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A Community Based Child Drowning Prevention Programme in Bangladesh: a model for low income countries

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ABSTRACT

Background: Drowning is a global public health problem of children. Children of low- and middle-income countries are the most susceptible victims. Prevention measures implemented in high-income countries have effectively reduced drowning. However, in low- and middle-income countries, due to a severe lack of information, drowning has not been recognized as a child survival issue. Moreover, prevention efforts remain non-existent as there is no proven effective measure applicable for these countries, including Bangladesh.

Objectives: The objectives of the research activities were to determine the current child drowning situation and risk-factors in rural areas of Bangladesh (Paper I); to understand the community perception of drowning problems and the possible solutions for designing a preventive programme in the rural area of Bangladesh (Paper II); to develop, pilot and assess initial community response to an intervention package in terms of acceptability, feasibility and sustainability (Paper III) and to evaluate the package for its effectiveness (Paper IV).

Methods: A cross sectional survey and a case-control study were conducted to determine the magnitude and identify risk-factors of child drowning respectively (Paper I). Community perception on drowning prevention was explored by using a qualitative method (Paper II). Intervention measures were identified through workshops with the relevant stakeholders. Utilizing qualitative methods community acceptability, feasibility and sustainability of the intervention package were initially assessed (Paper III). A quasi-experimental design was used to evaluate the effectiveness of the intervention package (Paper IV). Two sub-districts were selected each having a population of 200,000. One was allocated as an intervention area and the other as a comparison area. Quantitative data was collected through structured pre-tested questionnaires and the qualitative data was gathered through Focus Group Discussions (FDGs) and in-depth interviews.

Results: The drowning rate of Bangladeshi rural children aged 1-4 years was found to be 156.4 per 100,000 (95% CI 138.5 - 176.6 per 100,000). The proportional mortality due to drowning in the children was about 28.0 percent. Natural water bodies were the most frequent places of drowning, and over 40 percent occurred in ponds. The child's sex, mother's age and literacy, family income and ownership of agricultural land by the families were identified as risk factors (Paper I).

Community people wrongly perceive that children 5 - 10 years are at the greatest risk of drowning. Participants of the FGDs, parents, adolescents and community leaders, knew the common causes of drowning and were able to mention a few preventive measures. However, they do not act on this knowledge (Paper II).

Increased supervision of children through the creation of drowning-safe homes and the establishment of community crèches, raising water safety awareness, and educating the community on first response skills were the three core aspects identified through workshops to include in the intervention package. Qualitative study revealed that these measures are accepted by the community, feasible and sustainable (Paper III).

After three years of implementation of the intervention package the evaluation showed that 36 percent of households became drowning safe and through 100 community crèches 2,680 children aged 1-4 years were kept safe under direct supervision. Nearly all the population of the intervention area were reached through various behaviour change communication materials. In the intervention area fatal drowning rate declined from 120.8 to 53.7 per 100,000; however, in the comparison area the rate remained the same in the base-line and the end-line data (Paper IV).

Conclusion: Drowning is one of the major survival issues among children aged 1-4 years in rural Bangladesh. The intervention model developed through these research activities was found to be effective in reducing child drowning. Improved supervision, creating a heightened water safety culture of the community and utilizing low cost locally available resources are the fundamental intervention strategies identified in reducing child drowning in rural Bangladesh. This model is developed in such a way that it could be applicable in similar low-income settings.

Key words: Child drowning, prevention, rural, Bangladesh, low-income countries.

LIST OF PUBLICATIONS

This thesis is based on the following papers:

- I. Rahman A, Giashuddin SM, Svanström L, Rahman F. Drowning - a major but neglected child health problem in rural Bangladesh: implications for low income countries. *International Journal of Injury Control and Safety Promotion* 2006; 13(2): 101 - 105.
- II. Rahman A, Shafinaz S, Linnan M, Rahman F. Community perception of childhood drowning and its prevention measures in rural Bangladesh: a qualitative study. *Australian Journal of Rural Health* 2008, 16: 176 - 180.
- III. Rahman A, Miah AH, Mashreky SR, Shafinaz S, Linnan M, Rahman F. Initial community response to a childhood drowning prevention programme in a rural setting in Bangladesh. *Injury Prevention* 2010; 16: 21-25.
- IV. Rahman A, Mashrekey SR, Shafinaz S, Linnan M, Svanström L, Rahman F. Prevention of drowning among children 1-4 years in a low resource setting: a community trial in Bangladesh. 2010 (Manuscript ready for submission)

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LIST OF ABBREVIATIONS

ARI □	Acute Respiratory Infection
BHIS □	Bangladesh Health and Injury Survey
CDD□	Control of Diarrhoeal Diseases
CI □	Confidence interval
CIPRB □	Centre for Injury Prevention and Research, Bangladesh
CPR □	Cardiopulmonary resuscitation
EPI □	Expanded Programme on Immunization
FGD □	Focus group discussion
GBD □	Global Burden of Disease
HIV □	Human Immuno-deficiency Virus
ICMH □	Institute of Child and Mother Health
MDGs □	Millennium Development Goals
NNP □	National Nutrition Programme
OR □	Odds ratio
PFD □	Personal flotation device
TASC □	The Alliance for Safe Children
UNICEF □	United Nations Children's Fund
WHO □	World Health Organization

*Dedicated to the children of the world
who needlessly die of drowning
due to our carelessness*

1. INTRODUCTION

Drowning is a major, but often neglected, public health problem. The first Global Burden of Disease (GBD) study conducted by the World Bank and WHO in the 1990s showed that, worldwide, drowning is one of the most common causes of death. The study found that death by drowning (504,000) was more common than death through war (502,000) or HIV infection (312,000) (van Beeck *et al.*, 2005). The recent GBD study data reveals global mortality from drowning to be 6.8 per 100,000 person-years. Drowning affects all age groups, but over half of the global mortality occurs among children less than 15 years of age, and children 1-4 years appear at the greatest risk. Furthermore, 98.1% of all deaths from drowning occur in low- and middle-income countries (Peden *et al.*, 2008).

In the eastern and south-eastern regions of the world, more children die annually from drowning than from pertussis, measles, diphtheria, plague, cholera, dengue fever and typhoid fever combined (UNICEF/TASC, 2004)

In high-income countries, various drowning prevention measures including pool fencing (Fergusson and Horwood, 1984; Pitt and Baland, 1991; Present, 1987), pool fencing legislation (Morgenstern, Bingham & Reza, 2000; Morrison *et al.*, 1999) parent education (Coffman, 1991), close supervision of young children (Lassman, 2002) use of personal flotation devices (Treser, Trusty and Yang, 1997; CDC, 2001; Jones, 1999), cardiopulmonary resuscitation (Am Acad Ped, 1993) and swimming instruction (Asher *et al.*, 1995; Tan, 2004) have been advocated.

However, prevention efforts in low- and middle-income countries including Bangladesh are almost non-existent. As for other injuries, the prevention of drowning requires an adequate knowledge of its epidemiological characteristics, associated risk factors and information on effective interventions. There is a lack of information on the magnitude and risk factors of drowning and as a result child drowning is not yet recognized by policy makers as a major cause of child mortality in these countries.

Moreover, there are no proven effective measures applicable for low- and middle-income country settings. Furthermore, as there are marked differences in environmental, cultural and socio-economic aspects, the proven measures of high income countries may not be feasible to implement in a low- or middle-income country setting like Bangladesh.

This thesis seeks to contribute an effective model of drowning prevention programme for children 1-4 years of age in rural Bangladesh, which may be applied to similar settings by exploring drowning epidemiology, risk factors and people's perception of prevention and applying the information in designing, implementing and evaluating the prevention package.

