

Child Drowning

Evidence for a newly recognized cause of child mortality in
low and middle income countries in Asia

Special Series on Child Injury 2012

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CHILD DROWNING: EVIDENCE FOR A NEWLY RECOGNIZED CAUSE OF CHILD MORTALITY IN LOW AND MIDDLE INCOME COUNTRIES IN ASIA

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Abstract:

Drowning is a leading cause of death among children in low- and middle-income countries (LMICs) in Asia, but current data greatly underestimate mortality due to drowning. This is due to the way drowning data is collected, classified and reported as well as the difficulty in correcting and adjusting the data. The sum of all the biases and uncertainties has masked the fact that drowning is a leading cause of child death in LMICs in Asia. Cost-effective, affordable and sustainable interventions appropriate for LMICs are available to address this newly recognized and significant killer of children. Large numbers of these deaths could be prevented annually if these drowning interventions were included in current country programmes. When implemented at national scale and as an integral part of country programmes, the prevention of these drowning deaths, which mostly occur in early childhood, would result in a rapid decrease in early childhood mortality and contribute to meeting Millennium Development Goal 4 (MDG4). In older children, where drowning is a leading cause of death before adolescence, it would allow a larger proportion of children to reach adulthood.

EXECUTIVE SUMMARY

Childhood drowning in low- and middle-income countries (LMICs) in Asia has been greatly under-reported since the 1980s when efforts to estimate child mortality were accelerated. Beginning in 2001, research conducted using large-scale surveys featuring direct interviews at households in the community has demonstrated that drowning is a leading cause of death in childhood after infancy in Bangladesh, Cambodia, China (one province and the capital, Beijing), Thailand and Viet Nam. This finding represents a significant shift in the prevailing understanding of childhood mortality in LMICs in Asia. It has led to trials of interventions that address the specific needs of LMICs. This research from across the region is drawn together here for the first time.

Drowning is under-recognized

The very nature of drowning deaths has contributed to its absence from most sources of official data. The contributing factors are mainly structural and cultural. They represent the difficulties of operating in low-resource environments where data collection is limited due to an inability to measure mortality that occurs outside hospitals and other health facilities. Generally, staff with the capacity to diagnose and record the cause of death are only present in hospitals and clinics. But, a majority of drowning deaths among children occur at home or in the community and drowned children are rarely brought to a health facility. The traditional reliance on facility-based reporting has meant that causes of death that result in immediate or very rapid death such as drowning are rarely seen or known about at the hospital or facility that submits death reports. In LMICs, in addition to the evident futility of going to a health facility because the child is already dead, societal factors ranging from financial considerations to a fear of punitive legal implications for the persons reporting the drowning reduced the number of incidents reported at health facilities to around 20 per cent in all countries surveyed. Factors such as distance to health facilities and lack of transportation were also major impediments to reporting. Without the data being captured at the local level, it is not represented in national reports. Thus, child drowning has remained undetected as a significant health issue.

Previous surveys have had major limitations that have also served to mask the scope of the issue. These include: small sample sizes; unrepresentative samples; poorly defined populations; short survey time frames; definitional inconsistencies; lack of detail on antecedent events or risk factors; and different recall periods, all of which limited researchers' ability to establish the scale of the issue or to compare drowning rates.

The absence of drowning as a cause of mortality and morbidity in statistics captured at local level ensures its absence from national data. Consequently, drowning is not fully reported to the World Health Organization (WHO) and is therefore under-represented in the global mortality database. As an example, a 2005 assessment of the data supplied by WHO's 192 member countries, 114 had either no drowning data available or no data more recent than 1990 to report.

The structure of the International Classification of Diseases (ICD) reporting system also hinders capture of drowning deaths in official statistics. While the classification is effective at recording information relevant to high-income countries (HICs), the coding options make inclusion of relevant detail in LMICs difficult. Many of the categories in the ICD refer specifically to recreational activities that have little or no relevance to LMICs, such as scuba diving and water skiing. In addition, staff at the local level that are

aware of the drowning lack the specialized training to report the death using the complex codes required. The few staff that have the necessary training and certification are only available at top-level referral hospitals, but do not receive reports from the community-level facilities where the drowning occurs.

The ICD structure also requires that drowning be reported in relation to place and circumstances of occurrence, rather than in one single category named 'drowning'. There are separate categories for drowning that occurs, for example as a result of transport (boat/ship sinking); forces of nature (floods, typhoons) and intentional injury (suicide/homicide). These categories are not counted as drowning in the WHO global statistics. Excluding these drowning cases from the WHO Mortality Database and the Global Burden of Disease (GBD) analysis has resulted in further underestimations of the true scale of the problem.

Drowning – Not newly occurring, just newly recognized

Given the lack of recognition of drowning, it would be easy (but incorrect) to assume that it is a new issue that has emerged due to gains in other areas of public health in Asian LMICs, such as increasing control of respiratory infections and diarrhoeal diseases. Drowning has always occurred at high levels even as these other causes of mortality have been reduced through large-scale interventions. In Bangladesh, for example, data collected in ongoing research over the past three decades through the Matlab Demographic Surveillance System show the presence of drowning at rates similar to those reported in household surveys. However an intense focus on communicable diseases has led to drowning being largely overlooked.

Communicable disease deaths that occur over a period of days are better reported and are much easier to convey to the general public and potential donors than drowning deaths, which occur in minutes and are infrequently reported. Public awareness campaigns for communicable disease have been extraordinarily effective at mobilizing resources, in part because of the immediate and visible link between illness and prevention or treatment options. In contrast, drowning seems to provoke a sense of powerlessness and fatalism that may be in part responsible for the lack of awareness-raising campaigns.

The nature of drowning has thus ensured that despite being an ongoing public health issue, it has not received the same attention as other leading killers of children. As a result of this neglect, while the overall rate of drowning has remained stable, the rapid decrease in communicable disease deaths has resulted in drowning now becoming a large proportion of all causes of child death. In the Matlab research area in Bangladesh over the past twenty-five years, drowning has gone from being responsible for less than 10 per cent to over 50 per cent of all child deaths among children aged 1-4, making it a leading cause of death in early childhood. Without intervention strategies being scaled up, LMICs in Asia that are not on track to achieve MDG 4 (a two-third reduction in the under-five mortality rate) may struggle to achieve it.

One conclusion is that in Asian LMICs – the region contains two-thirds of the world's children – drowning is an urgent health policy priority. Addressing it will facilitate achievement of the MDG on reducing child mortality.

Household survey findings

Drowning is a leading cause of death for children in all age groups after infancy. Common factors for all childhood drowning deaths reported in Bangladesh, Cambodia, China (Jiangxi Province, Beijing), Thailand and Viet Nam included:

- Most children drown before age four.
- Most child drowning occurs in rural areas.
- More boys than girls drown, especially after age five.
- Before age four, 80 per cent of child drowning occurs within 20 metres of the home; after age four more than 100 metres from the house (in the community).
- For children of all ages, 75 per cent drown during the day between the hours of 8 a.m. to 4 p.m. and less than 5 per cent at night from 8p.m. to 6 a.m.
- For children of all ages, 90 per cent drown in sunny weather, 5 per cent in rainy weather and 5 per cent during flooding from monsoons.
- For children over age four, 95 per cent drown while engaging in non-recreational activities or daily activities; 5 per cent during recreation and less than 2 per cent during pre-planned swimming activities.
- Ship/ferry accidents are not a significant contributor to drowning deaths.
- Swimming pools are not a significant contributor to drowning deaths.
- For children aged 1 to 4 years, drowning is responsible for almost one out of every four deaths (23.4 per cent) from all causes.
- For children aged 5-9 years, drowning is responsible for more than one out of four (28.3 per cent) deaths from all causes.
- After infancy and through the rest of childhood, drowning is responsible for almost one out of five deaths (19.8 per cent) from all causes.

Drowning occurs throughout childhood. However, there are two separate epidemics: one affects children under four years of age and accounts for a large majority of drowning. It occurs in very young children who escape supervision of their caretakers and play and drown in unprotected water sources within 20 metres of the home. Their caretakers are often unaware of the drowning for an hour or longer. The second is for older children who drown further from home, often 500 metres or more, where they swim alone or with a same-aged peer who does not have swimming, rescue or resuscitation skills. They drown in the community, but without any rescue from community members.

The two scenarios require different intervention approaches. For the children who escape supervision and drown close to home, the interventions must focus on parents, caretakers and the home environment. The intervention for older children who drown further from the home must focus on the children themselves.

To prevent it from being overly long, this Working Paper focuses only on drowning deaths (as opposed to non-fatal drowning). A great deal of data on morbidity was also collected in the individual surveys and would be a necessary consideration in the design of intervention programmes; this data can be accessed in previous country-specific publications.

Headlines do not reflect true incidence

If a review of purely media-reported drowning incidents were undertaken, it would erroneously appear that natural disasters such as tsunamis and flooding or boat/ferry sinking were the primary causes of drowning deaths in Asian LMICs. Where natural disasters do have a significant regional impact with implications for increasing the rate of drowning, they tend to be rare events such as the Indian Ocean tsunami of 2004. While they result in the death of many tens of thousands of children drowning, as was the case in Aceh, Indonesia, a disaster of this magnitude is rare, usually occurring less than once in 20 years. Drowning from other causes is responsible for most drowning deaths in any given year.

More recently, the devastating monsoon floods across Southeast Asia from June–November 2011 provide a similar example. While the regional total was almost 1,500 deaths, with a large proportion of them children, the surveys show that many times this number drown every year in each of the countries affected by the flooding.

The incorrect impression that natural disasters cause most drowning is directly related to how such occurrences are picked up by the media. Journalists rarely hear about individual drowning deaths; yet when a boat sinks or a large area floods, a full-scale rescue and recovery operation is mounted, which draws press attention. These events tend to be drawn out over time, so the media has time to reach the site before the action is over; whereas in an individual drowning case the event is over within minutes. The death of a child in a drowning incident is tragic for the family and their community, but there are rarely political or broader social implications that would be considered by journalists as newsworthy and it goes uncovered.

