findings
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9 support the need for programmes that can assist families with supervision.
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16 **STRENGTHS AND LIMITATIONS OF THE STUDY**

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18 The strength of this study was that to ensure the quality of data, trained supervisors were recruited,
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20 and they observed 10.0% of interviews conducted by the data collectors, checked 10.0% of the
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22 collected data, and re-interviewed 2.0% of the households. In addition, field level research officers
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24 and managers were appointed to re-check all data for inconsistencies. If inconsistency was detected,
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26 the respective data collector was asked to revisit the household to collect correct information.
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31 Another strength was that to include as fatal drowning the study used those external cause codes of
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33 fatal drowning of ICD – 10 which provided more representative true burden of fatal drowning. In
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35 addition to unintentional external cause of drowning codes, watercraft and flood related drowning,
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37 and intentional self-harm by drowning codes were also included. Studies suggested to include these
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39 later codes (watercraft, flood related and intentional self-harm) to obtain more representative
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41 magnitude of fatal drowning [25, 26].
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46 Given that the mortality burden is highest in children aged under five years, it should be noted that
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48 under-reporting in overall mortality rates is an issue in this age group because of poor birth /vital
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50 registration systems, so our results may have under-estimated the true burden. This is likely to affect
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52 data on children aged under-one year to a larger extent. However, given that a two-year recall
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54 period was used in this survey, the fatal drowning rates are likely to be conservative.
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56
57 One of the major challenges in this study was to use the electronic data capturing system with an
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59 intent to obtain real time data. Each data collector was given a tablet loaded with REDCap
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3 application, and a sim was inserted in the device to obtain wireless internet connection. However, in
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5 the remote locations the internet connectivity was very poor and initially the data collectors could
6
7 not upload their collected data from the site of data collection. To resolve this issue, offline data
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9 collection system was created in the software. Each day after data collection in the afternoon the
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11 data collectors returned to the local office to get a high quality Wifi connection to upload their data.
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15 The survey was purposively conducted in Barishal division which is one of the eight divisions of
16
17 Bangladesh. In previous national injury surveys the highest drowning mortality rate among children
18
19 was observed in the Pirojpur district of Barishal division[3]. Considering this high rate the Barishal
20
21 division was selected for Project Bhasa.
22

23
24 The study findings highlight the very high magnitude of drowning deaths in the Barishal division.
25
26 Socio-demographic factors including being male, aged 1-4 years and having five or more children in
27
28 households was associated with increased risk of fatal drowning. The findings further demonstrate
29
30 that drowning is predominantly a problem that affects children in Bangladesh. The Barishal division
31
32 demands urgent interventions targeted at high risk groups identified here. Project Bhasa aims to
33
34 provide evidence-based interventions, including community day-care for under-five children to
35
36 ensure adult supervision during day time and providing swimming instruction and school water
37
38 safety education to children aged five years and over, to reduce drowning. It is expected that the
39
40 project will generate knowledge to assist with drowning reduction efforts both nationally and in
41
42 other similar settings.
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50 **ACKNOWLEDGEMENTS**

51
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53
54 thank Royal National Lifeboat Institution (RNLI) UK, The George Institute for Global Health (TGI),
55
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57
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59
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1
2
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4 providing all necessary administrative support to accomplish the baseline survey. We also would like
5 to thank Steve Wills and Ashim Kumar Saha for their contribution during data collection.
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9

10 11 **CONTRIBUTORS**

12
13
14 AR participated in the design, implementation and supervision of field work and analysis and wrote
15 the paper. JJ contributed on project design, data analysis and writing of the paper. KB and MJH
16 contributed on project design, implementation, Data management and supervision of field work and
17 writing of the paper. DR contributed on project design and writing of the paper. TA and KR were
18 involved in data management and analysis and contributed to write the paper. RI and FR conceived
19 the study and supervised throughout and contributed to the writing of the paper. RI and FR are the
20 guarantors.
21
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23
24
25

26 27 **FUNDING**

28
29 The research was funded by Royal National Life Boat Institution (RNLI), UK
30
31

32 33 **COMPETING INTERESTS**

34
35 Authors declare no conflict of interest.
36
37

38 39 **ETHICAL APPROVAL**

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41 Obtained
42
43

44 45 **PROVENANCE AND PEER REVIEW**

46
47 Not commissioned; externally peer reviewed.
48
49

50 51 **DATA SHARING STATEMENT**

52
53 We have deidentified data which are available at Centre for Injury Prevention and Research,
54 Bangladesh and The George Institute for Global Health. This was the baseline survey data generated
55 from BHASA project which is a collaborative work of Royal National Lifeboat Institution, Centre for
56 Injury Prevention and Research, Bangladesh and The George Institute for Global Health. Royal
57
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1
2
3 National Lifeboat Institution funded to conduct the research work. The mentioned organisations
4
5 have rights to use the data. Data are available upon request to Dr Aminur Rahman
6
7 (aminur@ciprb.org) and Dr. Jagnoor Jagnoor (jjagnoor@georgeinstitute.org.au).
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9

10 Figure 1: *Map of the Barishal division – the study area*

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13 Figure 2: *Distribution of fatal drowning by type of water bodies (2a) and their use (2b)*

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16 Figure 3: *Distribution of fatal drowning by time of the year in Barishal Division, Bangladesh*

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19 Figure 4: *Distribution of fatal drowning by time of the day in Barishal Division, Bangladesh*
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For peer review only



Figure 1: Map of the Barishal Division - the study area

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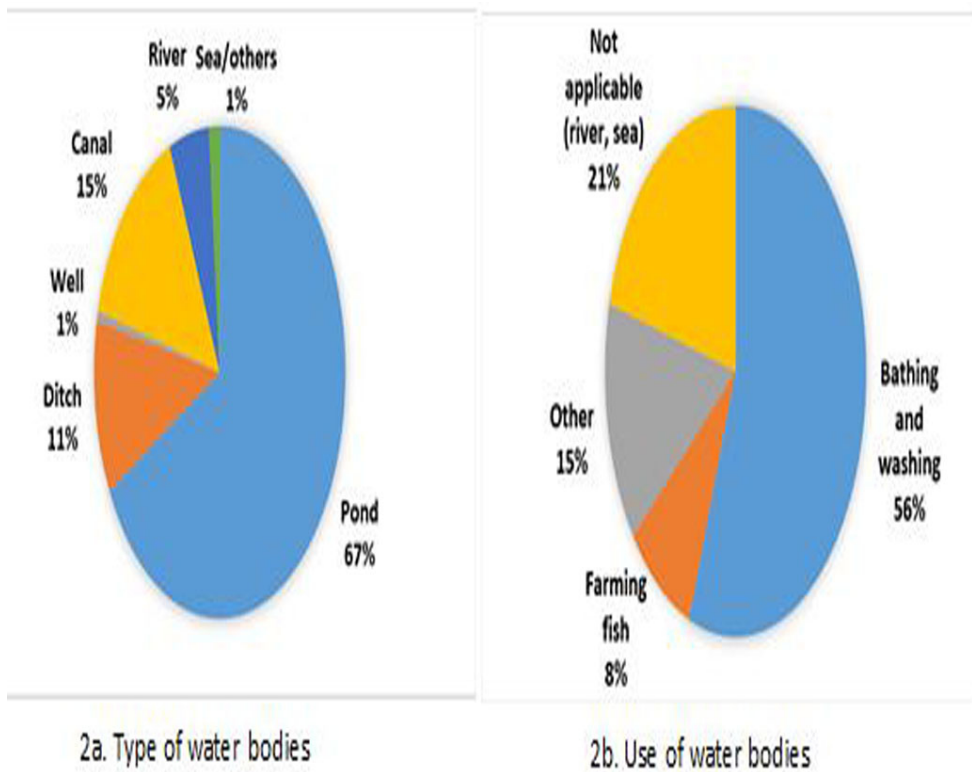


Figure 2: Distribution of fatal drowning by type of water bodies (2a) and their use (2b)

Figure 2: Drowning by types and use of water bodies

90x90mm (300 x 300 DPI)

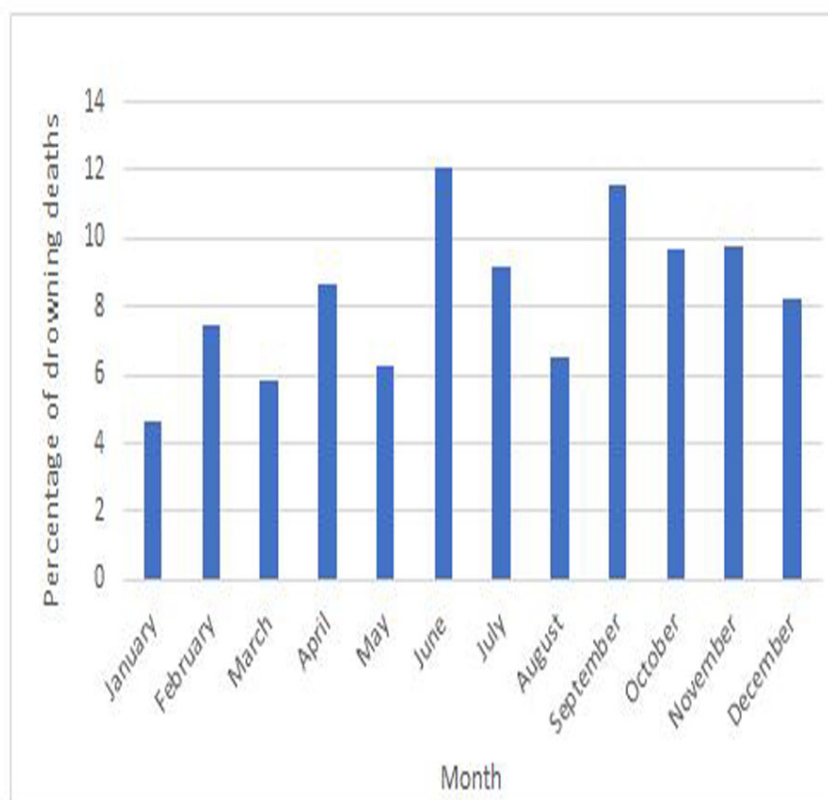


Figure 3. Distribution of fatal drowning by time of the year in Barishal Division, Bangladesh

Figure 3: Drowning by time of year

90x90mm (300 x 300 DPI)

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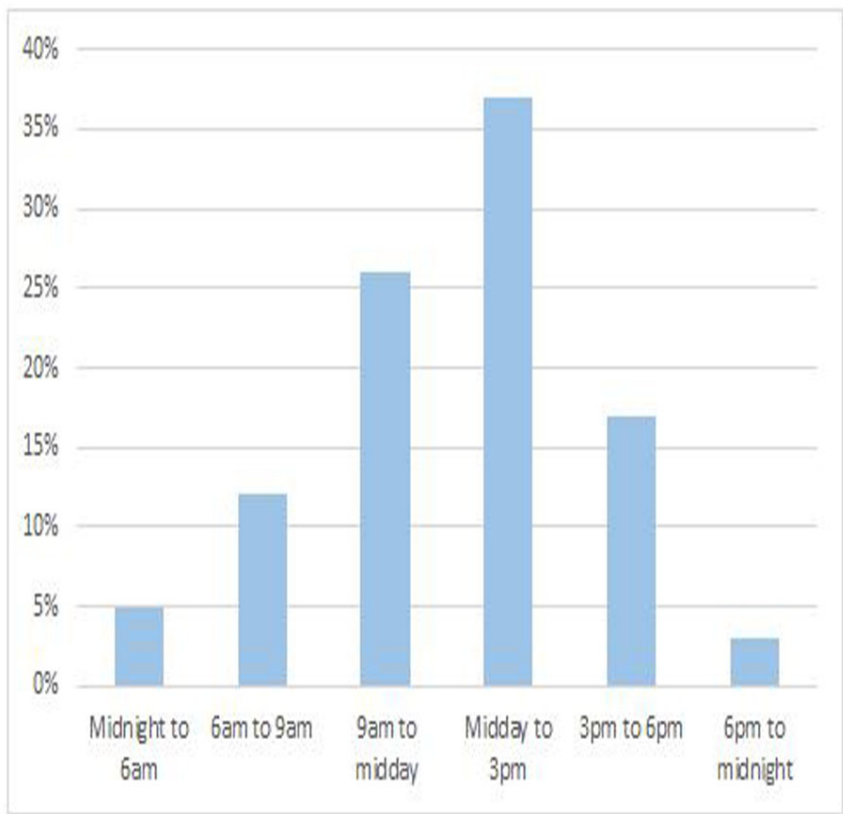