2. BACKGROUND

Drowning refers to the *process of experiencing respiratory impairment from submersion or immersion in liquid*. This definition is one agreed upon by experts at a recent "World Congress on Drowning", which was held in Amsterdam in 2002. The definition is simple and comprehensive, encompassing cases that result in death, a certain level of morbidity or no morbidity (van Beeck EF *et al.*, 2005). In this thesis we dealt with fatal drowning.

2.1 Incidence of Fatal Child Drowning

According to the WHO GBD estimates, 175,000 children and youth under the age of 20 years died in 2004 as a result of drowning around the world (WHO, 2008). Fatal drowning ranked 13th as the overall cause of death among children under 15 years old, with the 1-4 year age group appearing at the greatest risk. The overall global rate for drowning among children is 7.2 deaths per 100,000 population, though with significant regional variations. The overwhelming majority, 98 percent, of these child drowning deaths, occurred in low- and middle-income countries. The fatal drowning rate in these countries is six times higher than that of high-income countries; 7.8 per 100,000 and 1.2 per 100,000 respectively (Peden *et al.*, 2008).

A large degree of variation of drowning incidence is observed between and within regions and also within countries, given the different geography and populations. In the under 20 year-old population the highest rate (13.9 per 100,000 population) of fatal drowning occurs in the low- and middle-income countries of the WHO Western Pacific Region, followed by the African Region, the low- and middle-income countries of Eastern Mediterranean Region and the South-East Asia Region where the rates are 7.2, 6.8 and 6.2 per 100,000 population respectively (WHO, 2008).

2.2 Risk Factors for Child Drowning

Identifying the risk factors that lead to drowning is essential for developing targeted, efficient prevention strategies (Spzilman, 1997). Through literature review the following socio-demographic, environmental and behavioral factors have been identified in an attempt to facilitate critical review and to enable more effective implementation.

2.2.1 Age

Although drowning-related mortality occurs in all age groups, several studies suggest that children aged 1 - 4 years are at the highest risk of drowning (Coffman, 1991; MacKellar, 1995; Smith, 1995; Cass *et al.*, 1996; Fingerhut *et al.*, 1996). In Los Angeles County, Washington in the USA and Australia, higher drowning rates were noticed in children aged 1 - 4 years and the rates were 3.6, 3.0, 4.6 per 100,000 per children-year respectively (Mackie, 1999, Morgenstern *et al.*, 2000, Quan and Cummings, 2003). A review of child deaths from the United Arab Emirates revealed that drowning was the second leading cause of death (Bener *et al.*, 1998). Mortality rates from drowning for children less than 5 years are found to be the highest in China, followed by Sub-Saharan Africa (Sethi and Zwi, 1998). In a small-scale study conducted in 1999 at Matlab, a rural community in Bangladesh, the rate of drowning in children 1-4 years was found to be 200 per 100,000 children per year (Ahmed *et al.*, 1999).

In both high- and low-income countries when a single year of age was considered 1-year olds have peak rate followed by 2 year-olds, with rates falling rapidly as children get older. (Cass *et al.*, 1991; Blum and Shield, 2000; Rahman *et al.*, 2009).

2.2.2 Gender

Regarding gender distribution, several studies of both developed and developing countries including Bangladesh, suggest that the rate of drowning for boys exceeds the rate for girls (Mizuta *et al.*, 1993; Warneke and Cooper, 1994; Ahmed *et al.*, 1999; Peden *et al.*, 2008).

2.2.3 Place of drowning

All around the world, drowning in the home, family garden or its surroundings has become a leading cause of unintentional death among children under the age of 5 years. The sites of such incidents include family-owned swimming pools, the family bathtub, buckets and pails, fish ponds and ornamental pools (Pearn and Calabria, 2006). In the developed world 1-4 year-old children mostly drown in the recreational swimming pool (Kemp and Sibert, 1992; Stevenson *et al.*, 2003; Fenner, 2000; Riley *et al.*, 1996; Warneke and Cooper, 1994) where as in the poorer communities drowning occurs in natural water bodies including ponds, rivers, lakes and dams (Ahmed *et al.*, 1999; Matzopoulos, 2001) near the home.

2.2.4 Child supervision status

Studies have found that most childhood drownings occur in 1-4-year-old children when they are not supervised by adults (Coffman, 1991; Warneke and Cooper, 1994; Lee and Thompson, 2007). A Bangladeshi study supports the finding that lack of adequate supervision is strongly associated with drowning (Rahman *et al.*, 2009).

2.2.5 Socio-economic status indicators

The Global Burden of Disease 2004 update, revealed that the fatal drowning incidence among children aged 1-4 years was five folds more in low- and middle-income countries than in high-income countries (WHO, 2008). Even within high-income countries there were discrepancies in fatal drowning rates between population subgroups. For example, in the United States and the Netherlands the drowning incidence was higher among the ethnic minorities than the native populations (Karr *et al.*, 2005; Saluja *et al.*, 2006). Several studies found that the children of families with less educated mothers or caregivers were more vulnerable to drowning. (Barss *et al.*, 1998; Celis, 1997).

2.2.6 Seasonal variation

Although drowning occurs throughout the year, some seasonal patterns can be observed, which vary from region to region. For example in China, Singapore and Australia most of the drownings occur during summer (Ma *et al.*, 2008; Tan, 2004; Blum and Shield, 2000). Ahmed *et al.* (1999) found that April through to September are the high-risk months of drowning in Bangladesh. These months cover both the summer and the monsoon seasons.

2.3 Interventions

After reviewing a range of literature the following categories of interventions were identified. Most of these were implemented in high-income countries.

2.3.1 Environmental measures

Pool fencing

The term 'fencing' means installation of barriers around a water body intended to prevent a child having access to a body of water. It is suggested that pool fencing should be at least 1.22 metres high, with a vertical opening between bars of less than 10.2 cms wide and with a self-

installation of fencing be at least 1.52 metres high (Logan *et al.*, 1998). Only a few of the studies were evaluated to measure the effectiveness of pool fencing in reducing the risk of childhood drownings, which are summarised in Table 1.

Table 1: Evaluation of different types of pool fencing

Authors	Type of study	Intervention strategy	Outcome/Findings
1. Þergusson <i>et al.</i> , 1984	Case-control study	Pool fencing vs. no fencing	Risk of drowning in fenced pool is significantly lower than unfenced pool OR range = 0.21 - 0.48 Reduction of risk of drowning in domestic pools by 40% to 67%
2. Pitt <i>et al.</i> , 1991	Case-control study	Pool fencing (isolated, three-sided, none)	The risk of a drowning or near-drowning involving unintended access to an unfenced pool is 3.76 times higher than the risk associated with a fenced pool (RR 95% CI 2.14- 6.62).
3. Present, 1987	Case-control study	Isolation fencing vs. three-sided fencing (access from house or no fencing)	Logistic regression showed a non-significant, negative relationship between isolation fencing and drowning
4. Intergovernmental □ working Party on swimming □ pool safety, Australia, 1988	Case-control study	Perimeter fencing vs. isolation fencing	Significantly decreased risk of drowning in isolation-fenced pool compared to perimeter-fenced pool (OR=0.16, 95% CI 0.05-0.49); AR%=0.84

Covering wells

Covering wells or open barrels with grills, creating an embankment or fenced barrier near ponds and riverbanks, and building a flood-control embankment, are all effective in preventing drowning (Celis, 1997; Myaux *et al.*, 1997).