Economic conditions pose risk

The surveys show a potential causal link between poverty and drowning. Children in LMICs tend to drown in the water bodies that are ubiquitous in their daily environment. Key risk factors identified included: a lack of access to piped water, which necessitates having wells or other water bodies near the home; large family sizes with supervision of younger children falling to older siblings rather than adults; lack of access to pre-school education in poorer LMICs (pre-school supervision had a direct correlation with lowered drowning rates in countries like Viet Nam); and a higher proportion of the population living in rural areas and therefore at greater exposure rates to water bodies. On average, for almost 9 out of 10 children in rural areas, a hazardous water body lay within 20 metres of their home.

In the case of China, economic migration resulted in parenting duties falling to grandparents whose age and failing health made direct and active supervision of very young children difficult. As a result, these children left behind by their parents had almost triple the drowning rates compared to children living with their parents.

Loss of health and social investments

Drowning rates are highest in early childhood, at which stage most health investments in the young child have already been made. Examples are antenatal care and immediate postnatal care delivered to mothers and infants, and vitamin A, zinc and other micronutrient supplementation. At the point where child drowning rates are highest in the countries surveyed (16-24 months), a young child has received almost all immunizations and many have benefited from early child development and other child enrichment programmes.

The loss of the health and social investments made in these young children by their drowning deaths represents a major indirect cost, as well as the loss of their future potential. Given that drowning is also a leading cause of child death among primary and secondary school-aged children, educational investments are also lost when older children drown.

Differences between HICs and LMICs

In HICs where drowning deaths are well reported, childhood drowning has been shown to have a direct connection with recreational activity. Swimming pools are a common location for drowning deaths among young children. Older children tend to drown while engaged in planned recreational activities (e.g. while at the beach or boating). In LMICs, on the other hand, children rarely, if ever, have access to swimming pools; the threat of drowning comes from daily exposure and spontaneous actions that put them at risk. The strategies used to prevent childhood drowning in HICs therefore have an entirely different focus than the strategies required to prevent and address the high levels of drowning in LMICs.

The sheer scale of the issue is a further challenge. The disparity between drowning rates in HICs and LMICs in Asia is stark; when standardized to the world standard population (2001) to enable comparison, the difference in rates is between 10 and 25 times higher in the Asian LMICs surveyed in early and middle childhood, depending on age group and gender. Much of the progress in the reduction of drowning rates in HICs has resulted from a multi-sectoral approach that depends on human and institutional capacity that is not available in LMICs.

Large-scale prevention trials - PRECISE

Between 2006 and 2010, the Prevention of Child Injuries through Social Intervention and Education (PRECISE) programme was run in Bangladesh. It was implemented by the Centre for Injury Prevention and Research, Bangladesh (CIPRB) with technical assistance from The Alliance for Safe Children (TASC) and the Royal Life Saving Society – Australia (RLSSA), with field operations funded by UNICEF Bangladesh. The PRECISE project covered over three-quarters of a million people in villages in rural Bangladesh in three separate, sub-district intervention areas. It implemented specific prevention methods geared towards addressing the differing causal factors in drowning in children under age four and children over four. A village crèche programme was established for younger children; a programme called SwimSafe taught children aged four years and older survival swimming, safe rescue and water safety skills.

Both the village crèche programme for younger children and the SwimSafe programme for older children were effective in reducing drowning deaths. Death rates from drowning in children who had

attended the village crèche were 82 per cent lower than death rates in an age-, sex- and location-matched control group of children who did not. Drowning death rates among children who participated in SwimSafe were 93 per cent lower than in an age-, sex- and location-matched control group of children who did not. Both were large and statistically significant reductions.

Cost-effectiveness was estimated using the WHO CHOICES (World Health Organization - CHOosing Interventions that are Cost Effective) methodology by determining the numbers of deaths averted, the number of disability-adjusted life years averted (DALY) and the cost associated with preventing the deaths. Implementing both the community crèche and SwimSafe programmes together in rural Bangladesh would result in over 196,000 child deaths prevented at a cost of \$12,596 per death prevented and \$362 per DALY averted. These costs compare very favourably with the cost of preventing other causes of child mortality in the same region, such as diarrhoeal and respiratory deaths.

Conclusions

Having established that drowning is a significant and preventable cause of death in children in LMICs in Asia, we need to focus on how this previously unidentified public health issue is transformed from a neglected matter into a one that is addressed by national, regional or global level programmes.

To produce a significant reduction in the burden of drowning in LMICs, substantial investment in building capacity at all levels of the development continuum will be needed. At national level, there needs to be a recognition that drowning prevention requires multisectoral collaboration. Fundamental to this is ensuring that the limited resources and energies of key groups and government agencies align in a manner that increases the overall capacity of the system to reduce drowning.

Building the capacity to implement, manage and monitor drowning prevention programmes is essential, but focus must also be given to the issue of elevating drowning prevention into the national priorities of governments, increasing the availability of funds and devising systems and plans to prevent and reduce drowning at a national level.

The development community is now at the same place with drowning as it was with communicable diseases such as measles in the 1970s and 1980s. In the region of the world that holds the largest number of children at risk of drowning, LMIC Asia, we know drowning is a leading killer of children after infancy. We also know that there are cost-effective interventions against this leading killer – and that for the children who are taught to swim, the evidence suggests that they are protected for life (or at least through childhood) and they also provide ‘herd immunity’ for their peers through their ability to rescue them when they are drowning.

There is much to be done to address the pressing needs for more evidence, expertise, recognition and intervention; but the evidence now in front of us is more than enough to act on. Simply put, child drowning is a leading cause of death in children in LMICs in Asia. This region contains two thirds of the children in the world, thus making it a problem of global proportions. Now that we know it is as preventable as other leading causes of child death in these countries, it is time to act.

It really is that simple.

INTRODUCTION

Children living in developing countries today inhabit a world that is very different from just a half a century ago. Globally, the infant mortality rate (IMR), a measure of the proportion of infants born who survive the first and most critical year of life, has decreased from 127 per 1,000 live births in 1960 to 40 per 1,000 live births in 2010.¹ This two-thirds decrease has led to an increase in life expectancy from 56 years in 1970 to 70 years in 2010.² Over 30 years of investments in communicable disease prevention and nutritional interventions have resulted in large reductions in the number of deaths caused by these diseases and conditions.

The same is not true of child injury because there have not been similar investments in prevention. As a result, injury is now a leading cause of death, permanent disability and serious morbidity for children in low- and middle-income countries (LMICs) in Asia. This threatens the gains already achieved at such great cost in preventing other causes of sickness and death among children, and puts at risk continued advances in survival and protection.

Previous papers in this series examined child injury in LMICs in Asia. One conclusion was that one particular cause of injury – drowning – was of such significance that it deserved to be addressed with the highest priority.³ This current paper examines the epidemic of child drowning in Asian LMICs and presents evidence on each of the following points to underpin why drowning deserves to be targeted as a significant priority:

- Drowning is a leading cause of injury for all children; it occurs in early and later childhood and affects both boys and girls. It is a leading cause of death of children after infancy (1- 17 years).
- Drowning may be a serious impediment to achieving Millennium Development Goal (MDG) 4 of a two-thirds reduction in child mortality, in countries not yet achieving the goal, now only three years away.
- Drowning reduces the impact of other child interventions. Children who drown have often already received immunizations, vitamin A supplementation and other nutritional support. They have often benefited from early childhood development programmes and primary schooling. All these investments are lost when a child drowns.
- There are effective drowning interventions that work in all stages of childhood and are of similar cost-effectiveness as classical child survival interventions.

This paper begins with an overview of the numbers of children who drown each year in LMICs in Asia and the circumstances in which the drowning occurs. Building on that knowledge, the paper presents evidence that drowning is preventable at low cost with proven interventions that have shown to be sustainable in low-resource settings. Finally, the paper argues that drowning interventions need to be applied in the same manner as interventions for other child survival and protection programmes. When applied as large-scale intervention programmes, for example in the same manner as the expanded programme on immunization (EPI) or control of diarrhoeal diseases (CDD), child drowning programmes can be expected to result in large reductions in child drowning rates, which lead to more rapid reductions in early child mortality.

¹ Data for 1960: United Nations Children's Fund (2005). *The State of the World's Children 2005*. New York: UNICEF. Table 1, p. 106; data for 2010: United Nations Children's Fund (2012). *The State of the World's Children 2012*. New York: UNICEF. Table 1.

² Data for 1970: United Nations Children's Fund (2000). *The State of the World's Children 2000*. New York: UNICEF. Table 5, p. 103; Data for 2010: United Nations Children's Fund (2012). *The State of the World's Children 2012*. New York: UNICEF. Table 1.

³ See: Linnan, M. et al. (2007). 'Child Mortality and Injury in Asia: Survey methods', *Innocenti Working Paper*, No. 2007-05, Special Series on Child Injury. Florence: UNICEF Innocenti Research Centre.

1. SCOPE OF THE PROBLEM

1.1 AN INVISIBLE ISSUE

The magnitude of child drowning in LMICs in Asia has been invisible for many reasons. Among them are the following:

- Lack of national-scale, community-based surveys to provide population-based estimates of the burden of drowning
- Reliance on facility-based reporting that fails to capture most cases of drowning
- Use of a classification system unsuitable for LMICs
- Incomplete, poor quality LMIC data reported to the World Health Organization (WHO)
- Reliance on models and expert opinion to adjust incomplete drowning data, which results in underestimates.

As a consequence, the actual number of children in LMICs in Asia who drown each year has not been recognized until recently. New surveys jointly conducted by UNICEF and The Alliance for Safe Children (TASC) show that the numbers estimated in the WHO Global Burden of Disease process for child drowning in the countries surveyed are substantial underestimates.

1.2 LACK OF NATIONAL SCALE, COMMUNITY-BASED SURVEYS TO PROVIDE POPULATION-BASED ESTIMATES OF THE BURDEN OF DROWNING

Information has been available from previous population-based studies on child drowning in various LMICs in Asia. However, the survey data are of limited quality and largely incomplete. Given these constraints, it has not been possible to detect the actual number of children who drown in the communities surveyed. The limitations include the following:

(i) Scope:

- None of the community-based surveys used a large representative population that included both urban and rural areas to cover an entire country.
- Most of the surveys had small sample sizes, often only 500-2,500 children and lacked statistical power.
- The small sample sizes limited the findings to small groups of children (e.g. urban primary schoolchildren).