Figure 4. Distribution of fatal drowning by time of the day in Barishal Division, Bangladesh

Figure 4: Drowning by time of day
90x90mm (300 x 300 DPI)

STROBE Statement

Vulnerability to fatal drowning among the population in Southern Bangladesh: findings from a cross-sectional household survey

	Item No	Recommendation	Page and Line Number(s)
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	P2, L13
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	P2, L13-38
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	P5, L3-23
Objectives	3	State specific objectives, including any pre-specified hypotheses	P5, L15-22
Methods			
Study design	4	Present key elements of study design early in the paper	P5, L36-45
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	P5, L36-41
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	P5, L40-43 P6, L39-43
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	P6, L3-31
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	P5, L51-54 P6, L37-38
Bias	9	Describe any efforts to address potential sources of bias	P6, L57-60
Study size	10	Explain how the study size was arrived at	P5, L40-45
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	P7, L12-21
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	P7, L12-21
		(b) Describe any methods used to examine subgroups and interactions	P7, L3-8
		(c) Explain how missing data were addressed	P6, L44-47 P7, L22
		(d) If applicable, describe analytical methods taking account of sampling strategy	P7, L12-17
		(e) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	P7, L45-55
		(b) Give reasons for non-participation at each stage	Not provided, less than 5%
		(c) Consider use of a flow diagram	N/A

Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	P7, L47-53
		(b) Indicate number of participants with missing data for each variable of interest	P7, L21-22
Outcome data	15*	Report numbers of outcome events or summary measures	P7, L52-55
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	P8, L31-56
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	P9, L11-3- P9, L32-49 P9, L54-59 P10, L6-13 P10, L21-29 P10, L34-50 P11, L7-50
Discussion			
Key results	18	Summarise key results with reference to study objectives	P12, 9-30
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	P14, L10-20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P13, L17-51
Generalisability	21	Discuss the generalisability (external validity) of the study results	P14, L47-52
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	P15, L43

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Vulnerability to fatal drowning among the population in Southern Bangladesh: findings from a cross-sectional household survey

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3 **Vulnerability to fatal drowning among the population in Southern Bangladesh: findings**
4 **from a cross-sectional household survey**
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ABSTRACT

Objectives: To determine the fatal drowning burden and associated risk factors in Southern Bangladesh.

Settings: The survey was conducted in 39 sub-districts of all six districts of the Barishal division, Southern Bangladesh.

Participants: All residents (for a minimum 6 months prior to survey) of the Barishal division, Southern Bangladesh.

Intervention/methods: A cross-sectional, divisionally representative household survey was conducted in all six districts of the Barishal division between September 2016 and February 2017, covering a population of 386,016. Data were collected by face-to-face interview with adult respondents using handheld electronic tablets. International Classification of Diseases, 10, Chapter XX codes for drowning W65 – W74, X36 – X39, V90, V92, X71 or X92, were used as operational definition of a drowning event .

Results: The overall fatal drowning rate in Barishal was 37.9/100,000 population per year (95% CI 31.8–43.9). The highest fatal drowning rate was observed among children 1-4 years (262.2/100,000/year). Mortality rates among males (48.2/100,000/year) exceeded females. A higher rate of fatal drowning was found in rural (38.9/100,000/year) compared to urban areas (29.3/100,000/year). Results of the multivariable logistic regression identified that the factors significantly associated with fatal drowning were being male (OR 1.7, 95% CI: 1.2 - 2.3), aged 1-4 years (OR 3.0, 95% CI 1.4 - 6.4) and residing in a household with 4 or more children (4 or more children OR 1.8, 1.1 – 2.9; and 5 or more children OR 2.1, 1.2 – 3.7).

Conclusion: Drowning is a public health problem, especially for children, in the Barishal division of Southern Bangladesh. Male gender, children 1-4 years of age and residing in a household with 4 or more children were associated with increased risk of fatal drowning events. The Barishal division demands urgent interventions targeted at high risk groups identified in the survey.

Trial Registry: Not applicable

Key words: Drowning, fatal drowning, mortality, injury, risk factor, Bangladesh

ARTICLE SUMMARY**Strengths and limitations of this study**

- A key strength of this study was the large divisionally representative sample of Barishal division in Bangladesh, to guide contextual implementation of effective interventions.
- The study used multiple methods for quality control, of significance are the learnings from use of electronic data capture system with low access to internet.
- Limitations included the cross-sectional nature of the study which may have introduced recall bias. Although the proportion of refusals was small (2%), collecting data on reasons for non-participation could have added to the strength of the study.
- Under reporting in overall mortality rates is a concern for children under five years and may have contributed to an under-estimate of the true mortality in this age group.

INTRODUCTION

An estimated 322,149 drowning deaths occur globally every year making fatal drowning a major global health problem^[1]. Half of all drowning fatalities occur in people under the age of 25 with children aged between 1 – 4 years most vulnerable. More than 90% of drowning incidents take place in low- and middle-income countries (LMICs) where men, women and children have a higher exposure to the risks associated with open water^[2]. According to the 2012 WHO Global Health Estimates, the overall mortality rate from drowning globally was 5.2 per 100,000 population with the highest rates observed in the African Region (7.9 per 100,000 population) followed by South-East Asia Region (7.4 per 100,000 population)^[2].

In 2005, the first Bangladesh Health and Injury Survey (BHIS), identified drowning as the leading cause of death among children 1-17 years with approximately 17,000 children dying each year^[3]. In 2016, the BHIS was carried out for the second time and again drowning was found to be the main cause of injury deaths among children aged 1-4 and 5-9 years. According to the 2016 BHIS, every day 40 children (aged between 0-17 years) lost their life due to drowning and this was the highest among

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3 all injury fatalities. Among adults (aged 18 years or more) there were 13 deaths from drowning per
4 day and this was the sixth leading cause of injury death in that age category^[4]. The 2011 Bangladesh
5 Demographic Health Survey (BDHS) found that while the risk of dying from other conditions, such as
6 vaccine preventable communicable diseases, had significantly decreased, fatalities from drowning
7 among children aged 1-4 years rose alarmingly from 19.0% in 2004 to 43.0% in 2011^[5].

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10 Bangladesh is a highly disaster prone country, ranked sixth in the 2015 World Risk Report^[6]. It is
11 especially vulnerable to cyclones and frequent flooding which claim many lives each year^[7]. The
12 country is intersected by many rivers, drowning during inland water transport accidents is also
13 common^[8].

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16 The 2005 BHIS identified that the highest mortality rate due to drowning occurred in the Pirojpur
17 district of Barishal division in Bangladesh^[3]. Geographically, the Barishal division is located in the
18 central southern region of Bangladesh where several large rivers converge; with a land mass of
19 13,644.85 km² and a population of 8,147,000. As a low lying, coastal division, Barishal is vulnerable
20 to natural hazards and the effects of climate change. All six districts under this division are affected
21 by water-related hazards^[9].

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24 Considering these factors, Project *Bhasa*, a Comprehensive Drowning Reduction Strategy was
25 designed to reduce fatal drowning and morbidity utilizing evidence-based interventions. As part of
26 this initiative, a baseline survey was conducted to determine the burden and context of fatal
27 drowning in the Barishal division of Southern Bangladesh.

28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 **METHODS**

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53 The *Bhasa* baseline survey was a population-based cross-sectional survey representative to the
54 Barishal Division, one of the country's eight divisions. Geographically, the division is located in the
55 central southern region of Bangladesh where several large rivers converge. The survey was
56 conducted between September 2016 and February 2017 in 39 sub-districts of all six districts
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3 (Barguna, Barishal, Bhola, Jhalokathi, Patuakhali and Pirojpur) of the division (Fig. 1). The survey
4 covered 95,063 households comprising 386, 016 population in the selected sub-districts and used a
5 multi-stage stratified cluster sampling method. The sampling frame for upazilas (county)/villages was
6 designed to give a probability of selection proportional to population, and household sampling was
7 conducted using the WHO EPI approach ^[10].
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17 **INSERT Figure 1: Map of the Barishal division – the study area**

21 **Measures**

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23 The operational definition of injury mortality used in this study was in accordance with International
24 Classification of Disease (ICD), Version 10, Chapter XX recording intent and mechanism of injury ^[11].
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26 It was defined as, ‘any death occurred due to external harm resulting from a fall, burn, cut,
27 transportation, suffocation, drowning, machine/tool injury, electrocution, animal injury, blunt object
28 injury, poisoning, suicide and violence’. Drowning was described as ‘the process of experiencing
29 respiratory impairment from submersion or immersion in liquid’^[12]. Drowning deaths were included
30 if the cause was any of the following external cause codes from Chapter XX ICD-10^[11, 13]: codes W65
31 – W74 (unintentional drowning), X36 – X39 (exposure to forces of nature –water related, V90
32 (drowning or submersion due to accident to watercraft), V92 (drowning and submersion due to
33 accident on board watercraft, without accident to watercraft), X71 (intentional self-harm by
34 drowning and submersion) or X92 (assault by drowning and submersion while in bath tub).
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49 Information on all fatal injuries was collected over a two-year recall period, from the day of survey.
50 Whilst there is a potential issue of recall bias, previous literature from Verbal Autopsy (VA) reporting
51 cause of death has shown high validity and sensitivity for up to three years for causes of death
52 involving injury ^[14]. For all cases of fatal drowning additional information was collected on potential
53 risk factors. These included socio-demographic characteristics, access to water, and risk factors pre-
54 event (e.g. location and type of water body, activity of the person prior to drowning, person
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3 accompanying prior to drowning, accompanying person's age) , event (e.g. time and season of
4 drowning) and post-drowning event (e.g. time of rescue, person rescued, action taken after rescue).
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6 Information was gathered on knowledge, attitudes and practices related to drowning, drowning
7 prevention and disaster preparedness. Finally, data were also collected on all mortality and all
8 causes of injury mortality.
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17 **Data collection and procedures**

18 Data were collected using a pre-tested structured questionnaire by 50 trained data collectors.
19 Information was gathered from household heads, mothers or any residing adults aged 18 years or
20 older through face-to-face interviews after obtaining written informed consent. Each selected
21 respondent provided information of all household members including children. Each day data
22 collectors visited 25-30 households to collect information. Non-participation due to refusal was
23 2.0%. To ensure data quality, responsible supervisors randomly re-surveyed 2.0% of the households.
24 An electronic data capturing tool using the REDCap application, was used on tablets for data
25 collection^[15].
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39 **Statistical analysis**

40 In this study, to estimate the rates, weights were created for the survey data to appropriately adjust
41 for differences in probability of selection and response rates according to age and sex. The
42 probability of selection based on sampling information (number of upazilas that are the sub- districts
43 of a division, and number of villages) was calculated and then adjusted to the age and sex
44 distribution from the 2011 Bangladesh Population and Housing Census. All data were analysed using
45 SAS 9.4 with SAS/STAT 14.2.
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57 While analysing the rates (per 100,000/population) for fatal drowning and percentage for other
58 variables Taylor Series method was used. This incorporated the survey weights and the other
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3 features of survey design (stratification by district, and cluster sampling of villages). Multivariable
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5 logistic regression was used to examine associations between various socio-demographic factors
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7 with fatal drowning. Due to electronic data capture and in-built internal validity checks, missing data
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9 was minimised with only 1.01%; 977 records were not used due to missing data. Denominator
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11 population data was based on Bangladesh Bureau of Statistics, accommodating for a growth rate of
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13 1.37 from the 2011 census ^[16].
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20 **Ethical considerations**

21 This study received ethical approvals from the ethical review committee of the Centre for Injury
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23 Prevention and Research, Bangladesh (CIPRB), Bangladesh and the Human Ethics Committee of the
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25 University of Sydney, Australia. The ethics approval numbers were CIPRB/ERC/2016/12 and USyd
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27 HREC - 2016/606 respectively.
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33 **Patient and public involvement statement**

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36 *"This is a community-based household survey. Community leaders were consulted for filed*
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38 *implementation of the survey, and input sought on the tool for capturing context relevant data."*
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RESULTS

A total of 95,063 households were visited of which 92,616 household representatives (97.4%) completed the survey. Males and females were equally represented among the sampled population (49.1% vs 50.9%) and over one-third (37.2%) of the population were children under-18 years. A total of 4,128 deaths were reported in the two-year recall period, giving an overall mortality rate of 5.3/100,000 population per year (data not shown).