2.3.2 Engineering measures

Pool alarms

Pool alarms provide warning that the water surface has been disturbed (e.g. by a toddler falling in), either by detection of waves on the surface or by motion beneath the surface. A study evaluated that surface pool alarms were the most consistent and most reliably detected the weight of a "child like object" entering the pool. However, it was suggested that pool alarms can supplement, but are not a substitute, for supervision or barriers completely surrounding pools (Whitefield, 2000).

2.3.3 Legislations

The results from three ecological studies support the beneficial effect of pool-fencing legislation: (a) a comparison between two cities - Honolulu and Brisbane - with and without pool fencing legislation (Pearn *et al.*, 1979); (b) a comparison between two communities in northern Australia with and without pool-fencing legislation (Milliner *et al.*, 1980); (c) a comparison of King County, Washington, USA, before and after enactment of a pool-fencing ordinance (Quan *et al.*, 1989). A survey from New Zealand, however, revealed that due to ambiguities within the legislation and differing levels of commitment by authorities to locate pools and monitor compliance, compliance with the Fencing of Swimming Pool (FOSP) Act was not consistent in New Zealand. Pool-owner resistance was considered the main difficulty in enforcing the act (Morrison *et al.*, 1999).

2.3.4 Personal protection

Personal flotation devices (PFDs)

The use of personal flotation devices (PFDs), also known as life jackets or life vests, has been suggested as a method of reducing drowning mortality and morbidity in children when boating or playing beside streams, rivers, or lakes (National Committee for Injury Prevention and Control, 1989; Seattle King County Department of Public Health, 1991; Washington State Department of Health, 1994). In Sweden, increasing the availability of life vests at water sites was one component of a programme that decreased drowning among children (Bergman and Rivara, 1991).

2.3.5 Education, Supervision and Skills

Parent education

The education of parents is a key variable in drowning prevention. Knowledge about water safety is centered around three important concepts: (a) supervision, (b) barriers, and (c) emergency procedures. We were not able to find any study carried out to evaluate the effectiveness of parent education. Nevertheless, the pediatric nurse (health nurse or nurse visitor) plays an invaluable role in educating parents about these concepts and in increasing parental awareness of safety risks (Coffman, 1991).

Close supervision

Numerous studies have shown that inadequate supervision is an important contributory factor for paediatric drowning (Coffman, 1991; Warneke and Cooper, 1994; Lee and Thompson, 2007; Rahman *et al.*, 2009). However, the effectiveness of supervision as a drowning prevention measure has not been formally evaluated (Peden *et al.*, 2008).

Teaching swimming skills

The role of equipping children with swimming ability to reduce the risk of drowning has been a focus of Asher *et al.* (1995) and Brenner *et al.* (2003); both groups highlight that children should receive swimming lessons from instructors. The American Academy of Pediatrics, however, does not endorse swimming instruction for infants and toddlers, perhaps, because children at this age lack judgment in rescuing themselves (Am Acad of Ped, 1993).

Cardiopulmonary resuscitation (CPR)

Once an immersion injury has occurred, performing CPR at the incident site, with a rapid reestablishment of effective oxygenation and ventilation with speedy transportation of severely compromised children to paediatric critical care centres should improve the outcome. The CPR should be started immediately upon recovery from the water reservoir. Every second counts and the brain cannot be sustained without oxygen for longer than four minutes (Am Acad of Ped, 1993). Studies have shown that children who received immediate resuscitation from bystanders - before the arrival of medical personnel - have improved outcomes (Kyriacou *et al.*, 1994; Wigginton, 2002).

2.4 Rationale of Studies

Drowning has been identified as a major killer of children both in developed and developing countries (WHO, 2008). In high income countries various prevention measures have been proven effective and are in place (Am Acad Ped, 1993; Fergusson and Horwood, 1984; Morgenstern *et al.*, 2000; Coffman, 1991; Asher *et al.*, 1995).

However, in low- and middle-income countries, including Bangladesh, the epidemiology and risk factors for child drowning are not clearly known. For example, in Bangladesh there are only a few small scale studies on the magnitude and risk factors of drowning, which show the high incidence of child drowning, however, this data does not represent the whole country. As a result policy planners have failed to recognize it as a public health problem and have not paid the required attention to its prevention. As a result, prevention efforts in Bangladesh, as in other low- and middle-income countries, are almost non-existent. Moreover, there is no successful model for transferring effective interventions from high income countries to a low- and middle-income country setting like Bangladesh (Rahman *et al.*, 2009).

There is great diversity in the circumstances in which drowning occurs in these different areas. Whereas swimming pools, sailing, and water sports may be priority areas in high-income countries, in low- and middle-income countries attention must need to be paid to drowning in ponds, lakes, wells, dams, cisterns, and while fishing. Clearly there are a huge range of different environmental and behavioral circumstances. The obvious intervention to keep the child who cannot swim away from water must have a different interpretation in the different regions. Although swimming pools can be fenced in high-income countries, the fencing of waterways and water reservoirs would be impractical in countries where these run for hundreds of kilometers, particularly in a rural Bangladesh, where villages are usually surrounded and intersected by canals and rivers and there are numerous ponds surrounding households.

This is not to say that there are no common approaches. Education about the risks, closer supervision, and training in resuscitation are important first steps which could be applied globally. Data on good practice needs to be collated so that appropriate interventions, which are transferable to other low- and middle-income countries can be easily identified. Whatever the intervention there is an urgent need to get drowning higher on the agenda for policy makers and researchers (Sethi and Zwi, 1998).

Considering this it is essential to formulate effective interventions for child drowning in low income settings like Bangladesh. In order to do that it is important to determine the magnitude of child drowning mortality and its risk-factors and also explore community perception on drowning prevention. Based on this evidence and also reviewing the successful interventions of the developed world, intervention measures are needed to be developed according to the need, acceptability and feasibility of the country's context. These then need to be piloted and evaluated to determine the effectiveness of the interventions in order to create evidence that child drowning is preventable even in low-income country settings including Bangladesh.

3. OBJECTIVES

3.1 General Objectives

The general objectives of the study were

- to design a community based drowning prevention package for 1-4 year old children in rural areas of Bangladesh
- to evaluate the programme in terms of community acceptability, feasibility, sustainability and effectiveness.

3.2 Specific Objectives

The specific objectives were

- to determine 1-4 year child drowning situation and risk-factors inherent in the rural areas of Bangladesh (Paper I)
- to understand community perception of drowning problems and its possible implications for designing a preventive programme at rural area of Bangladesh (Paper II)
- to develop, pilot and assess the community's initial response to an intervention package in terms of acceptability, feasibility and sustainability (Paper III)
- to evaluate the package for its effectiveness (Paper IV)

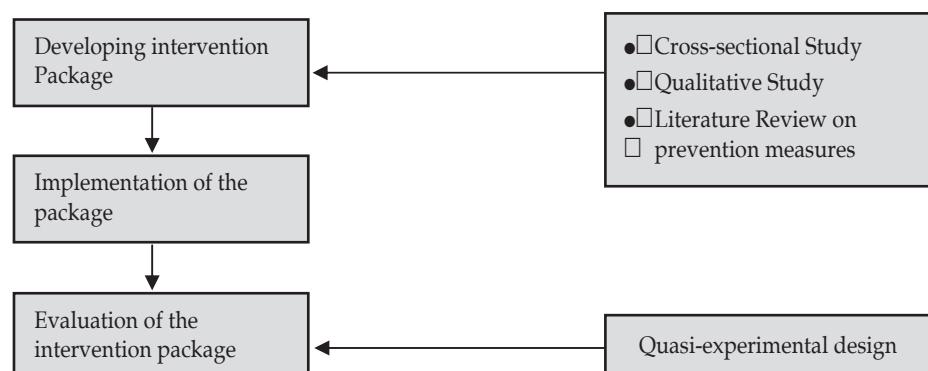
4. MATERIALS & METHODS

The thesis comprises of four studies. We utilized both quantitative and qualitative methods as required for the individual study to achieve the desired objectives. The outcome of the interventions was measured by collecting quantitative data using a structured questionnaire. To collect qualitative data focus group discussions (FGDs) and in-depth interviews with key informants were conducted. An intervention package was developed through a series of workshops with the professionals and stakeholders utilizing data gathered from a cross-sectional survey (Paper I), a qualitative study (Paper II) and literature review. The intervention package was piloted and assessed for community acceptability, feasibility and sustainability, utilizing qualitative methods (Paper III). We used the quasi-experimental design to evaluate the effectiveness of the intervention package after 36 months of implementation in a rural community of Bangladesh (Paper IV).