(ii) Not representative:

- Most surveys lacked well-defined populations. Often they used numerators and denominators drawn from hospitals or schools (e.g. per 1,000 admissions; per 1,000 students). It was not possible to calculate comparable drowning rates that showed the difference in rates and patterns of drowning among children of varying ages.
- Many of the surveys were conducted over a short period, and thus failed to capture the seasonal pattern of drowning (i.e. the number of child fatalities in the dry season vs. rainy season, during monsoon, floods, etc.).

(iii) Methodology:

- Most surveys had differing recall periods, resulting in a difference in calculated rates. The recall periods ranged from a few weeks to several months to a year.
- For surveys with recall periods of less than a year, different methods were used to convert the periods to annual rates, resulting in incomparable rates.
- Most surveys used different definitions of fatal drowning, such as immediately fatal; fatal within 24 hours; drowning in water only; drowning in any liquid. The dissimilar outcomes measured could not be compared.
- Most surveys used different definitions of severity in non-fatal drowning, such as hospitalization; missing school for a half day; missing school for one day; or seeking any medical care. Non-fatal outcomes therefore could not be compared.

(iv) Information for prevention:

- Almost none of the surveys collected information on antecedent events or risk factors other than age and sex.
- The drowning rates cannot be understood without taking into consideration the context of occurrence, predisposing factors, occupational connections, or linkage to aquatic transport.

The lack of adequate survey data has led to drowning being counted mainly at hospitals and clinics. However, fatally drowned children are rarely brought to a health facility so the estimates are unreliable. Few hospitals can provide reliable information on rapid causes of death, especially when the deaths occur in communities that are distant from the hospital. This is the case with drowning, which means that the majority of drowning cases go unrecorded.

Over the past decade a series of national and sub-national surveys have been conducted by TASC in collaboration with UNICEF country offices in Bangladesh, Cambodia, China, Thailand and Viet Nam. The surveys were conducted with the technical capacity in epidemiology, demography and statistics developed at the national and local levels in most countries in Asia over the past 20 years. They have shown the overall scale of child drowning and its scope at the different stages of childhood and have highlighted the need to undertake intervention research on drowning in children as an urgent priority.

In each country the survey counted deaths in the community and classified them by cause, including infectious (communicable) diseases, non-communicable diseases, injury and a category called 'unable to determine'. The surveys also counted serious and disabling injury events. The surveys had very large sample sizes, on the order of 100,000 households, and were able to examine causes of death in the different age groups of childhood and adulthood. The survey instruments were standardized, with common definitions of age groups, recall periods, risk factors, behavioural factors, circumstances and outcomes facilitating comparison across countries.

The countries surveyed span the gamut of development. They include countries classified as low income as well as middle income, countries with low and high child mortality rates, and countries in East and South Asia with the differing socio-cultural characteristics of each sub-region.

The surveys were reported in detail in the previous set of working papers entitled Child Mortality and Injury in Asia, published by the UNICEF Innocenti Research Centre (IRC) in 2007.⁴

The surveys assessed the adequacy of reporting at local and national levels. They counted child drowning directly at the household level in the communities where it occurred and compared it to what was seen or directly reported to nearby health facilities. Examples follow, but the reader is directed to the previous working paper series for further details.

1.3 FACILITY-BASED REPORTING IN LMICS RESULTS IN MOST CASES OF DROWNING BEING MISSED

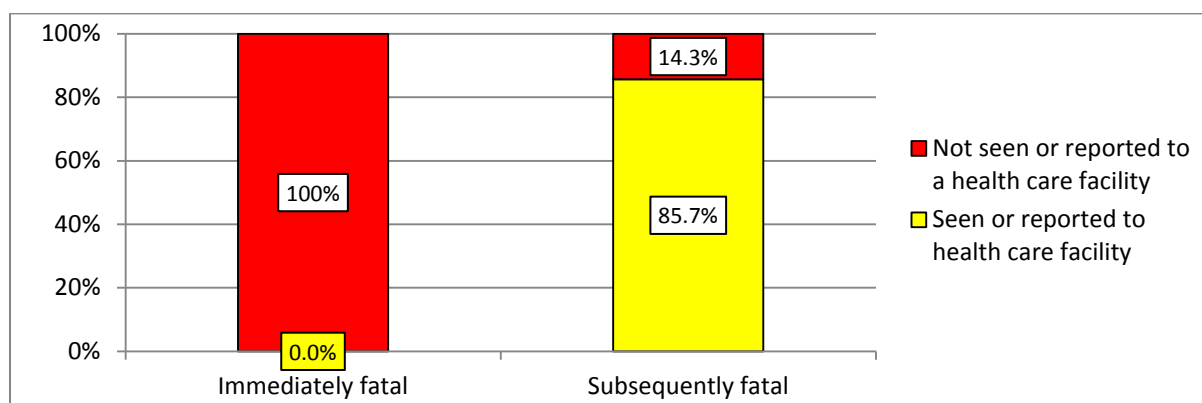
In the surveys, for each case of child drowning in the community, the outcome was categorized as: 'died immediately'; 'initially survived but later died'; 'survived with permanent disability'; or 'survived with no permanent disability'.

- The actions taken on discovery of the child were classified according to whether a rescue was attempted and if so, how it was performed; whether resuscitation was attempted and if so how it was performed, and what the outcome was.
- Follow-up actions related to care-seeking were determined, such as if the child was taken to a health-care provider, and if so, what was the type of provider.
- If the child was not taken to a health-care provider, it was determined if the drowning was reported to a health clinic, hospital or other government facility.

The figures that follow show that most cases of child drowning discovered in the community were not reported to, known about, or treated by the facilities that make up the national health-care system. Consequently, most cases of child drowning were not reflected in the national mortality and morbidity statistics, leading to incomplete and poor quality data reported to WHO.

⁴ See *Special Series on Child Injury*: Linnan, M. et al. (2007). 'Child Mortality and Injury in Asia: An overview', *Innocenti Working Paper*, No. 2007-04. Florence: UNICEF Innocenti Research Centre; Linnan, M. et al. (2007). 'Child Mortality and Injury in Asia: Survey methods', *Innocenti Working Paper*, No. 2007-05, Florence: UNICEF Innocenti Research Centre; Linnan, M. et al. (2007). 'Child Mortality and Injury in Asia: Survey results and evidence', *Innocenti Working Paper*, No. 2007-06, Florence: UNICEF Innocenti Research Centre; Linnan, M. et al. (2007). 'Child Mortality and Injury in Asia: Policy and programme implications', *Innocenti Working Paper*, No. 2007-07, Florence: UNICEF Innocenti Research Centre.

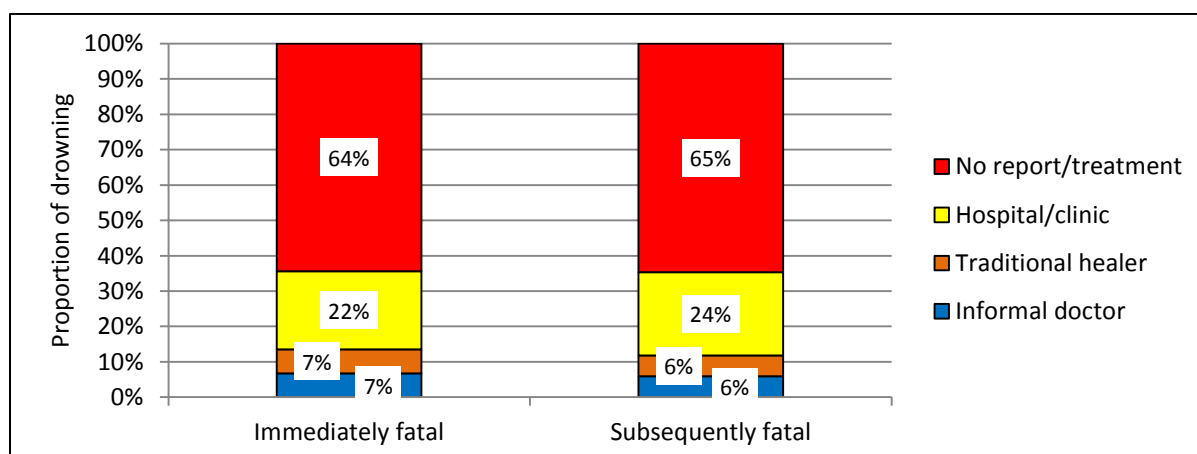
Figure 1: Drowning in Thailand among children 0- 17 years old, by cases seen or reported to a health-care facility, 2003



Source: Survey data from the Thailand National Injury Survey 2003.

Figure 1 shows reporting of the drowning events in the Thai survey. The survey had a nationally representative sample of 100,000 households; the field work was done from 2002–2003. Of 65 child drowning events identified at the community level, only 14 (21.5 per cent) were seen by or reported to a health-care facility (fatal and non-fatal drowning combined). None of the immediately fatal drowning events were seen by or reported to a health-care facility. Overall, the survey found that drowning caused about half of all injury deaths among children. Thus, missing most fatal drowning meant a marked under-reporting of fatal injury as well as fatal drowning. Figure 2 illustrates a similar situation in Bangladesh.