Drowning burden and mortality rates

Drowning accounted for 6.6% of deaths across all age group, however among children aged 1-4 years drowning was the cause of more than one-third of all deaths (35.1%). One in ten deaths among infants (<1 year) and children aged 5 to 9 years were a result from drowning (data not shown). In the two-year recall period, there were 285 fatal drownings across all ages giving an all-age drowning mortality rate of 37.9/100,000 population per year (95%CI: 31.8 - 43.9). All fatal drownings were reported to be unintentional. Fatal drowning rates were consistently higher among males compared to females across all ages except among those aged 10-14 years where a higher rate was observed among females. However, this higher rate among 10-14 year girls was not statistically significant.

The highest fatal drowning rates were in children aged 1-4 years at 262.2/100,000 per year (95% CI: 216.4 - 308.0) followed by infants (88.6/100,000) then children aged 5-9 years (65.1/100,000). In early adolescence (10-14 years) fatal drowning rates decreased but increased again in early adulthood (18-24 years) and among those aged 60 years and over where higher rates of fatal drownings were observed (Table 1).

Table 1. Drowning deaths and mortality rates by age and sex in the Barishal division, Bangladesh

Sex	Male			Female			All persons			National Rate both sex BHIS 2016 ¹	
AGE (years)	Numerator (Denominator)	Rate (per 100,000/year)	95% CI (LL, UL)	Numerator (Denominator)	Rate (per 100,000/year)	95% CI (LL, UL)	Numerator (Denominator)	Rate (per 100,000/year)	95% CI (LL, UL)	Rate (per 100,000/year)	95% CI (LL - UL)
<1	7 (3389)	142.9	22.9, 263.0	3 (3380)	34.8	0, 81.9	10 (6769)	88.6	25.4, 151.9	53.3	2.8 - 345.8
1 to 4	96 (14147)	325.3	252.6, 398.0	74 (14192)	199.8	143.1, 256.5	170 (28339)	262.2	216.4, 308.0	71.7	31.4 - 154.8
5 to 9	31 (21454)	78.7	48.9, 108.4	21 (20640)	51.8	25.1, 78.4	52 (42094)	65.1	42.4, 87.9	28.1	9.0 - 77.3
10 to 14	5 (23085)	9.3	0, 18.8	9 (22765)	28.2	6.7, 49.8	14 (45850)	18.9	7.2, 30.5	3.2	0.0 - 36.2
15 to 17	6 (11094)	21.1	2.8, 39.3	0 (9240)	-	-	6 (20334)	11.2	1.5, 20.9	5.6	0.0 - 63.5
18 to 24	8 (17688)	24.1	0, 52.9	6 (24638)	10.8	1.3, 20.4	14 (42326)	17.2	2.9, 31.5	-	
25 to 39	6 (41449)	5.2	0, 10.9	1 (49676)	1.2	0, 3.5	7 (91125)	3.1	0.1, 6.1	2.5	0.1 - 16.2
40 to 59	4 (36444)	8.1	0, 18.2	2 (35568)	3.1	0, 7.4	6 (72012)	5.6	0.1, 11.1	8.6	1.9 - 30.3
60+	5 (20226)	22.3	3.6, 40.9	1 (16052)	3.1	0, 9.1	6 (36278)	12.6	2.9, 22.2	8.8	0.5 - 56.9
Total	168 (188976)	48.2	38.9, 57.4	117 (196151)	27.9	21, 34.9	285 (385127)	37.9	31.8, 43.9	11.7	7.1 - 19.0

¹Rahman A, Chowdhury SM, Mashreky SR, Linnan M, Rahman AKMF. (2016) Report on Bangladesh Health and Injury Survey, DGHS, CIPRB, Dhaka.

Fatal drowning rates were higher in rural areas compared to urban areas of the sub-district (38.9/100,000 vs 29.3 per 100,000), and across all age groups except in infancy (<1 year) and early adulthood (18-24 years) where drowning fatality rates were higher in urban areas (Table 2).

Table 2. Distribution rates of fatal drowning by age and region of residence in the Barisal Division, Bangladesh

	Rural	Urban*
Age (years)	Rate per 100,000 (95% CI)	Rate per 100,000 (95% CI)
<1 (infant)*	79.8 (13.6 - 145.9)	160.9 (0.0 - 438.2)
1-4	277.2 (225.7 - 328.6)	135.4 (40.8 - 230.0)
5-9	68.9 (43.4 - 94.3)	31.5 (0.0 - 66.1)
10-14	18.9 (6.4 - 31.3)	18.5 (0.0 - 51.8)
15-17	11.5 (0.7 - 22.3)	8.6 (0.0 - 25.3)
18-24	11.0 (3.3 - 18.6)	65.7 (0.0 - 177.4)
25-39	3.5 (0.2 - 6.9)	0
40-59	6.3 (0.1 - 12.4)	0
60 +	13.9 (3.2 - 24.6)	0
Total	38.9 (32.6 - 45.3)	29.3 (6.5 - 52.1)

*The event rate for infants and urban areas are very small, reporting very wide confidence interval

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3 ***Drowning by distance of water body from households, type of water body, activity, seasonality and***
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5 ***time of the day***
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8 Across all age categories about three quarters of fatal drowning events occurred within 100 metres
9 of the households. However, among adolescents aged 15-17 years and adults aged 40 years and
10 above over 20.0% of drowning deaths occurred at a distance of over two kilometres (data not
11 shown).
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17 The majority (98.0%) of drowning deaths took place in the community while less than 1.0% were
18 related to disasters or while using water transportation. Over three-quarters of drowning deaths
19 occurred in ponds and ditches (Figure 2a), and over half were in outdoor water bodies primarily used
20 for bathing and washing (56.0%) (Figure 2b).
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27 **INSERT FIGURE 2**
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30 Drowning occurred throughout the year, however fatalities peaked during the monsoon season
31 particularly in the months of June and September which accounted for nearly one quarter (23.7%) of
32 all drowning deaths (Figure 3).
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37 **INSERT FIGURE 3**
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40 Almost all fatal drownings occurred between the daylight hours of 6 *a.m.* and 6 *p.m.* with two-thirds
41 (63.0%) taking place between the hours of 9 *a.m.* and 3 *p.m.* (Figure 4). Among children aged 1-4
42 years most fatal drownings occurred between the hours of 12 *p.m.* and 4 *p.m.* (58.0%) which was
43 followed by 8 *a.m.* to 12 *p.m.* (31.0%) (data not shown).
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50 **INSERT FIGURE 4**
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53 ***Person accompanying prior to drowning event***
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55 Almost two-thirds (62.3%) of drowned individuals were not accompanied by anyone during the
56 drowning incident, while 15.0% were accompanied by a friend or colleague (data not shown).
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Individual involved in rescue

During fatal drownings, neighbours or bystanders (43.0%) were the individuals most often involved in the rescue, followed by mothers (21.2%).

Factors associated with fatal drowning

Univariate analyses for fatal drowning showed that children aged 1 to 4 years had three times higher odds of fatal drowning compared with those aged under one years. Similarly, households with four or more children had almost two times higher odds of experiencing a drowning fatality than households with one child. After adjustment, the factors that remained associated with fatal drowning were age, with children aged 1 to 4 years at three times higher odds than those aged less than one year, being male also significantly increased the odds of drowning fatalities by almost 70.0%. Number of children in the household was also significantly associated with fatal drowning and increased with increasing number of children (Table 3).

Table 3. Socio-demographic factors associated with drowning mortality

Characteristic	Univariate				Multivariable			
	OR	LCL	UCL	p-value	OR	LCL	UCL	p-value
Sex								
Male	1.7	1.3	2.3	0.0004	1.7	1.2	2.3	0.0007
Female	reference				reference			
Age group (years)								
<1	reference				reference			
1-4	3.0	1.4	6.3	<.0001	3.0	1.4	6.4	<.0001
5-9	0.7	0.3	1.6	.	0.7	0.3	1.5	.
10-14	0.2	0.1	0.6	.	0.2	0.1	0.5	.
15-17	0.1	0.04	0.4	.	0.1	0.03	0.3	.
18-24	0.2	0.08	0.5	.	0.097	0.030	0.313	.

Characteristic	Univariate				Multivariable			
	OR	LCL	UCL	p-value	OR	LCL	UCL	p-value
25-39	0.0	0.0	0.1	.	0.0	0.0	0.09	.
40-59	0.1	0.0	0.2	.	0.0	0.0	0.13	.
60 +	0.1	0.0	0.4	.	0.1	0.0	0.2	.
Maternal education								
None	1.9	0.4	8.2					
1 -5 years	2.8	0.7	11.4	0.3372	.	.	.	.
6-8 years	2.5	0.6	10.6	.	.	.	.	.
9-12 years	2.1	0.5	8.8	.	.	.	.	.
13-17 years	reference				reference			
Wealth quintile								
Q1 (Lowest)	1.5	0.9	2.5	0.5147	1.3	0.8	2.2	0.8396
Q2	1.2	0.6	2.2	.	1.1	0.6	2.0	.
Q3	1.3	0.8	2.1	.	1.2	0.7	1.9	.
Q4	1.2	0.6	2.1	.	1.1	0.6	2.0	.
Q5 (Highest)	reference				reference			
No. of children in household*								
1 child	reference				reference			
2 children	0.9	0.6	1.4	0.6273	0.9	0.6	1.5	0.0026
3 children	1.0	0.6	1.5	.	1.2	0.8	1.8	.
4 children	1.3	0.8	2.1	.	1.8	1.1	2.9	.
5+ children	1.4	0.8	2.4	.	2.1	1.2	3.7	.