Table 2. Summary of each study design and data collection techniques

Papers □	Objectives □	Study design □	Data collection technique
<i>Paper I</i>	To determine fatal child drowning situation and risk-factors	Cross-sectional and case-control study	Household survey using structured questionnaires by face-to-face interview
<i>Paper II</i>	To explore community perception on child drowning and its prevention	Qualitative study	FGD
<i>Paper III</i>	To develop and initial assessment of a child drowning prevention package	Workshops and Qualitative study	FGD and in-depth interview
<i>Paper IV</i>	To evaluate the prevention package for its effectiveness	Quasi-experimental study	Surveillance and household survey using structured questionnaire by face-to-face interview

4.1 Framework of the Thesis



4.2 Data Collection

Paper I

Hypothesis

Drowning is a major public health problem of children aged 1-4 years in Bangladesh.

Study design and population

A cross-sectional survey was carried out to estimate the drowning magnitude of 1 - 4 year old children in rural Bangladesh. Moreover, a case - control study was designed to identify the risk factors associated with drowning.

Sample size

By multistage cluster sampling 108,827 households were identified where the total population of 1 - 4 year old children was 51,147.

Sampling procedure

The households were selected from 12 randomly selected upazilas (sub-districts, smallest administrative units of the country, and each comprising about 200,000 to 300,000 population) of the six divisions of the country.

From each upazila, two unions were again randomly chosen. Each union comprised of 20,000 to 50,000 population. All households of the selected unions were included in the study. A screening of 1 - 4 year child deaths in the preceding 5 years was conducted first. All deaths were further investigated to identify drowning deaths. All drowning deaths identified in this process were recruited as cases and for each case two living children aged 1 - 4 years were selected from the same localities as controls.

Research instruments

To record 1-4 year old child deaths a screening form was used. When a drowning case was identified a pre-tested questionnaire was used to collect information related to the drowning death, e.g. time and place of drowning, activities of children prior to drowning, activities of mothers at the time of drowning. Moreover, socio-economic, demographic and environmental data of the deceased's family were also included in the questionnaire. For control another set of questionnaire was used to collect socio-economic, demographic and environmental data from those families. Trained data collectors collected data through face-to-face interviews with mothers of the deceased children between January and March 2001.

Paper II

Hypothesis

Community people are not aware of the child drowning situation and its prevention measures.

Study design

To gain an in-depth understanding of people's perceptions of the causes of childhood drowning and also to explore their concepts of prevention measures a qualitative study was conducted. The study used FGDs.

Respondents

Five groups of respondents were selected from four different villages of Shibpur, a sub-district of Narsingdi, which is situated about 70 kilometres to the north-east of Dhaka, Bangladesh. The FGD's with mothers, fathers and local community leaders were held in residences and at schools with the adolescent students. The number of respondents in the groups ranged from 8 to 12.

Research instrument

A checklist comprised of a series of prompts was used to collect data. After vigorous field testing we finalized a series of prompts.

Data collection procedure

Two trained teams, each consisting of one facilitator, two note-takers and one organiser, were deployed to conduct the FGDs. The discussion sessions were carried out during August and September 2003.

In each session the facilitator requested one of the participants to narrate a drowning event that s/he had observed or heard about. This story telling was an ice-breaking exercise as well as a thought provoking instrument for the participants. The facilitator then gradually introduced the series of prompts to explore the desired information. Each session was audio-taped with the respondents' permission. The investigators monitored all the sessions.

Paper III

Hypothesis

If a child drowning package is developed in conjunction with community responses and utilizing low cost, locally available resources, the package could be feasible and sustainable and accepted by the community.

Study design

The methods employed to develop and pilot the intervention package, and the initial evaluation were conducted to:

- 1. gather information on childhood drowning and its prevention measures
- 2. organise workshops with relevant stakeholders to formulate prevention strategies
- 3. pilot components of the programme in a rural community
- 4. assess initial responses of rural communities to the prevention programme

Through a series of workshops, applicable drowning prevention measures were identified. The measures were then shared with the community to gauge feedback. The package was then piloted on a small scale. The following intervention package was finalised.

Table 3: Child drowning prevention package

1 <input type="checkbox"/>	Increase child supervision <input checked="" type="checkbox"/> <input type="checkbox"/> Counsel mothers/caregivers <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> Establish community crèches
2 <input type="checkbox"/>	Create a heightened community water safety culture <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> Establish multi-sectoral collaboration <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> Form village committees <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> Conduct court-yard meetings <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> Conduct social autopsy meetings
3 <input type="checkbox"/>	Provide basic first response skills to community volunteers

Child drowning prevention package

From the workshops the following measures were identified.

1. Increased child supervision

Counsel mothers/caregivers

Most child drownings occur in water bodies located close to the home. Lack of supervision is one of the major contributing factors of childhood drowning in Bangladesh. To address this issue, supervision should be improved and the home and immediate environment modified to reduce injury risks. Studies suggest that improved child supervision and reduction of home hazards could reduce drowning and other injuries. The attitude and behaviour of parents/caregivers can be addressed through counseling by a trained worker. It has been reported that educating parents/caregivers about the risks for drowning is an important step for changing knowledge, beliefs, and attitudes, which in turn determine behaviour. Counseling should address child supervision, removing indoor drowning hazards and protecting children from outdoor water bodies by creating barriers such as fencing around a pond or home, installing door barriers, or utilising playpens.

Establish community crèches

The majority (>60%) of child drowning occurs during morning to noon, when mothers are engaged in household chores. Workshop participants suggested establishing community crèches to provide direct supervision of 20-25 children by a trained caregiver and to encourage early childhood development (ECD) during mothers' busy hours.

2. Create a heightened water safety culture

In order to heighten community awareness of water safety, the workshop participants suggested the following.

Establish multi-sectoral collaboration

In order to cultivate support from various departments including health, education, and local government, participants suggested organising advocacy meetings with department representatives.

Form village committees

There were suggestions to form village committees involving community leaders. In rural Bangladeshi culture, people accept and value suggestions of the community leaders. The committees were expected to support, guide, and oversee the activities.

Conduct courtyard meetings

Courtyard meetings are a well accepted awareness raising method in Bangladesh. In each courtyard meeting, about 40-50 neighbours participated. One community worker facilitated the session and described the magnitude and risk factors, and suggested possible prevention measures for various injuries including drowning. At the end, the audience interacted with the facilitator for further clarification.

Conduct social autopsy meetings

A social autopsy is an innovative strategy wherein an adult assists a socially challenged child to improve social skills by jointly analysing errors that a child makes and designing alternative strategies. This concept, of assessing a situation and creating alternative strategies to avoid further similar incidences, has been adapted and applied to child drowning prevention in rural Bangladesh.

In the study, a social autopsy meeting was held after a drowning death. It involved the deceased's family, neighbours, and local leaders. A trained worker led the group using a structured, standardised analysis of the incident. The dialogue served to elicit the social errors which caused the death, and to identify appropriate and achievable preventive measures.