Figure 2: Drowning in Bangladesh among children 0-17 years old, by place of report and/or receipt of care, 2002

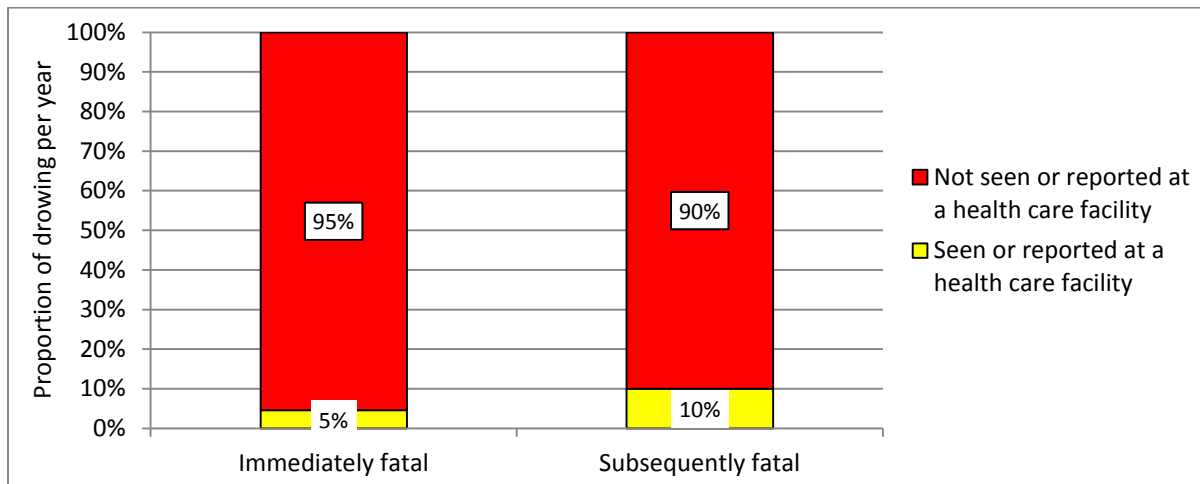


Source: Survey data from the Bangladesh Health and Injury Survey 2002. Note totals exceed 100% due to rounding.

The Bangladesh Health and Injury Survey (BHIS) had a nationally representative sample that included 174,000 households. Field work for the survey was completed in 2003. Figure 2 shows 12 per cent to 14 per cent of fatal drowning events were taken to traditional healers or informal doctors. These are not part of the health reporting system so that drowning was unreported in national health data. Regarding hospitals and health facilities, about two thirds (64 to 65 per cent) of fatal drowning cases (both immediately and subsequently fatal) were not taken for care or reported. Less than a quarter (22 to 24 per cent) of drowning victims were taken for care or reported to a hospital or clinic. Therefore, almost 8

out of 10 (76 to 78 per cent) fatal drowning events were unreported in the health information system. Figure 3 shows a similar situation in Cambodia.

Figure 3: Drowning among children 0–17 years old in Cambodia, by cases presented or reported to a health-care facility, 2006



Source: Survey data from the Cambodia Accident and Injury Survey (CAIS), 2006.

Figure 3 shows that in Cambodia the great majority of drowning was not seen or reported to a health-care facility, whether immediately fatal or subsequently fatal.⁵ Field work for the survey, which used a nationally representative sample of 67,500 households, was done in 2006. Less than 10 per cent of fatal drowning was seen at or reported to a health-care facility.

In Cambodia, similar to both Thailand and Bangladesh, drowning caused about half of all fatal injury in children. Missing most of the cases of fatal drowning results in marked under-reporting of both fatal drowning and all fatal injury.

The survey interviewers in the different countries investigated why drowning deaths were not reported. The responses indicated a lack of perceived benefits for reporting these deaths, and significant disincentives for doing so. The reasons given were practical:

- Due to the immediacy of death from drowning (less than five minutes), most children were already dead when discovered. Therefore there was no reason to seek medical care.
- In several countries, medically unattended deaths require an autopsy, with the person reporting the death bearing financial responsibility for the examination. Given the poverty of most parents, this was a major disincentive.
- In some countries, religion and culture require burial to be carried out on the same day as the death. The requirement to report the death was viewed as a hindrance to completing the ceremony in time and likely to delay the burial.
- Generally, respondents preferred not to contact the authorities, citing a fear that they might be blamed for the child's death.

⁵ Linnan, M., T. Reinten and J. R. Wei (2007). *A final report to UNICEF Cambodia on The Cambodia Accident and Injury Survey, 2007*, Bangkok: The Alliance for Safe Children.

In high-income countries (HICs), before a body can be buried or cremated the death must be reported and a formal death certificate issued. There are incentives to be derived from following that course of action, which play a large part in the relative success of reporting systems. For example, in order to receive death benefits from an insurance policy or a government social security programme, an official death certificate is required. This can only be received by a family if the death has been reported. In LMICs, on the other hand, there are no incentives to reporting the death; in fact, there are a number of disincentives to reporting, as outlined above.

1.4 A CLASSIFICATION SYSTEM UNSUITABLE FOR LMICS

Lack of contact between a family member who has knowledge of the death of a child and the health system is the primary reason for under-reporting drowning. However, in cases where a family member does report the drowning death, the place of report usually lacks the capacity to classify the death appropriately. In LMICs, which are predominantly rural, the village clinic or equivalent facility is the lowest level of the health system. The staff at this lowest level where almost all drowning occurs lack the necessary training to use the International Classification of Diseases (ICD) reporting system⁶ which is mandated by WHO for national reports of death.

The ICD system was developed in HICs for use in HICs. ICD coding staff usually require years of training, with completion of courses in medical anatomy, medical vocabulary, medical terminology, surgical procedural terminology, forensic and medico-legal issues. Trainee coders complete internships before being certified. Coders often specialize in specific types of medical coding due to the complexity of the system. Many HICs have professional bodies to certify the training process and provide continuing education with periodic re-certification due to updated classifications in the ICD, which occurs as often as every year.

In HICs the classification system is effective because coders are trained and supervised to classify the many different causes of death using death certificates, hospital discharge reports, coronial systems and other systems tied to governmental structures. These systems record numerous details of the circumstances surrounding the drowning death, which facilitates correct classification. However, even with all the resources and training available in HICs, there is abundant evidence that the complexity of the system lends itself to substantial problems with performance as noted by many authors.⁷

In HICs, well-trained coders are available at each level of the system, from the specialty hospitals at the top tier down to the facilities at county and city level. There is usually a coroner or medical examiner at each level of the health system as well. No matter where a death occurs or is reported, there is a trained specialist to provide the correct coding details. There is also a supervisor with the same training to provide quality assurance. In contrast, in LMICs the facilities staffed with individuals trained and

⁶The International Classification of Diseases (ICD) dates from 1893 when a classification scheme was adopted based on the system used by the City of Paris, which was itself based on English, German and Swiss systems. The system continued to be administered by the French Government until 1928 when it became a process of the Health Organization of the League of Nations. In 1948 it became a United Nations process with the advent of the World Health Organization and has continued to evolve into an increasingly complex taxonomic system as medicine has advanced. The ICD is published by WHO to standardize collection, processing and presentation of health conditions. New versions occur about every 10 years, with minor updates every year and major updates about every 3 years.

⁷Hunt, P. R., et al. (December 2007). 'Completeness and accuracy of International Classification of Disease (ICD) external cause of injury codes in emergency department electronic data'. *Injury Prevention*, 13(6):422-425; Schwartz, R.J. et al. (July 1995). 'Accuracy of e-codes assigned to emergency department records'. *Academic Emergency Medicine*, 2(7): 615-620; Lu TH, et al. (2007). 'The proportion of injury deaths with unspecified external cause codes – A comparison of Australia, Sweden, Taiwan and the US'. *Injury Prevention*, 13(4):276-281; McKenzie, K., et al. (February 2009). 'Accuracy of external cause-of-injury coding in hospital records'. *Injury Prevention*, 15(1):60-64; Bhalla K, et al. (November 2008). 'Estimating the distribution of external causes in hospital data from injury diagnosis'. *Accident Analysis and Prevention*, 40(6):1822-1829.

certified in the detailed coding procedures for ICD classification are usually only at the top level of the national hospital system. They are absent at community-level urban health centres and village clinics, where almost all drowning mortality actually occurs and where the details surrounding the drowning, required for correct coding, are known. Lacking trained coders at the lowest level where most drownings occur, the death often goes unrecorded. Where it is recorded, the lack of trained coders often results in incorrect, inaccurate or incomplete coding.

In the mid-1990s, the tenth version of the ICD was introduced. ICD-10 brought a major increase in coding complexity, doubling the number of codes to about 18,000. The migration from ICD 9 to ICD 10 required enormous resource commitments that many LMICs lacked. The new version required replacing reporting forms, retraining of all coders, supervisors and trainers. It rendered many of the previous classifications obsolete, causing comparability issues with data from previous years. In particular, the changes in coding for drowning raised questions because ICD-10 drowning codes are not mutually exclusive. This can result in duplicate counting, creating potential problems in determining incidence of drowning events.⁸ Further potential for incomparability exists with the upcoming revision. ICD-11, planned for 2015 has major changes in codes and classification structures which will further complicate any transition. As a result, many countries have not adopted ICD-10 and continue to use ICD-9.

For countries using ICD-9, the drowning codes focus on the recreational activity undertaken at the time of the drowning event (see Table 1). The categories are mainly applicable to HICs. Recreational activities such as water skiing and sport, or recreational activity with diving equipment are not relevant to LMICs. The table also includes a code for drowning in the bathtub. Rural homes in LMICs generally do not have bathtubs, making this category irrelevant for the great majority of cases of drowning in LMICs. Using ICD-9, even when reported, virtually all drowning would be classified as 'other', or 'unspecified place of occurrence code'. This has led users to question the utility of the classification system, which is a major disincentive to complete and correct coding.

Table 1: ICD-9 codes for drowning (1992)

E910	Accidental drowning and submersion
E910.0	While water-skiing
E910.1	While engaged in other sport or recreational activity with diving equipment
E910.2	While engaged in other sport or recreational activity without diving
E910.3	While swimming or diving for purposes other than recreation or sport
E910.4	In bathtub
E910.8	Other
E910.9	Unspecified place of occurrence code

One result of the change to ICD-10 was a change in focus for the mechanism of drowning (e.g. falling into a swimming pool versus being in the swimming pool, or falling into a bathtub versus being in the bathtub). The nature of the activity in the water body changed as well from ICD-9 to ICD-10 with water-skiing, other water sports, recreation and diving no longer mentioned. In ICD-10, the three digit codes (W65-W74) refer to the act of falling into water or being in the water as seen in table 2 below.

⁸ Langley J.D. and D. J. Chalmers (1999). 'Coding the circumstances of injury: ICD-10 a step forward or backwards?' *Injury Prevention*, 5:247-253.