*Number of household with no children were very small to draw plausible inference

95% CI's

DISCUSSION

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3 The mortality and morbidity reporting systems in Bangladesh are poor^[17]. To inform a large-scale
4 drowning prevention strategy, we conducted a cross-sectional household survey to provide
5 otherwise unavailable epidemiological data on drowning in the Barishal Division. Our study found a
6 mortality rate from drowning of 37.9 per 100,000 per year across all ages in the Barishal division,
7 which is over three times higher than the national rate reported in 2016 (11.7/100,000/year)^[4]. The
8 number of water bodies including rivers, lakes, ponds and ditches in this division is far higher than
9 the other parts of the country. For both males and females fatal drowning rates were high in infancy,
10 and peaked at 1-4 years of age, then fell rapidly through middle childhood and adolescence and
11 remained relatively low throughout adulthood. This pattern of fatal drowning rates across the age
12 groups in this study is consistent with another recent national survey^[4].
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26 Previous studies identified nearby ponds, ditches, and canals as the most common location of fatal
27 drowning among children in Bangladesh^[3, 17-20]. In the Barishal region, most households are
28 surrounded by water bodies. Similar to previous studies, this study revealed that the majority of
29 childhood drowning deaths occurred in ponds, ditches and canals situated within only 100 metres
30 from their residences. Children are often with other siblings (children) or unaccompanied at the time
31 of drowning. Lack of supervision in younger children is a major risk factor. Attentiveness and
32 continuity are essential characteristics of the hierarchical model of supervision,^[21] proximity to the
33 water exacerbates risk. However, among adults a considerable proportion of drowning fatalities
34 occurred at a distance of two kilometres from their houses. It is possible that these deaths occurred
35 in rivers where individuals were engaged in activities such as fishing or boating.
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49 Drowning deaths in Barishal occurred year-round but most frequently during the monsoon season
50 (June to October); this is similar to findings reported in prior studies^[18, 22-24]. It is also notable that in
51 the dry season (November-December) the fatal drowning rates remained relatively high in Barishal.
52 This is likely because most natural water bodies including those close to households are connected
53 to the rivers and given much of the division is subject to two high tides where waterbodies are filled
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3 twice a day by sea water including the dry season, this can increase the risk of exposure especially
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5 among children playing in water bodies. Previous studies, have also reported over 90% of fatal
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7 drowning events occurred in daylight hours^[17, 25].
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10 Fatal drowning was strongly and significantly associated with sex with males having over 1.5 times
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12 the odds of death from drowning. This may be related to males greater engagement in risk taking
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14 behaviours and exposure to high risk situations^[26] or to existing traditional gender roles in
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16 Bangladesh with young boys more likely to be out playing unsupervised whereas girls would be at
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18 home helping with household activities. This points to the need to place specific emphasis on
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20 targeting boys within drowning prevention programs. Age was also significantly related to fatal
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22 drowning with those in the age group of 1-4 years having the greatest risk of drowning. This age
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24 group has consistently been found to be at greater risk of drowning in Bangladesh and other South-
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26 East Asian and Western Pacific countries^[2, 18, 27] and may be related to challenges to achieve adult
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28 supervision, the lack of swimming ability in this age group and other behavioural factors^[18]. We did
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30 not find any significant association between mother's education and fatal drowning risk. The socio-
31
32 economic status of our study population was fairly homogenous and no associations were reported
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34 across the socio-economic groups. Increased number of children in the household, increased the risk
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36 of drowning events. Households with four or five children in the family were common place. In these
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38 circumstances parents may find it difficult to adequately supervise all of them. These findings
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40 support the need for programmes that can assist families with supervision.
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50 **STRENGTHS AND LIMITATIONS OF THE STUDY**

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52 The strength of this study was that to ensure the quality of data, trained supervisors were recruited,
53
54 and they observed 10.0% of interviews conducted by the data collectors, checked 10.0% of the
55
56 collected data, and re-interviewed 2.0% of the households. In addition, field level research officers
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3 and managers were appointed to re-check all data for inconsistencies. If inconsistency was detected,
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5 the respective data collector was asked to revisit the household to collect correct information.
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8 Another strength was that the study used external cause codes of fatal drowning from the ICD – 10
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10 that provided more representative true burden of fatal drowning. In addition to unintentional
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12 external cause of drowning codes, watercraft and flood related drowning, and intentional self-harm
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14 by drowning codes were also included. Studies suggested to include these later codes (watercraft,
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16 flood related and intentional self-harm) to obtain more representative magnitude of fatal drowning
17
18 [28, 29] Intentional drownings particularly suicides are culturally stigmatised in Bangladesh. Household
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20 surveys thus are not the best source of data for determining intent of drowning. However, given the
21
22 high burden among children, intent has little implications on the study findings.
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30 Given that the mortality burden is highest in children aged under five years, it should be noted that
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32 under-reporting in overall mortality rates is an issue in this age group because of poor birth /vital
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34 registration systems, so our results may have under-estimated the true burden. This is likely to affect
35
36 data on children aged under-one year to a larger extent. However, given that a two-year recall
37
38 period was used in this survey, the fatal drowning rates are likely to be conservative. Although the
39
40 proportion of refusals was small (2%), collecting data on reasons for non-participation could have
41
42 added to the strength of the study.
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46 One of the major challenges in this study was to use the electronic data capturing system with an
47
48 intent to obtain real time data. Each data collector was given a tablet loaded with REDCap
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50 application, and a sim was inserted in the device to obtain wireless internet connection. However, in
51
52 the remote locations the internet connectivity was very poor and initially the data collectors could
53
54 not upload their collected data from the site of data collection. To resolve this issue, offline data
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56 collection system was created in the software. Each day after data collection in the afternoon the
57
58 data collectors returned to the local office to get a high quality Wifi connection to upload their data.
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3 To best of our knowledge, this is the first survey using offline application for electronic data capture
4 (Redcap), in the region. The survey was huge with over 250 variables collecting information on
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6 multiple drowning events in each household. With English and Bangla translations, the screen size of
7
8 a hand held Android device posed challenge for accuracy in data entry, which was mitigated by
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10 division of survey into multiple sections/tools and optimising the font size. Bi-lingual presentation
11
12 was essential, as statistical programmes are primarily compatible with English, only.
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17 The contextual issues for example access to electricity for charging of devices, access to internet or
18
19 recharging the power banks also needed to be considered. Some of the learnings that have since led
20
21 to enhanced features within the Redcap application are synchronising of auto-generated
22
23 identification on an offline application, preventing data loss or duplication of data. It is due to the
24
25 success of using electronic data capture and utilising internal validity checks that the high quality and
26
27 completeness of the dataset was achieved.
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31 The survey was purposively conducted in Barishal division which is one of the eight divisions of
32
33 Bangladesh. In previous national injury surveys the highest drowning mortality rate among children
34
35 was observed in the Pirojpur district of Barishal division^[3]. Considering this high rate the Barishal
36
37 division was selected for Project Bhasa.
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41 The study findings highlight the very high magnitude of drowning deaths in the Barishal division.
42
43 Socio-demographic factors including being male, aged 1-4 years and having five or more children in
44
45 households was associated with increased risk of fatal drowning. The findings further demonstrate
46
47 that drowning is predominantly a problem that affects children in Bangladesh. The Barishal division
48
49 demands urgent interventions targeted at high risk groups identified here. Project Bhasa aims to
50
51 provide evidence-based interventions, including community day-care for under-five children to
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53 ensure adult supervision during day time and providing swimming instruction and school water
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55 safety education to children aged five years and over, to reduce drowning. It is expected that the
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1
2
3 project will generate knowledge to assist with drowning reduction efforts both nationally and in
4
5 other similar settings.
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9

10 11 **ACKNOWLEDGEMENTS**

12
13
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21 to thank Steve Wills and Ashim Kumar Saha for their contribution during data collection.
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30 31 **CONTRIBUTORS**

32
33 AR participated in the design, implementation and supervision of field work and analysis and wrote
34 the paper. JJ contributed on project design, data analysis and writing of the paper. KB and MJH
35 contributed on project design, implementation, Data management and supervision of field work and
36 writing of the paper. DR contributed on project design and writing of the paper. TA and KR were
37 involved in data management and analysis and contributed to write the paper. RI and FR conceived
38 the study and supervised throughout and contributed to the writing of the paper. RI and FR are the
39 guarantors.
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46 47 **FUNDING**

48
49 The research was funded by Royal National Life Boat Institution (RNLI), UK
50
51

52 53 **COMPETING INTERESTS**

54
55 Authors declare no conflict of interest.
56
57

58 59 **ETHICAL APPROVAL**

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3 Obtained
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6 **PROVENANCE AND PEER REVIEW**

7

8
9 Not commissioned; externally peer reviewed.
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11 **DATA SHARING STATEMENT**

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13
14 We have de-identified data which are available at Centre for Injury Prevention and Research,
15 Bangladesh and The George Institute for Global Health. This was the baseline survey data generated
16 from BHASA project which is a collaborative work of Royal National Lifeboat Institution, Centre for
17 Injury Prevention and Research, Bangladesh and The George Institute for Global Health. Royal
18 National Lifeboat Institution funded to conduct the research work. The mentioned organisations
19 have rights to use the data. Data are available upon request to Dr Aminur Rahman
20 (aminur@ciprb.org) and Dr. Jagnoor Jagnoor (jjagnoor@georgeinstitute.org.au).
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31 Figure 1: *Map of the Barishal division – the study area*
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34 Figure 2: *Distribution of fatal drowning by type of water bodies (2a) and their use (2b)*
35

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37 Figure 3: *Distribution of fatal drowning by time of the year in Barishal Division, Bangladesh*
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40 Figure 4: *Distribution of fatal drowning by time of the day in Barishal Division, Bangladesh*
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56 Government of the People's Republic of Bangladesh, Institute of Child & Mother Health
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Figure 1: Map of the Barishal Division - the study area

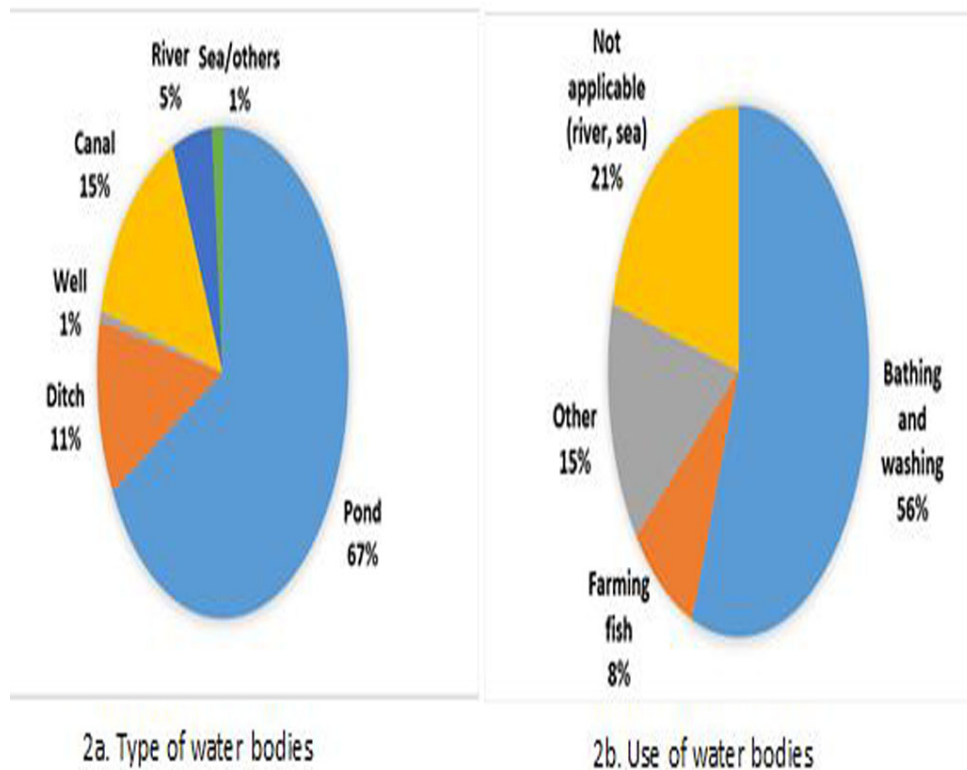


Figure 2: Distribution of fatal drowning by type of water bodies (2a) and their use (2b)