3. Basic first response

Many indigenous customs, practiced by rural community members, are harmful for a non-fatal drowning victim. To address this, workshop participants proposed introducing basic first response training to local volunteers. The first response training comprised of basic skills in common injuries including cuts, burns, animal bites, and poisoning, and cardiopulmonary resuscitation (CPR) and transportation of victims to the nearest health facilities.

We used qualitative methods including FGDs and key-informant in-depth interview techniques to assess initial community responses of the intervention package.

Respondents

Workshop attendees : The workshop attendees were relevant stakeholders and experts of child survival and injury prevention.

Participants of FGDs : Six groups of respondents were selected for FGDs from the four pilot villages of Raiganj's sub-district. Participants were parents of 1-4 year old children, village committee members, participants in "court yard" and "social autopsy" meetings and community first responders. The number of participants in the groups ranged between 8 and 11.

Research instrument

To conduct the FGDs and in-depth interviews we developed checklists comprised of a series of field tested prompts.

Data collection procedure

A trained team consisting of one facilitator, one note-taker and one organizer conducted the FGDs. To conduct in-depth interviews one trained interviewer and a note-taker were recruited. Each session was audio-taped with the respondents' permission.

Paper IV

Hypothesis

A child drowning intervention package which is low cost and utilized locally available resources and according to country context could reduce fatal drowning.

Study design

A quasi-experimental community trial was designed to evaluate the effectiveness of the intervention package in reducing fatal drowning in children 1-4 years old in rural Bangladesh.

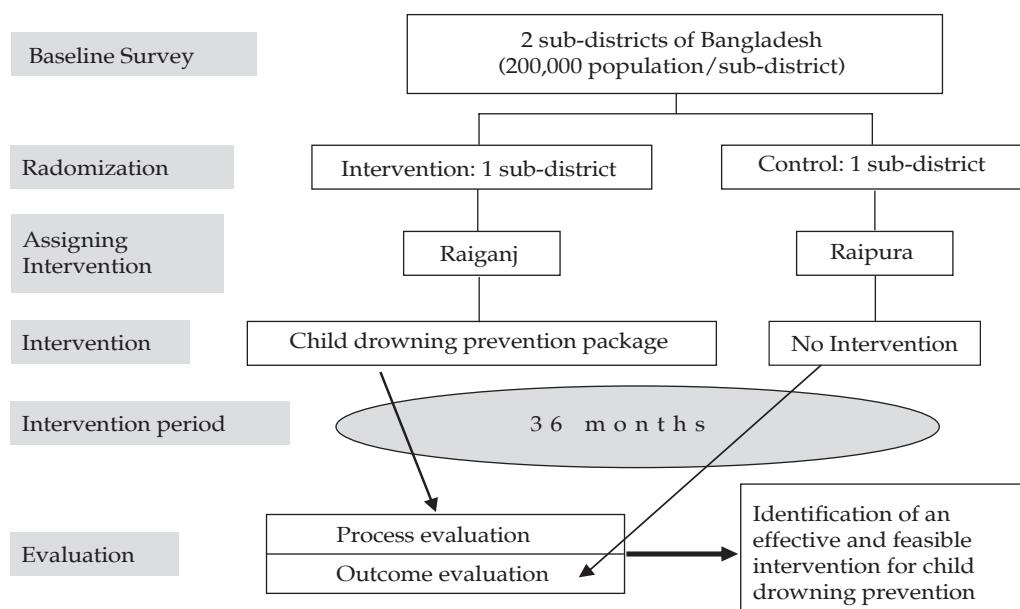


Figure 1: Quasi-experimental Study Design

Study settings and population

Raiganj, one of the sub-districts of Sirajganj district in Bangladesh was selected as the intervention area. The demographically matched comparison community, Raipura sub-district, is located in Narsingdi district which is about 300 kilometres away from the intervention community. Demographically and geographically rural Bangladesh is almost homogeneous. Therefore, both the selected sub-districts were representative of the rural community of Bangladesh. Children 1-4 years of these two sub-districts comprised the study population.

Sampling

In both intervention and comparison areas a total population of about 200,000 was covered. To capture the required population, five and eight unions of Raiganj and Raipura sub-districts respectively were selected. A union is the smallest local government entity with an average population of about 20,000.

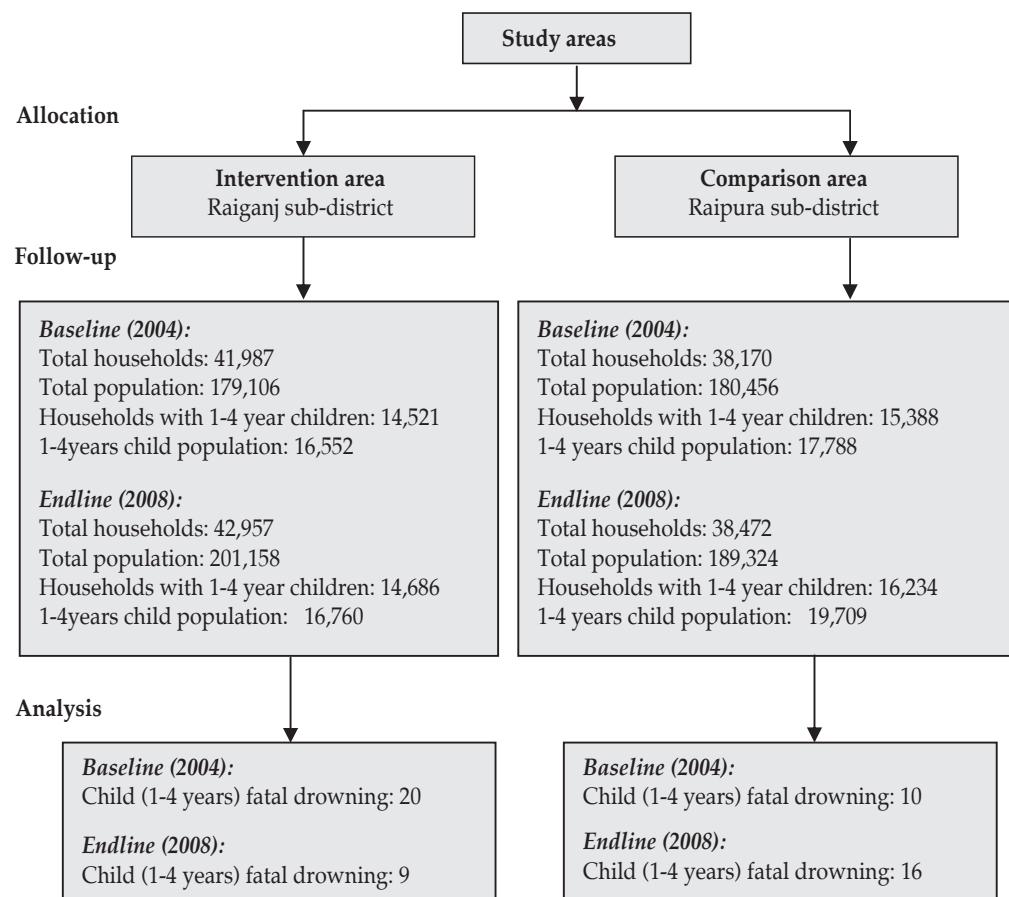


Figure 2: Community trial profile

Study duration

The duration of the study was over three years. The activities of the intervention programme began in September 2005 and ended in March 2009.

The study duration was divided into three phases with some overlap between the development and implementation phases. The first four months of the project period, September to December 2005 was the phase of development. January 2006 to December 2008, 36 months, was the implementation phase. During January to March 2009 the evaluation of the intervention was conducted.