Table 2: ICD-10 drowning (1997)

W65	While in bathtub
W66	Following fall into bathtub
W67	While in swimming pool
W68	Following fall into swimming pool
W69	While in natural water
W70	Following fall into natural water
W73	Other specified
W74	Unspecified

The drowning codes included in ICD-10 were designed to suit the environment of HICs, and their lack of applicability undermines use in LMICs. Most of the specific codes are not relevant for LMICs. In LMICs, most drowning occurs in rural areas and rural homes do not have bathtubs. Swimming pools are essentially non-existent. In LMICs, almost every source of water that constitutes a drowning hazard is 'natural water'. This term includes ditches, ponds, lakes, rivers and the ocean. Given the tendency of users of classification systems such as ICD-10 to overlook non-specific categories, almost all drowning would likely be classified in the non-specific codes "other" or "unspecified". Coding most drowning as "other" or "unspecified" is often seen as lacking utility and provides little impetus for completion of coding.

There are similar issues of unsuitability to LMICs seen in the location code appended to the drowning code in ICD-10 as a fourth digit. Table 3 shows the location codes.

Table 3: Location code for drowning (ICD-10, 1997)

.0 Home
.1 Residential institution
.2 School, other institution, public administrative area
.3 Sports and athletics area
.4 Street or highway
.5 Trade and service area
.6 Industrial or construction area
.8 Other specified place
.9 Unspecified place

In LMICs, most drowning in early childhood occurs nearby, but outside the home. Most drowning in older children occurs away from the home, but in agricultural settings that do not appear in the table and are not associated with the codes .0 through .6. Thus, the vast majority of drowning in LMICs would be coded as "other specified place" or "unspecified place". Again, coding most drowning in other or unspecified categories (.8 and .9) provides little impetus for careful and complete coding.

In summary, many aspects of the ICD system limit its appropriateness for reporting drowning in LMICs:

- The complexity requires users to undergo lengthy training and extensive periodic retraining. This is generally not available in LMICs.
- The few coders who have the training to be able to correctly use the ICD system are mainly located at top level referral hospitals. Very few, if any drowning patients are seen at these

facilities. The vast majority of drowning patients who are seen in facilities are seen at the lowest level clinics and health centres which lack staff with the training to code properly.

- The system works best in tandem with coronial systems and health information systems. These either do not exist or are severely constrained in LMICs.
- The lack of appropriate reporting categories that fit the environment of LMICs results in little perceived utility, which creates a major disincentive for reporting.

The systemic factors noted above result in poor performance of the reporting system. Cultural factors such as the reluctance of parents to bring drowned children to hospitals and the significant proportion of drowning that is seen by informal providers (traditional healers, etc) who do not report, all combine with the systemic factors. The end result is poor quality in the available drowning data at national level.

The issues noted relate to systemic factors such as the lack of resources and the practicalities of LMICs. There is also a structural issue that causes the ICD system to underestimate drowning incidence. Whether a drowning incident is classified as 'drowning' in the ICD system depends on where the drowning incident occurs. If it occurs as a result of a transport incident (e.g. car crashing into a pond, ship sinking), a flood or natural disaster, or from an assault or suicide, it is not classified as 'drowning', but as a sub-classification of transport, disaster or violence. This conflicts with the definition of drowning used by the global specialized drowning prevention and research community.

Representatives of the International Life Saving Federation and other lead drowning researchers led a global process in 2002 that created a standard definition of drowning. Drowning was defined as "death due to respiratory impairment resulting from immersion in a liquid".⁹ This applies to drowning in any environment and from any predisposing factor. However, ICD-10 excludes deaths as drowning if their occurrence stems from transport (ICD-10 codes V90, 92; ship sinking, boating accidents, etc.); environmental forces of nature (X-36-X-39, floods, hurricanes, typhoons, tsunamis, etc.); intentional self-harm (X-71, from suicide by drowning, etc.); and assault (X-92, assault by drowning and submersion). These excluded causes have been found to be responsible for a large proportion of total drowning in some HIC countries; 39 per cent in one study¹⁰ and between 40 to 50 per cent in another.¹¹

The impact of these biases results in large underestimates of child drowning. This has implications far beyond the specialized drowning research and prevention community. Drowning makes up a large proportion of total child deaths in LMICs in Asia. In the surveys it accounted for half of all child deaths from injury. Because drowning is largely under-reported, it also results in the lack of awareness that injury is a leading cause of child mortality in LMICs in Asia.

1.5 INCOMPLETE AND POOR QUALITY DATA REPORTED TO THE WORLD HEALTH ORGANIZATION

National reports are aggregated at the global level in the WHO Mortality Database. In 2005, an assessment was done of coverage and quality of the data reported to WHO. Of 192 WHO member countries, 114 had no data available or no data more recent than 1990. In the South East Asia region, none of the 11 countries assessed – including Bangladesh – had any data reported, or none reported after 1990. Fourteen of 27 countries assessed in the Western Pacific – including Cambodia and Viet Nam

⁹ International Life Saving Federation Position Statement: Swimming and Water Safety Education, available at: www.ilsf.org/index.php?q=en/about/statements_05.htm accessed 12 October 2011.

¹⁰ Passmore, J.W., J O. Smith and A. Clapperton (March 2007). 'True burden of drowning: Compiling data to meet a new definition'. *International Journal of Injury Control and Safety Promotion*, 14(1):1-3.

¹¹ Lunetta, P. et al. (October 2004). 'Unintentional drowning in Finland 1970–2000: A population-based study'. *International Journal of Epidemiology*, 33(5):1053-1063.

– had no data reported, or none reported since 1990. Thailand had usable data reported, but it was considered to be of poor quality.¹²

The problems introduced by requiring reporting in health facilities and using a classification system designed for use in HICs results in incomplete and poor quality data reported to WHO. Extensive adjustments are required in order to make use of this data. However, the multiple biases are not systematic and the poor quality of the data makes adjustment a very difficult process.

1.6 ADJUSTING INCOMPLETE NATIONAL DATA FOR GLOBAL ESTIMATES

Lacking complete and accurate reports from its member states, WHO has had to develop a process to correct and adjust reported data, as well as to impute missing drowning data. The process of completing, imputing and adjusting the reported mortality data for use in constructing the Global Burden of Disease (GBD) estimates is described in detail elsewhere.¹³ A brief summary of the GBD 2004 process that resulted in the estimations for the time period covered by the TASC-UNICEF country surveys follows:

- The first step was to indirectly estimate age-specific death rates by sex, using life tables derived from available data. The data were adjusted for coverage and completeness.
- Adjustments were made by reclassifying misclassified deaths and reassigning and redistributing deaths coded to partially-specified causes.
- Injury deaths, including drowning, were estimated by statistical models (GBD CODMOD - case of death model) and regional patterns of death.
- Mortality rates were constructed for 21 causes of death used in the GBD process. Once constructed, expert groups undertook country-level analyses to establish national rates for mortality by age, sex and cause, and adjusted for internal consistency and validity.

The lack of reporting of fatal drowning in national information systems requires the use of this adjustment process, which starts with large underestimates and corrects them by external adjustment. The complexity of the processes, the uncertainties involved in the adjustments, and the multiple non-linear sources of possible bias make this a process fraught with potential for error.

Some of this potential for error is due to the need to impute, estimate and adjust, but it is also in part due to definitional issues and problems in the ICD classification system. This can be seen with data from HICs in Asia-Pacific. These data come from death registries, coronial reports and other national systems that are far more complete and accurate than those used in Asian LMICs. Because of this, they are much less likely to require imputation and/or estimations through modeling. However, there are still significant differences when compared with GBD estimates. For example, in Australia, differences between GBD 2004 data and those produced by the Royal Life Saving Society Australia (RLSSA) for similar periods, show the GBD figures underestimate fatal drowning by more than 50 per cent.¹⁴

Following the GBD 2004 estimates, a second GBD process was undertaken to estimate the drowning rates and numbers of drowning for a 2008 update. Some of the difficulty and the inherent uncertainty

¹² Mathers, c. et al. (2005). 'Counting the Dead and What They Died from: An assessment of global status of cause of death data'. *Bulletin of the World Health Organization*, 83:171-177.

¹³ World Health Organization, *Global Burden of Disease 2004 Update*, Annex B, Data Sources and Methods, Geneva: WHO.

¹⁴ World Health Organization, *Global Burden of Disease 2004* figure 186 for Australia and Royal Life Saving Society Australia, *National Drowning Report 2011* figure (p. 3) is 286 for the 2004-2005 time period, a difference of 54 per cent.

can be seen in the changes that resulted in the 2008 GBD estimates when compared to the 2004 estimates. Table 3 compares the GBD 2004 and GBD 2008 estimates for fatal drowning in children 0-14 years old in LMIC countries in the Asian region.

Table 3: Changes in Global Burden of Disease fatal drowning estimates between 2004 and 2008, children 0-14 years old in LMICs in Asia¹⁵

Country	GBD 2004		GBD 2008		GBD 2004-2008 change			
	Number	Rate	Number	Rate	Number	% change	Rate	% change
Afghanistan	1,469	12.96	2,171	17.23	+701	+47.7	+4.27	+32.9
Bangladesh	3,828	7.14	2,573	5.02	-1,255	-32.8	-2.12	-29.7
Bhutan	10	4.87	14	6.67	+4	+37.6	+1.80	+37.1
Cambodia	1,074	20.37	796	16.01	-279	-25.93	-4.36	-21.4
China	50,339	17.28	27,289	9.90	-23,050	-45.8	-7.38	-42.7
India	21,785	5.84	32,166	8.58	+10,381	+47.7	+2.75	+47.0
Indonesia	3,050	4.76	1,628	2.62	-1,422	-46.6	-2.14	-45.0
Malaysia	336	4.19	212	2.62	-124	-36.8	-1.57	-37.4
Maldives	6	5.82	3	3.60	-3	-46.5	-2.22	-38.1
Nepal	833	7.96	541	5.05	-292	-35.1	-2.91	-36.6
Pakistan	3,380	5.72	3,423	5.19	+43	+1.3	-0.53	-9.3
Papua New Guinea	231	9.52	201	7.65	-29	-12.7	-1.87	-19.7
Philippines	2,027	6.70	1,640	5.30	-387	-19.1	-1.41	-21.0
Sri Lanka	72	1.52	6	0.12	-66	-91.7	-1.40	-92.0
Thailand	1,322	9.61	1,604	10.84	+281	+21.3	+1.23	+12.8
Timor-Leste	30	6.49	24	4.92	-6	-18.9	-1.57	-24.2
Viet Nam	1,311	5.14	2,537	10.98	+1,226	+93.5	+5.84	+113.5

The Asian region contains the majority of children in the world. Five of the countries above have almost a billion children in total.¹⁶ Due to the change in population in these countries over the four-year period 2004 to 2008, the numbers of fatal drowning would be expected to change. However, lacking any change in drowning risk factors, drowning rates would be expected to remain the same. In these five countries, drowning rates changed between -45 per cent and +47 per cent, accounting for a difference of over 36,000 children drowning in the two estimates in the same countries. Rates changed an average of 34.7 per cent in the five countries. Across the 17 Asian LMICs listed, the range of change in rates exceeded 200 per cent (Viet Nam increased 113.5% and Sri Lanka decreased 92 per cent).