Figure 2: Drowning by types and use of water bodies

90x90mm (300 x 300 DPI)

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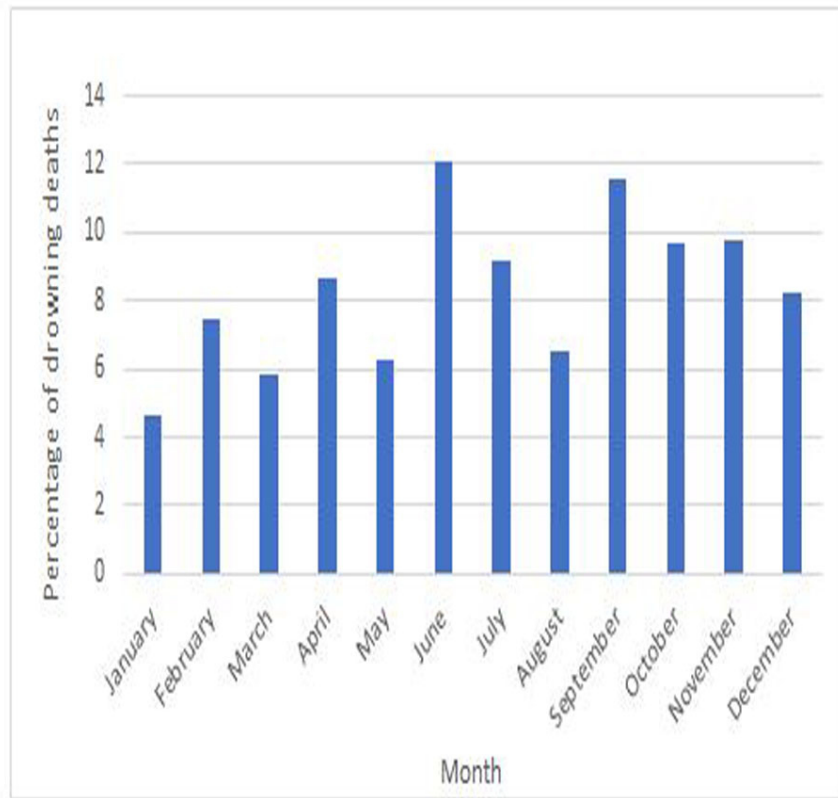


Figure 3. Distribution of fatal drowning by time of the year in Barishal Division, Bangladesh

Figure 3: Drowning by time of year

90x90mm (300 x 300 DPI)

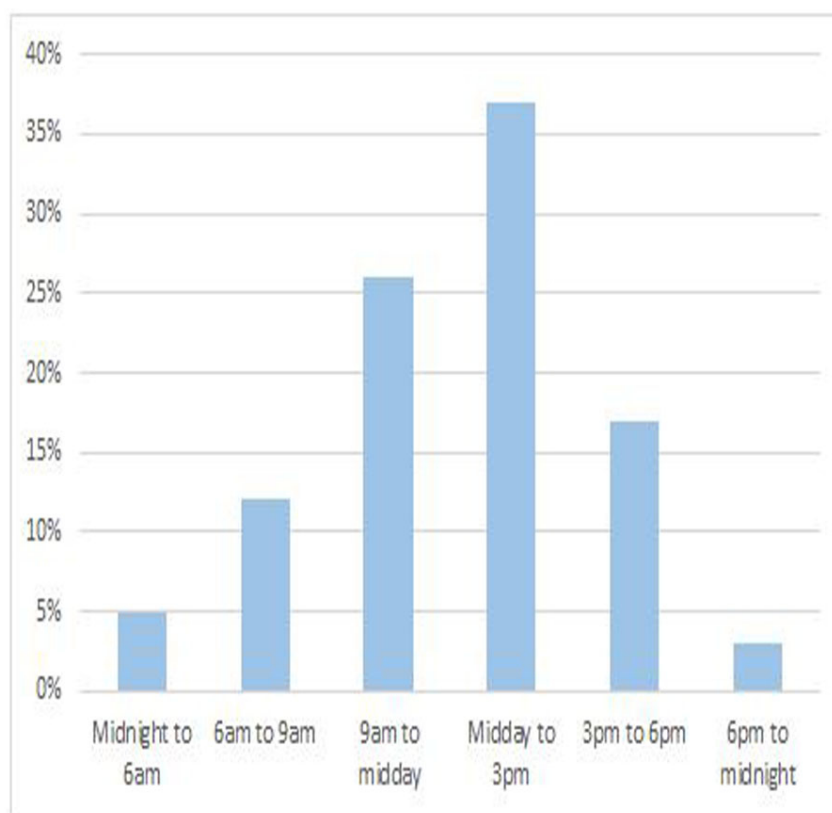


Figure 4. Distribution of fatal drowning by time of the day in Barishal Division, Bangladesh

Figure 4: Drowning by time of day

90x90mm (300 x 300 DPI)

STROBE Statement

Vulnerability to fatal drowning among the population in Southern Bangladesh: findings from a cross-sectional household survey

	Item No	Recommendation	Page and Line Number(s)
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	P2, L13
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	P2, L13-38
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	P5, L3-23
Objectives	3	State specific objectives, including any pre-specified hypotheses	P5, L15-22
Methods			
Study design	4	Present key elements of study design early in the paper	P5, L36-45
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	P5, L36-41
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	P5, L40-43 P6, L39-43
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	P6, L3-31
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	P5, L51-54 P6, L37-38
Bias	9	Describe any efforts to address potential sources of bias	P6, L57-60
Study size	10	Explain how the study size was arrived at	P5, L40-45
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	P7, L12-21
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	P7, L12-21
		(b) Describe any methods used to examine subgroups and interactions	P7, L3-8
		(c) Explain how missing data were addressed	P6, L44-47 P7, L22
		(d) If applicable, describe analytical methods taking account of sampling strategy	P7, L12-17
		(e) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	P7, L45-55
		(b) Give reasons for non-participation at each stage	Not provided, less than 5%
		(c) Consider use of a flow diagram	N/A

Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	P7, L47-53
		(b) Indicate number of participants with missing data for each variable of interest	P7, L21-22
Outcome data	15*	Report numbers of outcome events or summary measures	P7, L52-55
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	P8, L31-56
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	P9, L11-3- P9, L32-49 P9, L54-59 P10, L6-13 P10, L21-29 P10, L34-50 P11, L7-50
Discussion			
Key results	18	Summarise key results with reference to study objectives	P12, 9-30
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	P14, L10-20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P13, L17-51
Generalisability	21	Discuss the generalisability (external validity) of the study results	P14, L47-52
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	P15, L43

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Vulnerability to fatal drowning among the population in Southern Bangladesh: findings from a cross-sectional household survey

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Manuscript ID	bmjopen-2018-027896.R3
Article Type:	Original research
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Complete List of Authors:	Rahman, Aminur; Centre for Injury Prevention and Research Bangladesh (CIPRB), International Drowning Research Centre - Bangladesh (IDRC-B) Jagnoor, Jagnoor; The George Institute for Global Health, University of Sydney Baset, Kamran; International Drowning Research Centre-Bangladesh (IDRC-B) Ryan, Dan; Royal National Lifeboat Institution Ahmed, Tahera; International Drowning Research Centre-Bangladesh (IDRC-B) Rogers, Kris; The George Institute for Global Health, University of Sydney Hossain, Mohammad; International Drowning Research Centre-Bangladesh (IDRC-B) Ivers, Rebecca; The George Institute for Global Health, University of Sydney Rahman, AKM; International Drowning Research Centre-Bangladesh (IDRC-B)
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology
Keywords:	drowning, Fatal drowning, mortality, injury, risk factor, Bangladesh

SCHOLARONE™
Manuscripts

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3 **Vulnerability to fatal drowning among the population in Southern Bangladesh: findings**
4 **from a cross-sectional household survey**
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52 ³ Royal National Lifeboat Institution (RNLI), Poole, UK
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ABSTRACT

Objectives: To determine the fatal drowning burden and associated risk factors in Southern Bangladesh.

Settings: The survey was conducted in 39 sub-districts of all six districts of the Barishal division, Southern Bangladesh.

Participants: All residents (for a minimum 6 months prior to survey) of the Barishal division, Southern Bangladesh.

Intervention/methods: A cross-sectional, divisionally representative household survey was conducted in all six districts of the Barishal division between September 2016 and February 2017, covering a population of 386,016. Data were collected by face-to-face interview with adult respondents using handheld electronic tablets. ICD-10 Chapter XX: External causes of morbidity and mortality codes for drowning W65 – W74, X36 – X39, V90, V92, X71 or X92, were used as the operational definition of a drowning event .

Results: The overall fatal drowning rate in Barishal was 37.9/100,000 population per year (95% CI 31.8–43.9). The highest fatal drowning rate was observed among children aged 1-4 years (262.2/100,000/year). Mortality rates among males (48.2/100,000/year) exceeded females (27.9/100,000/year). A higher rate of fatal drowning was found in rural (38.9/100,000/year) compared to urban areas (29.3/100,000/year). Results of the multivariable logistic regression identified that the factors significantly associated with fatal drowning were being male sex (OR 1.7, 95% CI: 1.2 - 2.3), aged 1-4 years (OR 3.0, 95% CI 1.4 - 6.4) and residing in a household with 4 or more children (4 or more children OR 1.8, 1.1 – 2.9; and 5 or more children OR 2.1, 1.2 – 3.7).

Conclusion: Drowning is a public health problem, especially for children, in the Barishal division of Southern Bangladesh. Male gender, children 1-4 years of age and residing in a household with 4 or more children were associated with increased risk of fatal drowning events. The Barishal division demands urgent interventions targeted at high risk groups identified in the survey.

Trial Registry: Not applicable

Key words: Drowning, fatal drowning, mortality, injury, risk factor, Bangladesh

ARTICLE SUMMARY**Strengths and limitations of this study**

- A key strength of this study was the large divisionally representative sample of Barishal division in Bangladesh, to guide contextual implementation of effective interventions.
- The study used multiple methods for quality control, of significance are the learnings from use of electronic data capture system with low access to internet.
- Limitations included the cross-sectional nature of the study which may have introduced recall bias. Although the proportion of refusals was small (2%), collecting data on reasons for non-participation could have added to the strength of the study.
- Under reporting in overall mortality rates is a concern for children under five years and may have contributed to an under-estimate of the true mortality in this age group.

INTRODUCTION

An estimated 322,149 annual drowning deaths occur globally, making fatal drowning a major global health problem^[1]. Half of all drowning fatalities occur in people under the age of 25 with children aged between 1 – 4 years the most vulnerable. More than 90% of drowning incidents take place in low- and middle-income countries (LMICs) where men, women and children have a higher exposure to the risks associated with open water^[2]. According to the 2012 WHO Global Health Estimates, the global mortality rate from drowning was 5.2 per 100,000 population with the highest rates observed in the African Region (7.9 per 100,000 population) followed by South-East Asia Region (7.4 per 100,000 population)^[2].

In 2005, the first Bangladesh Health and Injury Survey (BHIS), identified drowning as the leading cause of death among children 1-17 years with approximately 17,000 children dying each year^[3]. In 2016, the BHIS was carried out for the second time and again drowning was found to be the main cause of injury deaths among children aged 1-4 and 5-9 years. According to the 2016 BHIS, every day 40 children (aged between 0-17 years) lost their life due to drowning and this was the highest among all injury fatalities. Among adults (aged 18 years or more) there were 13 deaths from drowning per day and this was the sixth leading cause of injury death in that age category^[4]. The 2011 Bangladesh Demographic Health Survey (BDHS) found that while the risk of dying from other conditions, such as vaccine preventable communicable diseases, had significantly decreased, fatalities from drowning among children aged 1-4 years rose alarmingly from 19.0% in 2004 to 43.0% in 2011^[5].