Data collection procedure

Baseline Survey

Data collectors conducted home visits to collect data from the selected unions of the intervention and comparison areas. Data was collected from the adult occupants through face-to-face interviews using a set of pre-tested questionnaires. The baseline survey was conducted between November 2004 and February 2005. Socio-demographic and mortality data including the fatal drowning of children were collected. The recall period for mortality was within one year.

In a sub-sample of 4,000 households (10 percent of all households) in both the intervention and comparison areas the baseline information on mothers' knowledge and practice of child drowning prevention was collected in early 2006, before the prevention package was implemented in the intervention area.

Surveillance

An active surveillance on injury mortality and morbidity, including fatal drowning, was implemented in the intervention area. Through monthly household visits using a set of questionnaires, data collection was undertaken during January 2006 to December 2008.

Endline survey

The endline survey was conducted across 38,000 households in the eight unions of the comparison area, Raipura. All the instruments were the same as those used in the baseline survey and the same procedure was followed to collect data. The survey was conducted in a two month period between January and February 2009.

In addition, similar to the baseline survey, in a sub-sample of 4,000 households, in both the intervention and comparison areas, the endline survey on knowledge and practice of mothers on child drowning prevention was conducted in February 2009.

In order to measure the impact of crèches on drowning prevention in the intervention area the same number of 1-4 year old children were randomly selected for crèche non-participants as enrolled for crèche participants, with equal number of boys and girls in each group.

4.3 Ethical Considerations

For the interview studies ethical permission was obtained from the Ethical Committees of the Institute of Child and Mother Health (ICMH) and the Centre for Injury Prevention and Research, Bangladesh (CIPRB), Dhaka, Bangladesh.

4.4 Statistical Analyses

In paper I the incidence rate of drowning was calculated per 100,000 children-year with 95% confidence interval (CI). Frequency distribution of some variables was conducted. The association of some selected factors and drowning was calculated by odds ratio (OR) with 95% CI. In paper II and III transcripts of the audiotapes were prepared and then analysis was done by examining the transcripts and note-takers' notes in detail to identify the range of ways in which the participants responded.

In paper IV drowning mortality rate was calculated per 100,000 children-years with 95% CI. The reduction of injury mortality was expressed in percentage change using the formula, percentage change = $(\text{Baseline rate} - \text{Endline rate}) / \text{Baseline rate} \times 100$. Relative risk was calculated with 95% confidence interval to measure the protective effect of the community crèches.

The changes in levels of knowledge and practice of the mothers or caregivers for prevention of child drowning were measured by calculating a knowledge and practice score. There were 10 questions for prevention of drowning among 1-4 years children. The mean scores were calculated for the intervention and comparison areas.

5. SUMMARY OF RESULTS

Paper I

Magnitude, pattern and risk-factors of drowning in children aged 1-4 years

The incidence of drowning among children aged 1 - 4 years old was 156.4 per 100,000 children-year. The highest rate (328.1 per 100,000; 95% CI 254.8 - 421.7) was observed in 1 year old male children. The proportional mortality due to drowning in the children was 27.9%. It was observed that childhood drowning was prevalent throughout the year; however, about half of drowning deaths occurred during the monsoon season. Almost all (98.8%) drownings occurred during the day, 0600 to 1800 hours. More than 40% of the fatal drownings occurred in ponds. About two-thirds of the drowning deaths occurred when the mothers were involved in household chores. Child's sex, mothers' age and literacy, family income and ownership of agricultural land by the families were identified as risk factors.

Paper II

Community perception of childhood drowning and its prevention measures in rural Bangladesh

The respondents of the FGDs considered that children 5-10 years are at risk of drowning. Ponds, ditches and canals were frequently mentioned locations of drowning. Most of the drownings were reported to occur around noon. For prevention of childhood drowning the participants suggested that the children should be constantly supervised, unwanted ditches should be filled in, ponds should be fenced and drowning prevention awareness in the community be increased by community leaders. They suggested that government should organise campaigns for preventing childhood drowning, promoting swimming instruction activities for children and motivating communities to fence ponds.

Paper III

Development of an intervention package for 1-4 year old child drowning prevention and communities' initial response to the package

Increased supervision of children, raising awareness of water safety and educating the community on first response skills were the three core aspects identified through workshops to include in the intervention package.

During development of interventions emphasis was given to finding low-cost local resources. An increase in child supervision, creation of drowning-safe homes and the establishment of community crèches were identified as key tactics of drowning prevention. To create heightened water safety the formation of village committees and conduction of court-yard and social autopsy meetings with communities were considered. It was revealed that the community actively participated and considered that these interventions would be useful for prevention of child drowning. Moreover, an increasing demand of some these interventions, especially for community crèches, was also noticed.

Paper IV

Evaluation of the intervention package for its effectiveness

The results of the evaluation of the intervention are divided into process evaluation and impact evaluation. The process evaluation observes the population reached through various components of the programme, the measure of changes in environment hazards and changes in mothers' knowledge and practices in child drowning prevention.

The impact evaluation measured the changes in child fatal drowning.

Process evaluation

Mothers over 14,600 households with children under 5 were counseled for 36 months to heighten their knowledge on drowning prevention. A significant proportion of mothers or caregivers translated their knowledge into practice.

Strategies	Activities	Target pop	Coverage	Knowledge	Practice	Impact
Increase supervision	Home visit and counseling of household occupants	Mothers/primary care givers having under 5 children	Mothers of 14,686 households counseled /month for 36 months	Improved	5,299 (36%) households reduced drowning hazards	
	Institutional supevision through community crèches	Children 1-4 years	100 crèches developed for children 1-4 years		2,680 (16%) children were sent to crèches	
Raise community awareness	Formation of village committees	Village leaders	100 committees formed	Influence		Child drowning reduction
	Orientation of village committee members	Village committee members	1,975 members oriented			
	Conduction of courtyard meeting	Mothers and other adult household occupants	through 4,930 courtyard meetings 197,000 population reached			
	Conduction of social autopsy meeting	Adult neighbours of a deceased family (40-50 households)	through 38 social meetings 2,128 population reached			
	Organising video-show	Men, especially fathers	through 216 videoshow 101,775 population reached			
	Organising IPT	Men, especially fathers	through 100 IPT nights 81,000 population reached			
Train community first responder	Organising first responders training	Community volunteers	through 20 sessions 383 community volunteers trained		383 volunteers started providing first response	

Figure 3: Programme coverage and changes in knowledge and practice

As a result 36 percent of households became drowning safe. For institutional supervision 100 community crèches were developed and 2,680 children aged 1-4 years i.e. 16 percent of children of that age group benefited from direct supervision.

To raise community awareness 100 village committees were formed to oversee the activities and 1,975 committee members received orientation on injury including drowning prevention. Through 4,930 court-yard meetings, 197,000 people of the intervention area were reached and made aware of injury prevention. Thirty-eight social autopsies for drowning deaths were organized and 2,128 adult neighbors of the deceased families attended the meeting. To increase men's participation 216 video-shows and 100 interactive popular theatre nights were arranged which reached 101,775 and 81,000 audience respectively. Over 380 community volunteers received first response training.

Impact evaluation: In the intervention area of Raiganj the baseline fatal drowning rate was 120.8 (95% CI 67.8-211.0) per 100,000 children which reduced to 53.7 (95% CI 21.8 - 123.2) per 100,000 children, i.e. the reduction was 55.5 percent. However, in the comparison area the drowning rate increased by 44.0 percent. In the baseline the rate was 56.2 (95% CI 24.1-123.7) per 100,000 children and in the endline survey the rate was 81.2 (95% CI 42.2-151.5) per 100,000 children. The interventions were found to be protective for child drowning and which is statistically significant (RR=0.44; 95% CI 0.20 - 0.98, p= 0.04).