The differences are not limited to the Asian region. Research conducted by the International Life Saving Federation (ILS) shows large differences between the national reported figure in the GBD process and that reported by many of its members in HICs. Some ILS members in HICs produce comprehensive national drowning reports that use the globally accepted drowning definition, and collect and review

¹⁵ These Global Burden of Disease (GBD) figures are an underestimate of all drowning deaths, since they exclude drowning due to cataclysms (floods), water and other transport accidents, assaults and suicide.

¹⁶ India 447,309,000; China 322,163,000; Indonesia 77,787,000; Pakistan 73,227,000; Bangladesh 55,938,000 totaling 976,424,000 children under 18 in 2010 according to *The State of the World's Children 2012*, UNICEF New York, February 2012, table 6, pp. 108-111.

data from multiple sources including national death registries, coronial investigations and other national mortality reporting systems. The differences between GBD figures and the member reported figures range from +50 per cent (Australia) to +300 per cent (United Kingdom).¹⁷

The GBD estimates have many uncertainties built into them. Normally, estimates with such an amount of uncertainty are stated with confidence intervals (e.g. 95% confidence intervals) or a range of likelihood scenarios (e.g. low, medium and high ranges). Listing a single, precise number can suggest precision in an estimate that is not there, especially to non-technically trained policy-makers.

Table 4 below shows for children aged 0-14, direct comparisons for the GBD 2004 estimates of fatal child drowning with the estimated numbers of drowning deaths in three countries surveyed.

Table 4: WHO Global Burden of Disease estimates and survey estimates of fatal drowning among children 0-14 years old

Country	GBD 2004 estimated drowning deaths	Drowning deaths estimated in the country survey	Year of survey	Percentage difference
Bangladesh	3,828	16,452	2002	+330%
Thailand	1,322	2,093	2003	+58%
Cambodia	1,074	1,871	2006	+74%

Source: Data from countries included in surveys (Bangladesh Health and Injury Survey, Cambodia Accident and Injury Survey, Thailand National Injury Survey) and World Health Organization Global Burden of Disease website. The comparison is between children aged 0–14, as GBD does not include a category for children aged 0- 17 years.

There is a substantial difference between the numbers of fatal child drowning deaths estimated by the GBD 2004 and by the surveys done in the three countries. Apart from regular seasonal flooding, there were no aquatic disasters or other factors that would increase the rate of child drowning in the three countries during the period. National records do not show any significant differences in annual reporting during the same period. The most likely explanation for the large difference is the virtual impossibility of adjusting for all the errors, biases, undercounts, and incompleteness in the raw data used in the estimation process. Many of the factors involved are simply unknowable. There are no means of validating the results against reliable drowning data from other LMICs as such reliable data does not exist. Hence the estimates, even when adjusted for the known factor of not counting drowning from transport, natural cataclysms and intentional injury, may have substantial inaccuracies built in.

The GBD 2008 update reported even lower drowning numbers in Bangladesh (-32.8%), Cambodia (25.9%), and an increase in Thailand (+21.3%) resulting in a net reduction in drowning deaths compared to 2004. The increase in Thailand is not related to the Indian Ocean tsunami (Dec 26, 2004). It was during the 2004 GBD time frame and this was a cataclysm of nature; thus these drowning deaths are excluded from GBD estimates. There were no other changes in environmental conditions or risk factors for drowning in the three countries between 2005 and 2008, further increasing the disparity between the GBD estimates and the country surveys.

Other corroborating evidence of the potential for large undercounts is available from India. The GBD 2004 estimate for India was 21,785 drowning deaths in children 0-14 years of age. The Million Death Study (MDS), a nationally representative verbal autopsy study in India, covered more than 1.1 million

¹⁷ Franklin R.C. and J. Scarr (2011). 'ILS Drowning Data and Research Survey', International Life Saving Federation, Leuven; in press.

homes and estimated 26,000 drowning deaths in children 0-4 years old in 2005. This figure was 20 per cent larger than the GBD estimate for the entire 0-14 age group.¹⁸ If the proportion of under-five drowning in India compared to the rest of childhood is similar to the proportion in the other LMICs surveyed, this would result in an undercount of the GBD estimates of at least 50 per cent. The GBD 2008 estimate increased 47.7 per cent and the additional information from the MDS may have been a factor.

Similar discrepancies were found with other causes of death in the MDS compared to GBD estimates, leading to questions concerning the accuracy and precision of the GBD methodology for estimating cause-specific mortality. For example, the GBD estimated 5,000 malaria deaths among children 0-4 year olds in India, whereas the MDS estimated a figure 11 times as large, 55,000 deaths.¹⁹

Drowning estimates that use imputation, modeling and expert adjustment have outputs where the estimate is composed of 'virtual deaths'. These virtual deaths are determined by an algorithm rather than by counting actual deaths. As virtual deaths, they exist in models and other outputs, but they do not exist as actual children who have drowned. The deaths cannot be physically verified as real deaths. Unless the virtual drowning is corroborated by measurements of actual drowning where age, sex and cause can be determined, they are physically unverifiable estimates. In the absence of reliable data that facilitates estimates based on a count of actual deaths, the use of virtual death estimation serves a policy purpose by allowing planners to prioritize causes of death. However, they may lead to unintended policy consequences if the estimates produced are not accurate.

There is a clear need for reliable data to underpin policy formulation. Given the choice between making policy decisions without any data versus using the best available data adjusted by modeling and expert review, the latter is the preferred process. However, recognizing the great potential for unintended adverse consequences in using such data, it is important to validate the modeled and adjusted outputs with actual measurements. There are a number of ways in which this can be done with mortality estimates. Some examples are:

- Introducing a special drowning module (or an injury module with a drowning sub-module) into an already planned large-scale nationally representative survey such as a national household health survey. These are usually conducted once every five years in many LMICs. The costs would be minimized by inclusion in an already planned survey. The findings would help validate external estimates made for the country as well as provide useful injury and drowning mortality data to national policymakers. This is often done in HICs to collect specific information on a particular disease or condition.
- Use the mortality sample from the most recent national census or inter-census in a country, which provides data every five years. The homes identified in the census as having deaths could be visited and a verbal autopsy conducted to allow specific causes of death to be determined. The costs would be minimized by using an already determined mortality sample. The mortality by cause data linked to the other social and demographic data from the census would add significant information for policymakers broadly across sectors. A modified version of this was used for the Million Death Study (MDS).
- In some countries, another possibility would be to establish nationally representative community surveillance systems that measure incidence of death in the community by specific cause. This is being done with the Disease Surveillance Points (DSP) system in China.

¹⁸ Jagnoor J. et al. (2011). 'Unintentional injury deaths among children younger than 5 years of age in India: A nationally representative study'; *Injury Prevention*, 17: 151-155.
¹⁹ Neeraj, Dhingra et al. (November 2010). 'Adult and child malaria mortality in India: A nationally representative mortality survey'; *The Lancet*, 376 (9754): 1768-1774.

A combination of these approaches in key countries in the regions where data was lacking would provide validation for the modeled and adjusted estimates outputs for the countries in the region. In the three countries mentioned above, the substantial differences between the GBD fatal drowning estimates and the national survey estimates, as well as the large changes in sequential GBD estimations only 4 years apart lends uncertainty to policymaking for prevention of child drowning that is based on these numbers.

1.7. A NEW ISSUE OR SIMPLY AN UNRECOGNIZED ISSUE?

An important question to ask is whether the large number of deaths from drowning is due to drowning replacing infectious and other causes of disease now being prevented by child survival programmes, or whether it has always been present but simply unrecognized due to biased reporting systems. This is important because it will drive policy choices in selecting which causes of child mortality for interventions or for funding research necessary to develop interventions.