Bangladesh is a highly disaster prone country, ranked sixth in the 2015 World Risk Report^[6]. It is especially vulnerable to cyclones and frequent flooding which claim many lives each year^[7]. The country is intersected by many rivers, drowning during inland water transport accidents is also common^[8].

The 2005 BHIS identified that the highest mortality rate due to drowning occurred in the Pirojpur district of Barishal division in Bangladesh^[3]. Geographically, the Barishal division is located in the

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3 central southern region of Bangladesh where several large rivers converge; with a land mass of
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5 13,644.85 km² and a population of 8,147,000. As a low lying, coastal division, Barishal is vulnerable
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7 to natural hazards and the effects of climate change. All six districts under this division are regularly
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9 affected by water-related hazards^[9].

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12 Considering these factors, Project *Bhasa*, a Comprehensive Drowning Reduction Strategy was
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14 designed to reduce fatal drowning and morbidity utilizing evidence-based interventions. As part of
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16 this initiative, a baseline survey was conducted to determine the burden and context of fatal
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18 drowning in the Barishal division of Southern Bangladesh.
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25 **METHODS**

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27 The *Bhasa* baseline survey was a population-based cross-sectional survey representative to the
28
29 Barishal Division, one of the country's eight divisions. Geographically, the division is located in the
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31 central southern region of Bangladesh where several large rivers converge. The survey was
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33 conducted between September 2016 and February 2017 in 39 sub-districts of all six districts
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35 (Barguna, Barishal, Bhola, Jhalokathi, Patuakhali and Pirojpur) of the division. The survey covered
36
37 95,063 households comprising 386, 016 population in the selected sub-districts and used a multi-
38
39 stage stratified cluster sampling method. The sampling frame for sub-districts was designed to give a
40
41 probability of selection proportional to population. Household sampling was conducted using the
42
43 WHO EPI approach ^[10].
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50 **Measures**

51
52 The operational definition of injury mortality used in this study was in accordance with ICD - 10
53
54 Chapter XX: External causes of morbidity and mortality, recording intent and mechanism of injury
55
56 ^[11]. It was defined as, 'any death occurred due to external harm resulting from a fall, burn, cut,
57
58 transportation, suffocation, drowning, machine/tool injury, electrocution, animal injury, blunt object
59
60

1
2
3 injury, poisoning, suicide and violence'. Drowning was described as 'the process of experiencing
4 respiratory impairment from submersion or immersion in liquid'^[12]. Drowning deaths were included
5 if the cause was any of the following external cause codes from ICD-10 Chapter XX: External causes
6 of morbidity and mortality: codes W65 – W74 (unintentional drowning), X36 – X39 (exposure to
7 forces of nature –water related, V90 (drowning or submersion due to accident to watercraft), V92
8 (drowning and submersion due to accident on board watercraft, without accident to watercraft),
9 X71 (intentional self-harm by drowning and submersion) or X92 (assault by drowning and
10 submersion while in bath tub)^[11, 13].

11
12 Information on all fatal injuries was collected over a two-year recall period, from the day of survey.
13
14 Whilst there is a potential issue of recall bias, previous literature from Verbal Autopsy (VA) reporting
15 cause of death has shown high validity and sensitivity for up to three years for causes of death
16 involving injury^[14]. For all cases of fatal drowning additional information was collected on potential
17 risk factors. These included socio-demographic characteristics, access to water, and pre-event risk
18 factors (e.g. location and type of water body, activity of the person prior to drowning, person
19 accompanying prior to drowning, accompanying person's age), event (e.g. time and season of
20 drowning) and post-drowning events (e.g. time of rescue, person rescued, action taken after rescue).
21
22 Information was gathered on knowledge, attitudes and practices related to drowning, drowning
23 prevention and disaster preparedness. Finally, data were also collected on all mortality and all
24 causes of injury mortality.

25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 **Data collection and procedures**

50 Data were collected using a pre-tested structured questionnaire by 50 trained data collectors.
51
52 Information was gathered from household heads, mothers or any residing adults aged 18 years or
53 older through face-to-face interviews after obtaining written informed consent. Each selected
54 respondent provided information of all household members including children. Each day data
55 collectors visited 25-30 households to collect information. Non-participation due to refusal was
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3 2.0%. To ensure data quality, responsible supervisors randomly re-surveyed 2.0% of the households.

4
5 An electronic data capturing tool using the REDCap application, was used on tablets for data
6
7 collection^[15].

11 12 **Statistical analysis**

13
14 In this study, to estimate mortality rates, weights were created for the survey data to appropriately
15
16 adjust for differences in probability of selection and response rates according to age and sex. The
17
18 probability of selection based on sampling information (number of upazilas that are the sub- districts
19
20 of a division, and number of villages) was calculated and then adjusted to the age and sex
21
22 distribution from the 2011 Bangladesh Population and Housing Census. All data were analysed using
23
24 SAS 9.4 with SAS/STAT 14.2.

25
26
27
28
29
30 While analysing mortality rates (per 100,000/population) for fatal drowning and for percentage for
31
32 other variables, the Taylor Series method was used. This incorporated the survey weights and the
33
34 other features of the survey design (stratification by district, and cluster sampling of villages).

35
36 Multivariable logistic regression was used to examine associations between various socio-
37
38 demographic factors with fatal drowning. Due to electronic data capture and in-built internal validity
39
40 checks, missing data was minimised with only 1.01%; 977 records were excluded due to missing
41
42 data. Denominator population data was based on Bangladesh Bureau of Statistics, accommodating
43
44 for a growth rate of 1.37 from the 2011 census ^[16].

45 46 47 48 49 50 **Ethical considerations**

51
52
53 This study received ethical approvals from the ethical review committee of the Centre for Injury
54
55 Prevention and Research, Bangladesh (CIPRB), Bangladesh and the Human Ethics Committee of the
56
57 University of Sydney, Australia. The ethics approval numbers were CIPRB/ERC/2016/12 and USyd
58
59 HREC - 2016/606 respectively.

Patient and public involvement statement

This is a community-based household survey. Community leaders were consulted for feedback on the implementation of the survey, and their input sought on the tool for capturing contextually relevant data.

RESULTS

A total of 95,063 households were visited of which 92,616 household representatives (97.4%) completed the survey. Males and females were equally represented among the sampled population (49.1% vs 50.9%) and over one-third (37.2%) of the population were children under-18 years. A total of 4,128 deaths were reported in the two-year recall period, giving an overall mortality rate of 5.3/100,000 population per year (data not shown).

Drowning burden and mortality rates

Drowning accounted for 6.6% of deaths across all age groups, however among children aged 1-4 years drowning was the cause of more than one-third of all deaths (35.1%). One in ten deaths among infants (<1 year) and children aged 5 to 9 years were a result from drowning (data not shown). In the two-year recall period, there were 285 fatal drownings across all ages giving an all-age drowning mortality rate of 37.9/100,000 population per year (95%CI: 31.8 - 43.9). All fatal drownings were reported to be unintentional. Fatal drowning rates were consistently higher among males compared to females across all ages except among those aged 10-14 years where a higher rate was observed among females. However, this higher rate among 10-14 year girls was not statistically significant.

The highest fatal drowning rates were in children aged 1-4 years at 262.2/100,000 per year (95% CI: 216.4 - 308.0) followed by infants (88.6/100,000) then children aged 5-9 years (65.1/100,000). In

early adolescence (10-14 years) fatal drowning rates decreased but increased again in early adulthood (18-24 years) and among those aged 60 years and over where higher rates of fatal drownings were observed (Table 1).

Table 1. Drowning deaths and mortality rates by age and sex in the Barishal division, Bangladesh

Sex	Male			Female			All persons			National Rate both sex BHIS 2016 ¹	
AGE (years)	Numerator (Denominator)	Rate (per 100,000/year)	95% CI (LL, UL)	Numerator (Denominator)	Rate (per 100,000/year)	95% CI (LL, UL)	Numerator (Denominator)	Rate (per 100,000/year)	95% CI (LL, UL)	Rate (per 100,000/year)	95% CI (LL - UL)
<1	7 (3389)	142.9	22.9, 263.0	3 (3380)	34.8	0, 81.9	10 (6769)	88.6	25.4, 151.9	53.3	2.8 - 345.8
1 to 4	96 (14147)	325.3	252.6, 398.0	74 (14192)	199.8	143.1, 256.5	170 (28339)	262.2	216.4, 308.0	71.7	31.4 - 154.8
5 to 9	31 (21454)	78.7	48.9, 108.4	21 (20640)	51.8	25.1, 78.4	52 (42094)	65.1	42.4, 87.9	28.1	9.0 - 77.3
10 to 14	5 (23085)	9.3	0, 18.8	9 (22765)	28.2	6.7, 49.8	14 (45850)	18.9	7.2, 30.5	3.2	0.0 - 36.2
15 to 17	6 (11094)	21.1	2.8, 39.3	0 (9240)	-	-	6 (20334)	11.2	1.5, 20.9	5.6	0.0 - 63.5
18 to 24	8 (17688)	24.1	0, 52.9	6 (24638)	10.8	1.3, 20.4	14 (42326)	17.2	2.9, 31.5	-	
25 to 39	6 (41449)	5.2	0, 10.9	1 (49676)	1.2	0, 3.5	7 (91125)	3.1	0.1, 6.1	2.5	0.1 - 16.2
40 to 59	4 (36444)	8.1	0, 18.2	2 (35568)	3.1	0, 7.4	6 (72012)	5.6	0.1, 11.1	8.6	1.9 - 30.3
60+	5 (20226)	22.3	3.6, 40.9	1 (16052)	3.1	0, 9.1	6 (36278)	12.6	2.9, 22.2	8.8	0.5 - 56.9
Total	168 (188976)	48.2	38.9, 57.4	117 (196151)	27.9	21, 34.9	285 (385127)	37.9	31.8, 43.9	11.7	7.1 - 19.0

¹Rahman A, Chowdhury SM, Mashreky SR, Linnan M, Rahman AKMF. (2016) Report on Bangladesh Health and Injury Survey, DGHS, CIPRB, Dhaka.

Fatal drowning rates were higher in rural areas compared to urban areas of the sub-district (38.9/100,000 vs 29.3 per 100,000), and across all age groups except in infancy (<1 year) and early adulthood (18-24 years) where drowning fatality rates were higher in urban areas (Table 2).

Table 2. Distribution rates of fatal drowning by age and region of residence in the Barisal Division, Bangladesh

Age (years)	Rural	Urban*
	Rate per 100,000 (95% CI)	Rate per 100,000 (95% CI)
<1 (infant)*	79.8 (13.6 - 145.9)	160.9 (0.0 - 438.2)
1-4	277.2 (225.7 - 328.6)	135.4 (40.8 - 230.0)
5-9	68.9 (43.4 - 94.3)	31.5 (0.0 - 66.1)
10-14	18.9 (6.4 - 31.3)	18.5 (0.0 - 51.8)
15-17	11.5 (0.7 - 22.3)	8.6 (0.0 - 25.3)
18-24	11.0 (3.3 - 18.6)	65.7 (0.0 - 177.4)
25-39	3.5 (0.2 - 6.9)	0
40-59	6.3 (0.1 - 12.4)	0
60+	13.9 (3.2 - 24.6)	0
Total	38.9 (32.6 - 45.3)	29.3 (6.5 - 52.1)

*The event rate for infants and urban areas are very small, reporting very wide confidence interval

Drowning by distance of water body from households, type of water body, activity, seasonality and time of the day

Across all age categories about three quarters of fatal drowning events occurred within 100 metres of the households. However, among adolescents aged 15-17 years and adults aged 40 years and above over 20.0% of drowning deaths occurred at a distance of over two kilometres (data not shown).