Table 4: Fatal drowning mortality rate (per 100,000) in children 1-4 years in intervention and comparison areas

□	Baseline □		Endline		□	□
Study areas □	n □	Rate (95% CI) □	n □	Rate (95% CI) □	% change □	Relative Risk (95% CI)
Intervention□ area (Raiganj) □	20 □	120.8□ (67.8-211.0) □	9 □	53.7□ (21.8-123.2) □	□ 55.5 □	0.44□ (0.20 - 0.98)
Comparison□ area (Raipura) □	10 □	56.2 □ (24.1-123.7) □	16 □	81.2□ (42.2-151.5) □	□ -44.5 □	1.44 (0.66 - 3.18)

During 2008 among the crèche participants and non-participants three children drowned, one (40 per 100,000) drowned who was a crèche participant and the other two (80 per 100,000) were non-participants. The crèche participant child drowned after crèche time i.e. between 1 p.m. and 9 a.m. where as the non-participant children drowned during the crèche hours.

6. DISCUSSION

A small scale Bangladeshi study (Ahmed *et al.*, 1999) tended to focus on the initial descriptions of epidemiology of fatal drowning. However, there remains a paucity of nationally representative scientific information on child drowning, including its magnitude, patterns of occurrence, risk factors, essential information for the development of prevention measures and rigorous, controlled evaluations of effective prevention measures.

The overarching objectives of this thesis are to contribute to the information platform required for development of fatal drowning prevention of 1-4-year-old children; and development, implementation and evaluation of a package of intervention effective for rural Bangladesh which may also be applicable to other similar low-income country settings.

The thesis makes the following contributions for prevention of fatal drowning in children 1-4 years in Bangladesh.

6.1 Epidemiology and risk factors of child drowning

In our first paper we determined the magnitude and risk factors of drowning of Bangladeshi rural children aged 1-4 years old. In an earlier child drowning study in Bangladesh (Ahmed *et al.*, 1999) such information was available but from a limited geographic area which did not represent the whole country.

This epidemiological description is the first and most detailed account from rural Bangladesh, and the first report from a low-income country. The drowning rate in children aged 1-4 years (156.4 per 100,000) that we found was almost the same as was revealed in the Matlab study; a rural community in Bangladesh. In the Matlab study the rate of drowning of 1 - 4 year old children was 200 per 100,000 children-year. The recently conducted "Bangladesh Health and Injury Survey (BHIS)", the world's largest survey in terms of sample size, revealed that drowning is the leading cause of death in children 1-17 years both in rural and urban communities of Bangladesh and the highest rate (136.9 per 100,000) was observed in children 1-4 years of rural communities (Rahman *et al.*, 2005).

However, in comparison to high-income countries the drowning rate of Bangladeshi children aged 1-4 years was 34 - 52 times higher. In Los Angeles County and Washington in the USA and Australia the drowning rates of children aged 1 - 4 years were 3.6, 3.0, 4.6 per 100,000/children-year respectively (Mackie, 1999; Morgenstern *et al.*, 2000; Quan and Cummings, 2003). When a single year of age was observed 1-year olds have peak drowning rate, with rates falling rapidly as the child gets older. Other studies also found that these ages of 1 and 2 years to be the most common (Cass *et al.*, 1991, Blum and Shield, 2000, Rahman *et al.*, 2005). This coincides with developmental achievements such as independent mobility and exploratory behaviour. The child is able to gain access to hazards but has not yet developed cognitive hazard awareness and avoidance skills (Agran *et al.*, 2003). Rowntree (1998) also found the most frequent medically attended injuries were among children who were already walking and up to 16 months of age, which he characterized as 'beginning to walk and becoming inquisitive'. In this study the proportional mortality due to drowning was about 28%. A similar proportion is also found in other studies. One study, conducted in a sample of children who died in Bangladesh between 1989 and 1992, shows that about 21% of deaths of children aged 1 - 4 years were due to drowning (Baqi *et al.*, 1998). In another small-scale longitudinal, population-based surveillance system at Matlab, Bangladesh during 1983 - 1995, the proportion of drowning deaths to deaths from all causes has increased from below 10%

in 1983 - 1984 to over 30% in 1995 (Ahmed *et al.*, 1999). During the last two decades there has been massive immunization coverage of children through Expanded Programme on Immunization (EPI), which has resulted in a considerable reduction of mortality due to infectious diseases in Bangladesh. Possibly for that reason the proportionate drowning mortality in this study was found to be slightly increased.

Several studies of different countries, including Bangladesh, suggest that the rate of drowning for boys exceeds the rate for girls (Mizuta *et al.*, 1993, Warneke and Cooper 1994, Ahmed *et al.*, 1999). A similar finding was also observed in the present study. A distinct temporal period for drowning, which peaked during monsoon was observed in this study. This pattern of seasonality of drowning is in accordance with other studies (Muhuri, 1996; Baqi *et al.*, 1998). The majority of drownings occurred in the daylight hours. This could be due to the fact that during this period mothers or caregivers remain very busy with their household activities and could pay less attention to their children.

Ponds were found as the most common water reservoirs where most of the drownings took place. This is because in the villages of Bangladesh there are numerous ponds surrounding households, which are used for bathing and washing purposes throughout the year. Children also go to these ponds for bathing and playing (Becker, 1981). Moreover, children in this age group (1 - 4 years) are able to walk around and fall into unprotected water bodies, but often lack the judgment to avoid such hazards and the physical capacity and knowledge to rescue themselves (Mello-Jorge *et al.*, 1985).

The risk of dying from drowning was found to be higher among children of older rather than younger mothers. Baqi *et al.* (1998) also observed the similar finding. This may be because older mothers usually have more children and mothers and other caregivers in households with many children could pay less attention to the safety of the children than in households having fewer children. Like other studies it was observed that the children of families with less educated mothers and lower socio-economic status are more vulnerable to drowning (Barss *et al.* 1998).

6.2 Community perception of drowning and its prevention

In our second study we conducted FGDs with parents, adolescents and local community leaders to explore their perception of child drowning and its prevention. Focus groups have been used in other studies with considerable success to examine knowledge of health-related matters (Kitzinger, 1994).

In this study it was revealed that the respondents wrongly perceived that the occurrence of drowning is high in children 5-10 years in Bangladesh instead of 1-4 year-olds. The participants' concept of male predominance, place of drowning, seasonality and lack of adult supervision corroborates with the findings of our first paper.

In terms of knowledge the participants appeared to be well aware of childhood drowning prevention measures, however, the FGDs revealed that they rarely take any preventive measures to protect their children from drowning. The gap between the knowledge and behavior may be due to the prevailing culture and practice to accept these events as natural and inevitable resulting in a lack of any effort taken at individual or at community level.

While the parents did realise children are at risk of drowning, they incorrectly believed that older children (5-10 years) were at higher risk than the younger children (1-4 years). This is possibly a contributing factor in the lack of preventative efforts focused on children under five. The majority of the participants expected that some measures, especially the fencing of ponds should be done by governmental or non-governmental organisations. In the developed world perimeter pool fencing along with some legislations have proved to be an effective means of drowning prevention.

However, in Bangladesh there are an infinite number of ponds and ditches, almost one for each household, therefore the practicality of pond fencing is questionable. As with most child survival interventions, such as immunisation or treatment of diarrhoeal diseases, success is dependant on reaching parents and caregivers with information and advice that will encourage behavioural change. This includes helping mothers to identify the risks their children face and teaching them simple, affordable and appropriate safety measures that may improve the skills and practices of the communities towards saving young lives from drowning.