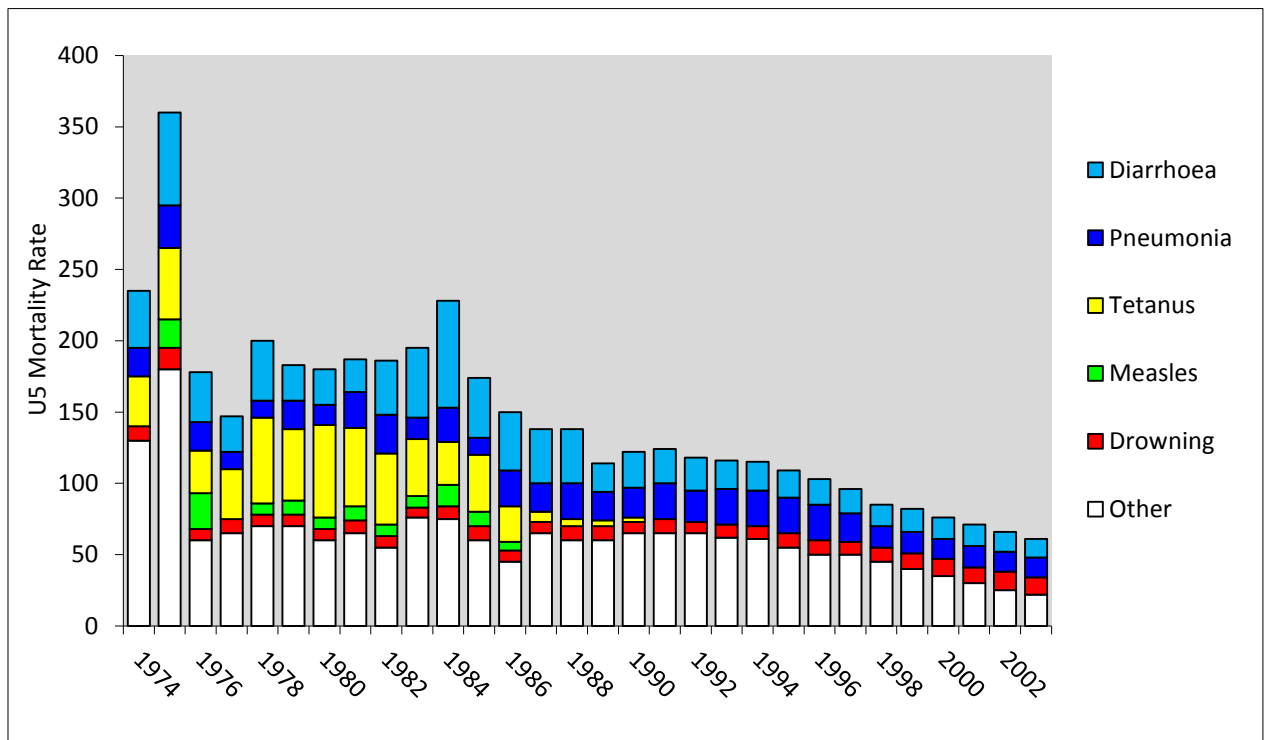
If drowning is replacement mortality, then it occurs after the primary causes of mortality have been eliminated. In this case, the priorities will be to eliminate the primary causes which precede drowning. If it is concurrent mortality that happens alongside the other causes of mortality – one that has always been there but is only now recognized – then drowning itself is a primary cause of early child death. As a primary cause, to rapidly decrease early child mortality, drowning interventions need to be integrated with programmes that target other primary causes of early child death, such as respiratory infections, diarrhoeal diseases and nutritional causes.

While the significant number of drowning cases has been invisible to most in the child and public health community, some public health experts such as researchers at Matlab, Bangladesh, have been aware of the problem for the past three decades. The Matlab Demographic Surveillance System (DSS) associated with the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) has provided precise information on the issue. ICDDR,B has published numerous reports that have specifically commented on the significance of child drowning on early childhood mortality and noted the increasing proportion of early child deaths due to drowning.²⁰

The Matlab DSS shows that drowning has been an ever-present and significant child-killer over the past three decades. It has not become a new cause of death as more children have survived due to immunizations, breastfeeding or other child survival interventions. It has been concurrent primary mortality alongside the other leading causes of child mortality such as measles. Figure 4 shows causes of under-five mortality from 1974 to 2003.

²⁰ Baqui, A. H. et al. (1998). 'Causes of childhood deaths in Bangladesh: Results of a nationwide verbal autopsy study'. *Bulletin of the World Health Organization*, 76(2): 161-171; Ahmed M. K., M. Rahman and J. van Ginneken (April 1999). 'Epidemiology of child deaths due to drowning in Matlab, Bangladesh', *International Journal of Epidemiology* 28: 306-311; International Centre for Diarrhoeal Disease Research, Bangladesh (November 2002). 'The emergence of drowning as a principal cause of childhood death in Bangladesh'. *Health and Science Bulletin*, 1(1): 10-12; Baqui, A. H. et al. (June 2001). 'Causes of childhood deaths in Bangladesh: An update', *Acta Paediatrica*; 90(6): 682-690.

Figure 4: Under-5 mortality rate by cause of death, Matlab, Bangladesh, 1974-2003

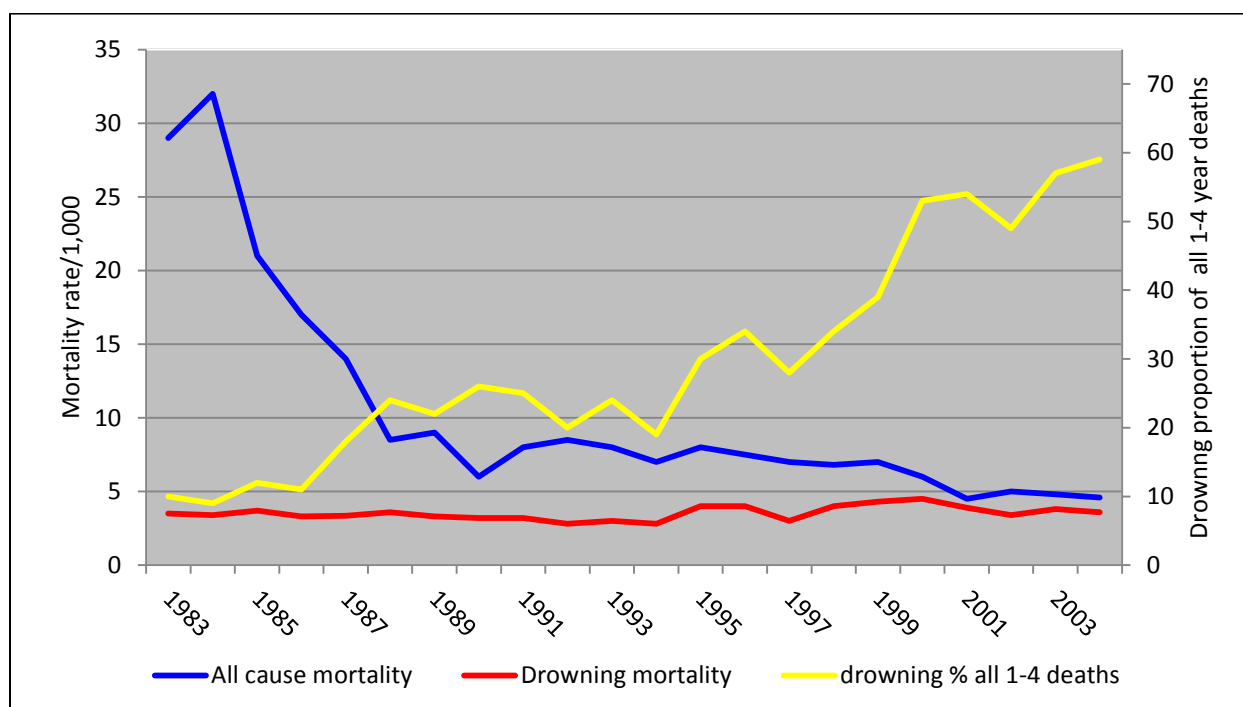


Source: International Centre for Diarrhoeal Disease Research, Dhaka, 2003.

In the pre-immunization era (1975-1980) drowning killed about the same number of children as measles. As measles and other vaccine-preventable causes of death were eliminated, drowning rose as a proportion of all deaths among children under five. This can be seen in Figure 5.²¹

²¹ International Centre for Diarrhoeal Disease Research, Bangladesh (November 2002). 'The Emergence of Drowning as a Principal Cause of Childhood Death in Bangladesh', ICDDR,B Periodicals, *Health and Science Bulletin*, 1(1).

Figure 5: Proportional mortality by cause in children 1-4 years old, Matlab, Bangladesh, 1983-2003

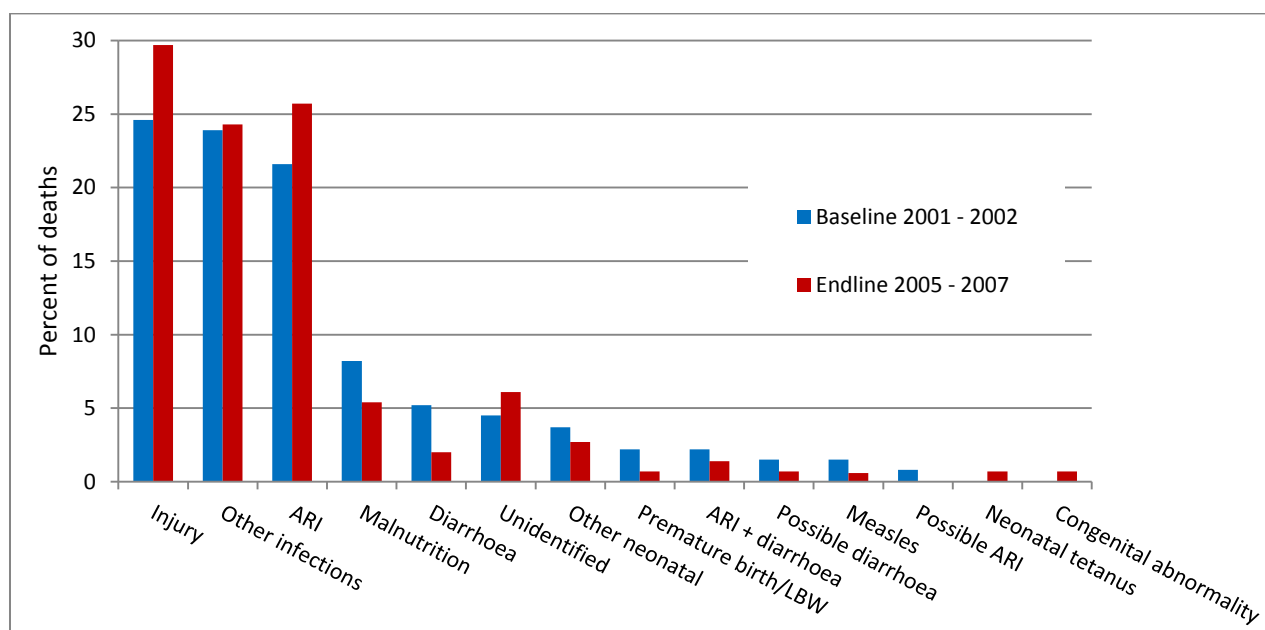


Source: *Health and Demographic Surveillance System Report*, International Centre for Diarrhoeal Disease Research, Dhaka, 2003.

Figure 5 shows a stable rate of fatal drowning over the 20 years reported from 1983 to the end of the reporting period in 2003. The red line at the bottom of the chart (read on the left axis) shows drowning mortality in children 1-4 years old. It is essentially unchanged at about 4 drowning deaths per 1,000 children over the 20 year period 1983 to 2003. As other causes of mortality (blue line, rates read on left axis) have decreased over the period due to widespread implementation of effective interventions, the proportion of drowning mortality as a percentage of all deaths has increased. This is shown by the yellow line whose value can be read on the vertical axis on the right side of the chart. While responsible for 9 per cent of deaths among children aged 1-4 in 1983 (yellow line, right axis), drowning was responsible for 57 per cent of deaths among the same age group 20 years later in 2003 (yellow line, right axis).