The majority (98.0%) of drowning deaths took place in the community while less than 1.0% were related to disasters or while using water transportation. Over three-quarters of drowning deaths occurred in ponds and ditches (Figure 1a), and over half were in outdoor water bodies primarily used for bathing and washing (56.0%) (Figure 1b).

INSERT FIGURE 1

1
2
3 Drowning occurred throughout the year, however fatalities peaked during the monsoon season
4
5 particularly in the months of June and September which accounted for nearly one quarter (23.7%) of
6
7 all drowning deaths (Figure 2).
8
9

10 **INSERT FIGURE 2**

11
12
13 Almost all fatal drownings occurred between the daylight hours of 6 *a.m.* and 6 *p.m.* with two-thirds
14
15 (63.0%) taking place between the hours of 9 *a.m.* and 3 *p.m.* (Figure 3). Among children aged 1-4
16
17 years most fatal drownings occurred between the hours of 12 *p.m.* and 4 *p.m.* (58.0%) which was
18
19 followed by 8 *a.m.* to 12 *p.m.* (31.0%) (data not shown).
20
21
22

23 **INSERT FIGURE 3**

24 ***Person accompanying prior to drowning event***

25
26
27 Almost two-thirds (62.3%) of drowned individuals were not accompanied by anyone during the
28
29 drowning incident, while 15.0% were accompanied by a friend or colleague (data not shown).
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33 ***Individual involved in rescue***

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36 During fatal drownings, neighbours or bystanders (43.0%) were the individuals most often involved in
37
38 the rescue, followed by mothers (21.2%).
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42 ***Factors associated with fatal drowning***

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45 Univariate analyses for fatal drowning showed that children aged 1 to 4 years had three times higher
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47 odds of fatally drowning compared with those aged under one years. Similarly, households with four
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49 or more children had almost two times higher odds of experiencing a drowning fatality than
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51 households with one child. After adjustment, the factors that remained associated with fatal
52
53 drowning were age, with children aged 1 to 4 years at three times higher odds than those aged less
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55 than one year. Being male also significantly increased the odds of drowning fatalities by almost
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70.0%. The number of children in the household was also significantly associated with fatal drowning and increased with increasing number of children (Table 3).

Table 3. Socio-demographic factors associated with drowning mortality

Characteristic	Univariate				Multivariable			
	OR	LCL	UCL	p-value	OR	LCL	UCL	p-value
Sex								
Male	1.7	1.3	2.3	0.0004	1.7	1.2	2.3	0.0007
Female	reference				reference			
Age group (years)								
<1	reference				reference			
1-4	3.0	1.4	6.3	<.0001	3.0	1.4	6.4	<.0001
5-9	0.7	0.3	1.6	.	0.7	0.3	1.5	.
10-14	0.2	0.1	0.6	.	0.2	0.1	0.5	.
15-17	0.1	0.04	0.4	.	0.1	0.03	0.3	.
18-24	0.2	0.08	0.5	.	0.097	0.030	0.313	.
25-39	0.0	0.0	0.1	.	0.0	0.0	0.09	.
40-59	0.1	0.0	0.2	.	0.0	0.0	0.13	.
60 +	0.1	0.0	0.4	.	0.1	0.0	0.2	.
Maternal education								
None	1.9	0.4	8.2					
1 -5 years	2.8	0.7	11.4	0.3372	.	.	.	.
6-8 years	2.5	0.6	10.6	.	.	.	.	.
9-12 years	2.1	0.5	8.8	.	.	.	.	.
13-17 years	reference				reference			
Wealth quintile								
Q1 (Lowest)	1.5	0.9	2.5	0.5147	1.3	0.8	2.2	0.8396
Q2	1.2	0.6	2.2	.	1.1	0.6	2.0	.
Q3	1.3	0.8	2.1	.	1.2	0.7	1.9	.

Characteristic	Univariate				Multivariable			
	OR	LCL	UCL	p-value	OR	LCL	UCL	p-value
Q4	1.2	0.6	2.1	.	1.1	0.6	2.0	.
Q5 (Highest)	reference				reference			
No. of children in household*								
1 child	reference				reference			
2 children	0.9	0.6	1.4	0.6273	0.9	0.6	1.5	0.0026
3 children	1.0	0.6	1.5	.	1.2	0.8	1.8	.
4 children	1.3	0.8	2.1	.	1.8	1.1	2.9	.
5+ children	1.4	0.8	2.4	.	2.1	1.2	3.7	.

*Number of household with no children were very small to draw plausible inference

95% CI's

DISCUSSION

The mortality and morbidity reporting systems in Bangladesh are poor^[17]. To inform a large-scale drowning prevention strategy, we conducted a cross-sectional household survey to provide otherwise unavailable epidemiological data on drowning in the Barishal Division. Our study found a mortality rate from drowning of 37.9 per 100,000 per year across all ages in the Barishal division, which is more than three times greater than the national rate reported in 2016 (11.7/100,000/year)^[4]. The number of water bodies, including rivers, lakes, ponds and ditches in this division is far higher than in other parts of the country. For both males and females fatal drowning rates were high in infancy, and peaked at 1-4 years of age, then fell rapidly through middle childhood and adolescence and remained relatively low throughout adulthood. This pattern of fatal drowning rates across the age groups in this study is consistent with another recent national survey^[4].

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3 Previous studies identified nearby ponds, ditches, and canals as the most common location of fatal
4 drowning among children in Bangladesh^[3, 17-20]. In the Barishal region, most households are
5 surrounded by water bodies. Similar to previous studies, this study revealed that the majority of
6 childhood drowning deaths occurred in ponds, ditches and canals situated within only 100 metres of
7 their residences. Children were often with other siblings (children) or unaccompanied at the time of
8 drowning. Lack of supervision in younger children is a major risk factor. Attentiveness and continuity
9 are essential characteristics of the hierarchical model of supervision^[21]. Proximity to the water
10 exacerbates risk, however, among adults a considerable proportion of drowning fatalities occurred
11 at a distance of two kilometres from their houses. It is possible that these deaths occurred in rivers
12 where individuals were engaged in activities such as fishing or boating.
13
14

15
16 Drowning deaths in Barishal occurred year-round but most frequently during the monsoon season
17 (June to October); this is similar to findings reported in prior studies^[18, 22-24]. It is also notable that in
18 the dry season (November-December) the fatal drowning rates remained relatively high in Barishal.
19 This is likely because most natural water bodies including those close to households are tidal and are
20 subject to two high tides each day. This can increase the risk of exposure especially among children
21 playing in water bodies. Previous studies, have also reported over 90% of fatal drowning events
22 occurred in daylight hours^[17, 25].
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26 Fatal drowning was strongly and significantly associated with sex with males having over 1.5 times
27 the odds of death from drowning. This may be related to male's greater propensity for risk taking
28 behaviours and increased exposure to high risk situations^[26]. It may also reflect existing traditional
29 gender roles in Bangladesh with young boys more likely to be out playing unsupervised whereas girls
30 would be at home helping with household activities. This points to the need to place specific
31 emphasis on targeting boys within drowning prevention programs. Age was also significantly related
32 to fatal drowning with those in the age group of 1-4 years having the greatest risk of drowning. This
33 age group has consistently been found to be at greater risk of drowning in Bangladesh and other
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3 South-East Asian and Western Pacific countries^[2, 18, 27] and may be related to challenges to achieve
4 adult supervision, the inability to swim in this age group and other behavioural factors^[18]. We did not
5 find any significant association between the level of mother's education and fatal drowning risk. The
6 socio-economic status of our study population was fairly homogenous and no associations were
7 reported across the socio-economic groups. A higher number of children in the household, increased
8 the risk of drowning events. Households with four or five children in the family were common place.
9 In these circumstances parents may find it difficult to adequately supervise all of them. These
10 findings support the need for programmes that can assist families with supervision.
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25 **STRENGTHS AND LIMITATIONS OF THE STUDY**

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27 The study was strengthened by steps taken to ensure the data quality of data. Field supervisors were
28 recruited and trained, and they observed 10.0% of interviews conducted by the data collectors. They
29 also checked 10.0% of the collected data, and re-interviewed 2.0% of the households. In addition,
30 field level research officers and managers were appointed to re-check all data for inconsistencies. If
31 inconsistency was detected, the respective data collector was asked to revisit the household to
32 collect correct information.
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41 Another strength was that the study used external cause codes of fatal drowning from the ICD – 10
42 that provided a more representative data on the true burden of fatal drowning. In addition to
43 unintentional external cause of drowning codes, watercraft and flood related drowning, and
44 intentional self-harm by drowning codes were also included. Studies have suggested to include these
45 later codes (drowning from watercraft, flood related and intentional self-harm) to obtain more
46 representative magnitude of fatal drowning ^[28, 29]. Intentional drownings particularly suicides are
47 culturally stigmatised in Bangladesh. Household surveys thus are not the best source of data for
48 determining intent of drowning. However, given the high burden among children, intent has little
49 implications on the study findings.
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6 Given that the mortality burden is highest in children aged under five years, it should be noted that
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8 under-reporting in overall mortality rates is an issue in this age group because of poor birth /vital
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10 registration systems, so our results may have under-estimated the true burden. This is likely to affect
11
12 data on children aged under-one year to a greater extent. However, given that a two-year recall
13
14 period was used in this survey, the fatal drowning rates are likely to be conservative. Although the
15
16 proportion of refusals was small (2%), collecting data on reasons for non-participation could have
17
18 added to the strength of the study.
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20

21
22 One of the major challenges in this study was to use the electronic data capturing system with an
23
24 intent to review and manage data as the survey progressed. Each data collector was given a tablet
25
26 loaded with REDCap application, and a sim was inserted in the device to obtain wireless internet
27
28 connection. However, in the remote locations the internet connectivity was very poor and initially
29
30 the data collectors could not upload their collected data from the site of data collection. To resolve
31
32 this issue, an offline data collection system was created in the software. Each day after data
33
34 collection in the afternoon the data collectors returned to their field office to get a high quality Wifi
35
36 connection to upload their data. To the best of our knowledge, this is the first survey using an offline
37
38 application for electronic data capture (Redcap), in the region. The survey was huge with over 250
39
40 variables collecting information on multiple drowning events in each household. With English and
41
42 Bangla translations, the screen size of a hand held Android device posed challenge for accuracy in
43
44 data entry, which was mitigated by division of the survey into multiple sections/tools and optimising
45
46 the font size. Bi-lingual presentation was essential, as statistical programmes are primarily
47
48 compatible with English, only.
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54 The environmental context presented issues that needed consideration, for example access to
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56 electricity for charging of devices, access to internet or recharging the power banks. Some of these
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58 learnings that have since led to enhanced features within the Redcap application including:
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3 synchronising of auto-generated identification on an offline application, preventing data loss or the
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5 duplication of data. It was due to the success of using electronic data capture and utilising internal
6
7 validity checks that the high quality and completeness of the dataset was achieved.
8
9

10 The survey was purposively conducted in Barishal division which is one of the eight divisions of
11
12 Bangladesh. In previous national injury surveys the highest drowning mortality rate among children
13
14 was observed in the Pirojpur district of Barishal division^[3]. Considering this high rate the Barishal
15
16 division was selected for Project Bhasa.
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18

19 20 **CONCLUSION**

21
22 The study findings highlight the very high magnitude of drowning deaths in the Barishal division.
23
24 Socio-demographic factors including being male, aged 1-4 years and having five or more children in
25
26 households was associated with increased risk of fatal drowning. The findings further demonstrate
27
28 that drowning is predominantly a problem that affects children in Bangladesh. The Barishal division
29
30 demands urgent interventions targeted at high risk groups identified here. Project Bhasa aims to
31
32 provide evidence-based interventions, including community day-care for under-five children to
33
34 ensure adult supervision during day time and the provision of swimming instruction and school
35
36 water safety education to children aged five years and over, to reduce drowning. It is expected that
37
38 the project will generate knowledge to assist with drowning reduction efforts both nationally and in
39
40 other similar settings.
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51
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53
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59
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1
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5 to thank Steve Wills and Ashim Kumar Saha for their contribution during data collection.
6
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8
9