6.3 Development of an intervention package for 1-4 years child drowning prevention and communities' initial response to the package

While rich countries can use wealth or technology to solve major public health problems, these are not available to developing countries such as Bangladesh. Consequently, the most efficient use of the available resources is paramount. Research can be used to develop an evidence-base upon which to allocate effort and resources. Drowning interventions that exist in high-income countries have not been imported into Bangladesh. Instead, efforts have been made to develop a prevention package considering the context and using local resources with community participation, which has been described in the third paper.

To enhance compliance, the community was involved from development to implementation. Because community needs and preferences were elicited in advance, most intervention components have been well accepted. For example, the increasing demand for community crèches proves the acceptability of the intervention. These are also sustainable as the interventions are very low cost. With some interventions, like the community crèche, cost sharing is possible. However, focus group discussions and in-depth interviews suggest that some subsidies may be required for the poorest sections of the community.

In most low-income countries including Bangladesh major public health issues are tackled by the Ministry of Health with financial and logistical support from development partners. As drowning is a major killer of children aged 1-4 years, it must be addressed in order to achieve the Millennium Development Goals (MDGs) on reduction of child mortality. In this context, it is not unrealistic to expect assistance from development partners and international aid agencies to prevent childhood drowning.

Our qualitative studies revealed that the intervention programme was well accepted by the community. As the programme was designed to utilize low cost local resources and involve the community, it was expected to be feasible and sustainable with some assistance from relevant organizations. To determine the effectiveness of the package we pursued its implementation on a much larger sample.

6.4 Evaluation of the intervention package for its effectiveness

The principal positive finding of the fourth study was a distinct reduction of fatal drowning in children aged 1-4 years in the intervention compared with the comparison area. It was difficult to measure the effectiveness of the individual intervention components separately. Therefore, the evaluation was done considering the effect of the whole package.

For assessing the effectiveness of the intervention package a comprehensive community-based "quasi-experimental" design was utilized in this study. In injury research, the use of community trials is quite common. Often it is the only practical methodology for assessing the efficacy of countermeasures or preventive interventions (Bangdiwala, 2001). Decades of injury prevention research and international experience have demonstrated that suitable injury reduction

requires a comprehensive and coordinated approach. Community-based programmes implementing multiple interventions that complement and reinforce each other are widely regarded as a critical element to reduce injury rates and promote health and safety (Towner and Dowswell, 2002).

In this study multiple prevention measures were implemented in conjunction with each other to develop an intervention package which consisted of both "passive" environmental or engineering solutions and "active" behavioural solutions. Moller (1992) stated that the community-based approach to injury prevention offers the opportunity to stimulate 'a process of cultural change which allows an optimal mix of environmental and behavioural solutions to be put into place'.

The Manifesto for Safe Communities was set out at the First World Conference on Accident and Injury Prevention held in Sweden in 1989 (WHO, 1989). Since then, an increasing number of communities around the world have used community-based approaches in injury prevention and some of these programmes have been evaluated (Towner and Dowswell, 2002).

Similar to other controlled trials in the high-income countries (Ozanne-Smith *et al.*, 1994; Hennessey *et al.*, 1994; Svanström *et al.*, 1995) a local Injury Surveillance System (ISS) was also in place in the intervention area in this study. The surveillance was not only used as a means of identifying local problems and targets for intervention, but also as a source of outcome data in programme evaluation.

Although the home should be a haven of safety for children, however, this setting represents the most frequent site of any injury occurrence (Baker *et al.*, 1992; Towner *et al.*, 1993). A Bangladeshi study showed that about 80 percent of drowning took place within 20 metres of the home and a quarter occurred within 5 metres of the house (Rahman *et al.*, 2009). In this study home visits by trained workers were found to be effective in reducing drowning risks in and near homes. This finding corroborates with a cluster randomized controlled trial conducted in four low-income communities near Johannesburg and Cape Town of South Africa. In the evaluation it was revealed that home visits by trained lay workers who provided education, home inspection, and safety devices contributed to child injury risk reductions (Swart *et al.*, 2008).

In this study the concept of institutional supervision of children through community crèches has for the first time been utilised and proven effective in preventing drowning. The evaluation of piloting of the community crèche also revealed that the concept was accepted by the community as feasible and sustainable. This community crèche not only prevented drowning and other injuries but also contributed to early childhood development and empowered the women who were engaged in child supervision in the crèche (Rahman *et al.*, 2009).

Similar to another study (Guyer *et al.*, 1989) our research design did not permit us to disaggregate the change in knowledge and practice of the community by the type of activities under the strategy of raising community awareness. Moreover, we were unable to measure its efficacy at the impact level. Different types of communication activities will likely have different effects, and these need further study. However, by process evaluation we assessed that a large number of the population was exposed to various types of community promotion activities, which could have imparted synergistic effects on the other intervention strategies and eventually helped in reducing child drowning.

Due to the relatively short duration of the intervention, the restricted number of trained first responders and as the number of non-fatal drowning was not large enough the first response system did not show any significant effect in reducing fatal drowning. If the intervention period has been prolonged, the number of first responders increased, and the sample size greater, some changes could be observed.

7. CONCLUSION

The evidence produced from the series of studies, which are included in this thesis, provided a wealth of new knowledge in child drowning situation and its prevention measures in a low-income country setting, Bangladesh.

The study results described drowning as one of the major public health issues in children 1-4 years. Although the rural community knew the common causes of drowning and were able to mention a few preventive measures. However, they do not act on this knowledge, possibly because of the combination of cultural factors and not having prevention practices explained to them which could be modeled. These silent deaths fail to get attention and were not recognised as major survival issues for children by the families, communities as well as by the child survival policy planners.

We developed a community-based intervention package keeping in mind socio-economic, cultural and geographical context. The intervention package constituted of multiple interventions that complement and reinforce each other. Our qualitative study revealed that the intervention package was well accepted by the community. As the programme was designed to utilize low cost local resources and to involve the community, it was expected to be feasible and sustainable with some assistance from relevant organizations.

To determine the effectiveness of the package we pursued its implementation on a large sample and it was found effective in reducing drowning in children. Improved supervision and creating a heightened water safety culture of the community and utilizing low cost locally available resources, were the fundamental intervention strategies identified in reducing child drowning in rural Bangladesh.

We assume that in similar socio-cultural, economic and geographic settings the intervention package could be replicated and would appear effective in reducing child drowning.

8. RECOMMENDATIONS

Bangladesh is one of the signatories of the United Nations' Millennium Development Goals (MDGs). MDG 4 is the reduction of under 5 mortality. Bangladesh has a target to reduce two thirds of under 5 mortality rate, i.e. to reduce child death from 133 to less than 50 per 1,000 live birth between 1990 and 2015.

Our first study, as well as other national studies, revealed that one quarter or more child deaths from all causes occur due to drowning alone. Much progress has been made in the reduction of deaths due to communicable diseases and nutritional problems through the Expanded Programme on Immunisation (EPI), the Control of Diarrhoeal Diseases (CDD), the Acute Respiratory Infection (ARI) programme, the National Nutrition Programme (NNP) and the Vitamin A supplementation programme. As there was no successful model for low-income country settings, drowning prevention measures were non-existent in the country.

Our quasi-experimental community trial, for the first time, has proven effective in reducing child drowning in the intervention area. Now the intervention package demands wider coverage, if not across the whole country, to understand its success and challenges in scaling up. In order to overcome challenges further research would be necessary. Thus feasible drowning prevention measures will be evolved in a low-income country setting, thereby helping to achieve the MDG 4 and save thousands of children from drowning.

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