10 11 **CONTRIBUTORS**

12
13
14 AR participated in the design, implementation and supervision of field work and analysis and wrote
15 the paper. JJ contributed on project design, data analysis and writing of the paper. KB and MJH
16 contributed on project design, implementation, Data management and supervision of field work and
17 writing of the paper. DR contributed on project design and writing of the paper. TA and KR were
18 involved in data management and analysis and contributed to write the paper. RI and FR conceived
19 the study and supervised throughout and contributed to the writing of the paper. RI and FR are the
20 guarantors.
21
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25

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30 this paper, Dan Ryan, works for the RNLI. He contributed in designing the study and was also
31 involved in writing the manuscript.
32
33
34
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36 37 **COMPETING INTERESTS**

38
39 Competing interests or state 'None declared': None declared.
40
41

42 43 **ETHICAL APPROVAL**

44
45 Obtained
46
47

48 49 **PROVENANCE AND PEER REVIEW**

50
51 Not commissioned; externally peer reviewed.
52
53

54 55 **DATA SHARING STATEMENT**

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57 We have de-identified data which are available at Centre for Injury Prevention and Research,
58 Bangladesh and The George Institute for Global Health. This was the baseline survey data generated
59
60

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3 from BHASA project which is a collaborative work of Royal National Lifeboat Institution, Centre for
4 Injury Prevention and Research, Bangladesh and The George Institute for Global Health. Royal
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6
7
8 have rights to use the data. Data are available upon request to Dr Aminur Rahman
9
10
11 (aminur@ciprb.org) and Dr. Jagnoor Jagnoor (jjagnoor@georgeinstitute.org.au).
12
13
14

15 Figure 1: *Distribution of fatal drowning by type of water bodies (1a) and their use (1b)*

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18 Figure 2: *Distribution of fatal drowning by time of the year in Barishal Division, Bangladesh*

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21 Figure 3: *Distribution of fatal drowning by time of the day in Barishal Division, Bangladesh*
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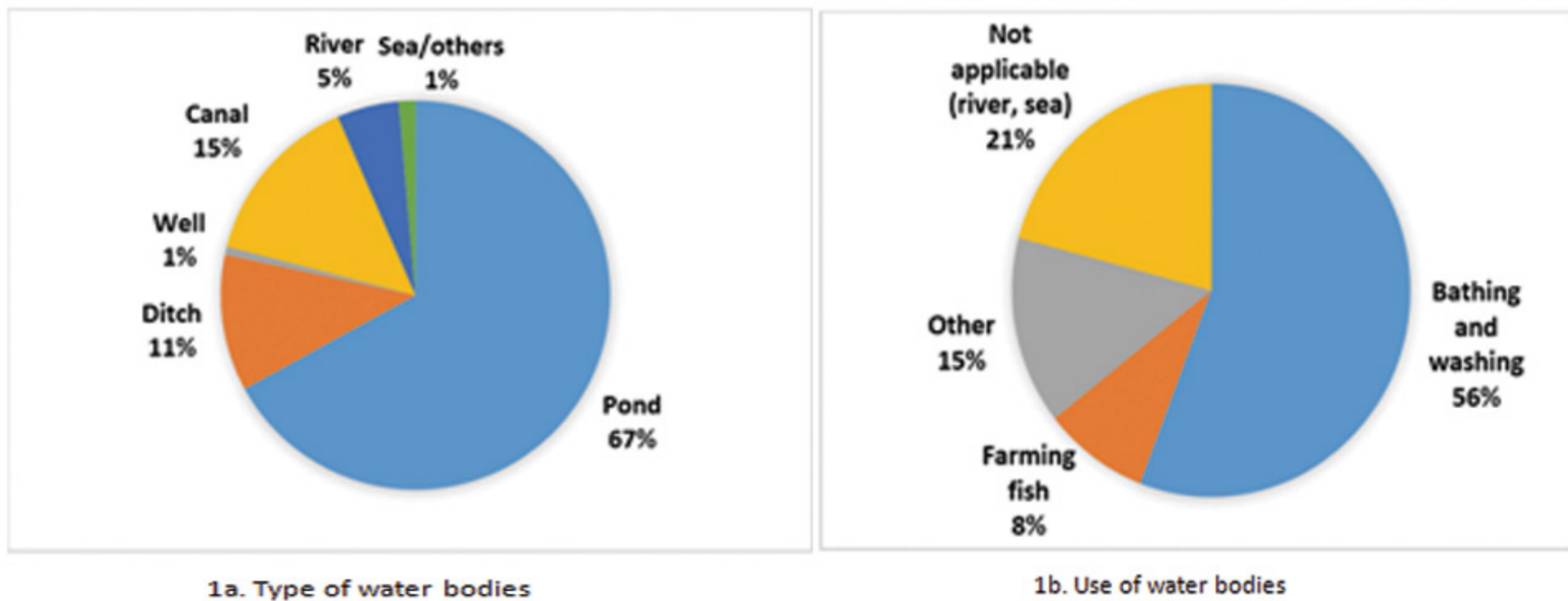


Figure 1: Distribution of fatal drowning by type of water bodies (1a) and their use (1b)

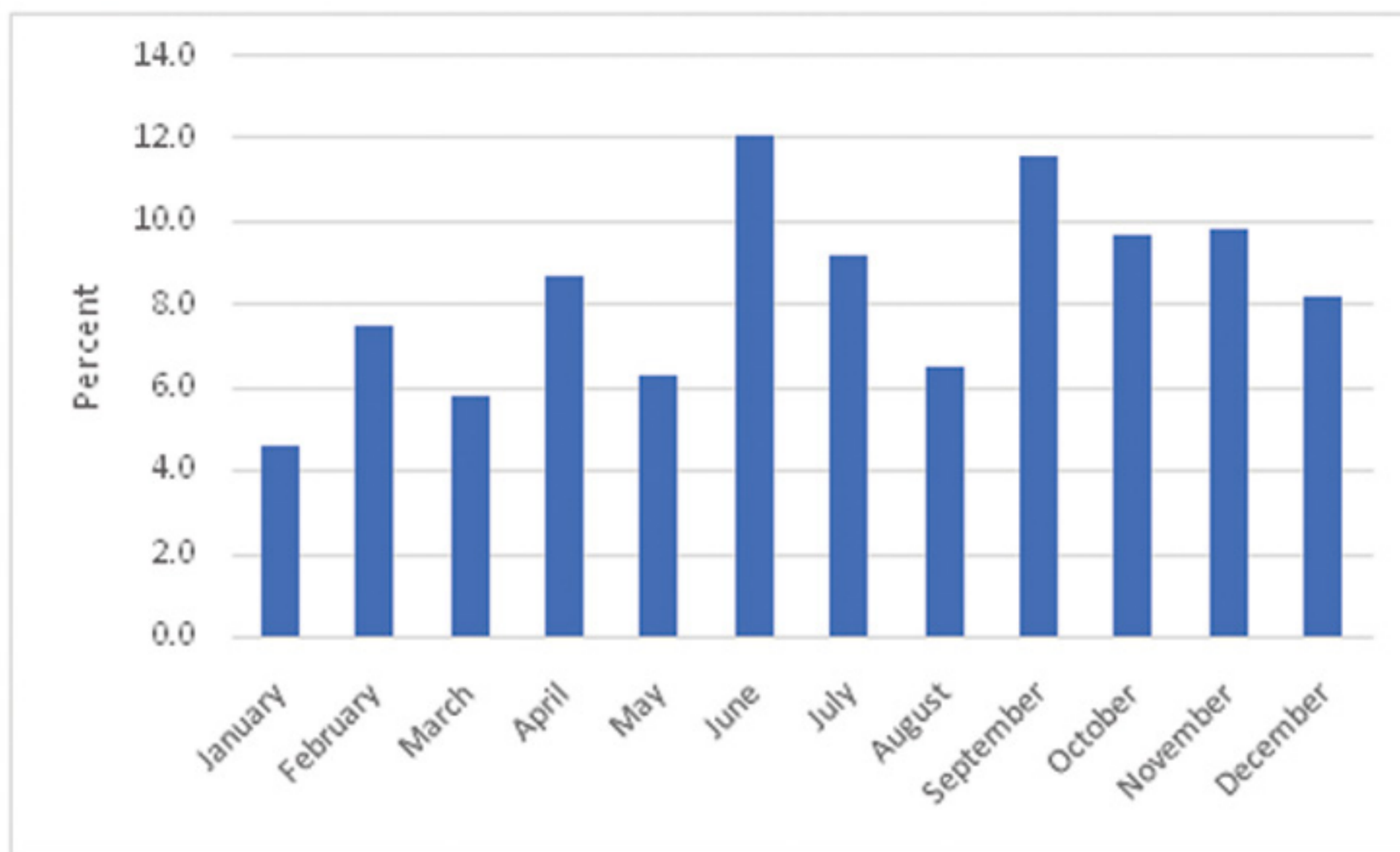


Figure 2. Distribution of fatal drowning by time of the year in Barishal Division, Bangladesh

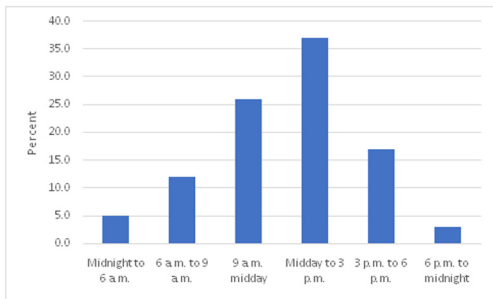


Figure 3. Distribution of fatal drowning by time of the day in Barishal Division, Bangladesh

STROBE Statement

Vulnerability to fatal drowning among the population in Southern Bangladesh: findings from a cross-sectional household survey

	Item No	Recommendation	Page and Line Number(s)
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	P2, L13
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	P2, L13-38
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	P5, L3-23
Objectives	3	State specific objectives, including any pre-specified hypotheses	P5, L15-22
Methods			
Study design	4	Present key elements of study design early in the paper	P5, L36-45
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	P5, L36-41
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	P5, L40-43 P6, L39-43
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	P6, L3-31
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	P5, L51-54 P6, L37-38
Bias	9	Describe any efforts to address potential sources of bias	P6, L57-60
Study size	10	Explain how the study size was arrived at	P5, L40-45
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	P7, L12-21
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	P7, L12-21
		(b) Describe any methods used to examine subgroups and interactions	P7, L3-8
		(c) Explain how missing data were addressed	P6, L44-47 P7, L22
		(d) If applicable, describe analytical methods taking account of sampling strategy	P7, L12-17
		(e) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	P7, L45-55
		(b) Give reasons for non-participation at each stage	Not provided, less than 5%
		(c) Consider use of a flow diagram	N/A

Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	P7, L47-53
		(b) Indicate number of participants with missing data for each variable of interest	P7, L21-22
Outcome data	15*	Report numbers of outcome events or summary measures	P7, L52-55
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	P8, L31-56
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	P9, L11-3- P9, L32-49 P9, L54-59 P10, L6-13 P10, L21-29 P10, L34-50 P11, L7-50
Discussion			
Key results	18	Summarise key results with reference to study objectives	P12, 9-30
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	P14, L10-20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P13, L17-51
Generalisability	21	Discuss the generalisability (external validity) of the study results	P14, L47-52
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	P15, L43

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.