Although figure 5 excludes infants, drowning is a significant killer of infants as well as children aged 1-4, as can be seen in Figure 6.

Figure 6: Causes of mortality in IMCI trial, children 0-4 years old, Matlab, Bangladesh, 2001-2002 and 2005-2007



Source: Arifeen S. et al. (August 2009). 'Effect of the Integrated Management of Childhood Illness strategy on childhood mortality and nutrition in a rural area of in Bangladesh: A cluster randomized trial', *The Lancet*, 374(9687):393-403, table 3.

Figure 6 shows that injury, including drowning, now impacts under-five mortality in both infants under one and children 1-4 years old. The first month of life (the neonatal period) is the period with the largest number of deaths in childhood. Injury was responsible for almost one out of four (24.6 per cent deaths) in children from day 7 of life through 59 months in 2001-2002.²² The figure also shows that over the five-year period of the Integrated Management of Childhood Illnesses (IMCI) trial, injury increased from 24.6 per cent deaths at the baseline to 29.7 per cent at the end of the trial. This is consistent with the previous figure showing the increasing proportion of deaths from drowning among children 1-4 years old over the period 1983 to 2003.

Reports from the Matlab DSS as well as findings from the 2003 Bangladesh Health and Injury Survey show that over 9 out of 10 injury deaths in children aged 1-4 are due to drowning.²³ Since this cohort is a key age group for attainment of MDG4, it follows that drowning reduction is an important strategy for achievement of the goal.

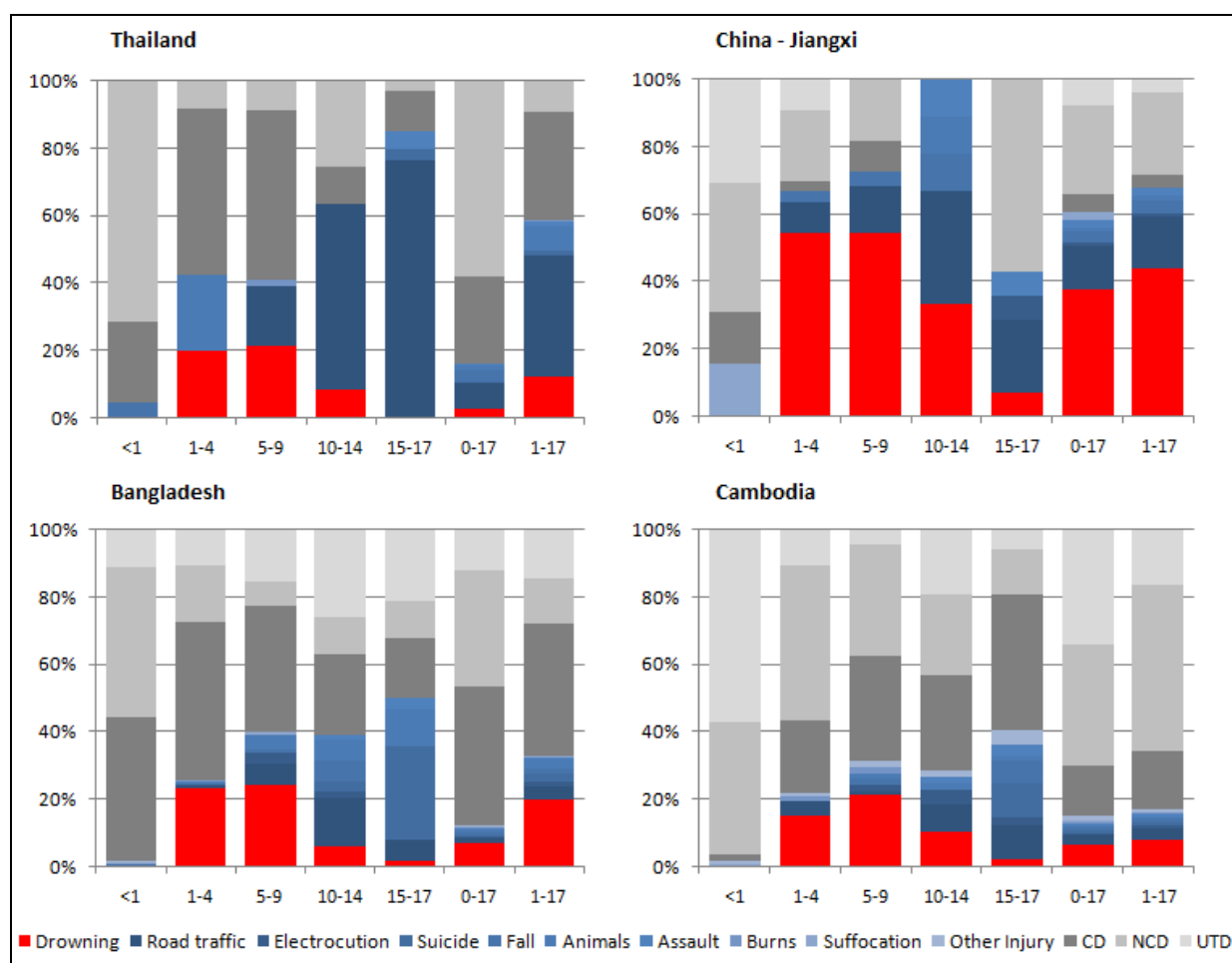
1.8 IMPACT ON EARLY CHILD MORTALITY IN THE ASIAN REGION

Drowning rates are especially high in early childhood. The peak rates are usually in the second year of life. Over half of drowning occurs before the end of the fifth year of life. Unless drowning reduction becomes a priority in countries struggling with early child mortality reduction, this may present a major barrier to MDG 4 achievement. The large proportional contribution of drowning in early child mortality in LMIC countries in Asia is shown in Figure 7.

²² Arifeen S. et al. (2009). 'Effect of the Integrated Management of Childhood Illness strategy on childhood mortality and nutrition in a rural area of in Bangladesh: A cluster randomized trial', *The Lancet* 374:393-403.

²³ Rahman, A. et al. (January 2005). *Bangladesh Health and Injury Survey: Report on children*. Dhaka: Government of the People's Republic of Bangladesh, Institute of Child and Mother Health, United Nations Children's Fund and The Alliance for Safe Children.

Figure 7: Mortality among children 0-17 years old, by cause and age group



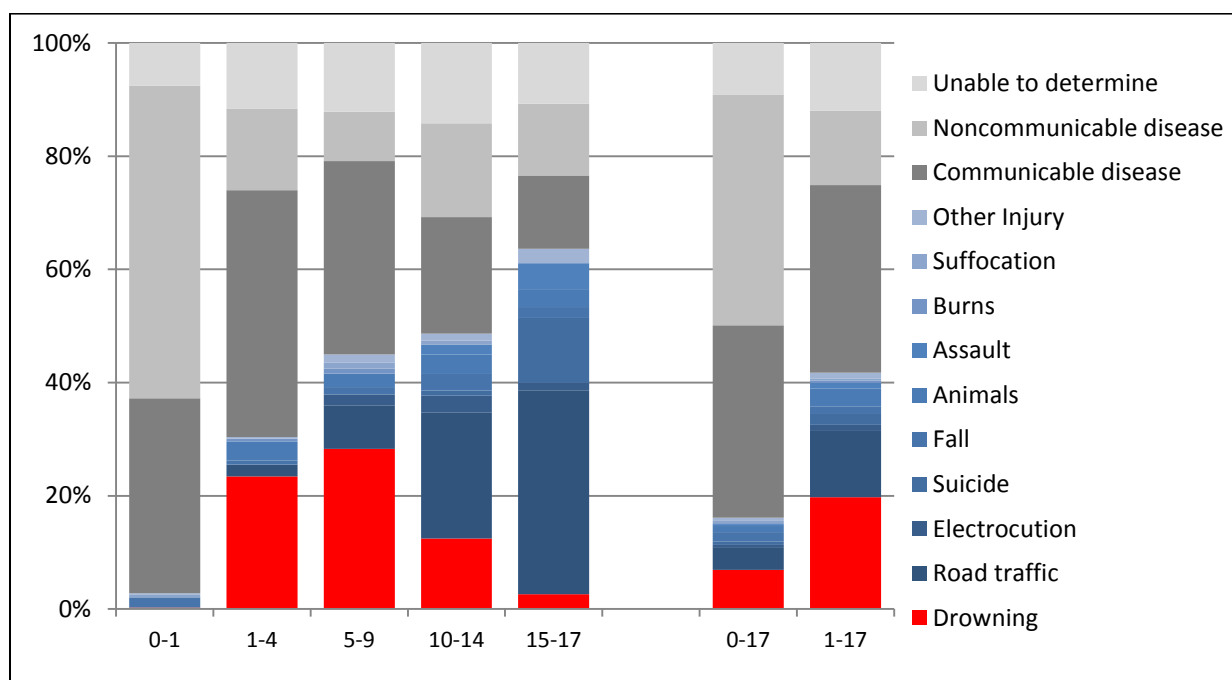
Source: Data from countries included in the surveys: Bangladesh Health and Injury Survey 2002, Cambodia Accident and Injury Survey 2006, Jiangxi Injury Survey 2005 (China) and Thailand National Injury Survey 2003.

Drowning is represented by the red bars in each graph. The bars of different shades of blue represent other injury causes (such as road traffic, animal bites, burns, falls, etc.). The dark grey bars represent communicable disease (CD) and the medium grey bars represent non-communicable disease (NCD). The light grey bar at the top of each country represents those deaths where the cause was unable to be determined (UTD) by the verbal autopsy process.

At a glance, it is clear that drowning makes up a significant proportion of child mortality in each country and is heavily concentrated in early childhood. Yet drowning interventions are currently not included in child mortality reduction interventions in any of the country programmes.

In the countries surveyed that have not yet achieved MDG 4 (Bangladesh and Cambodia), the proportion of mortality due to drowning in the 1-4 age group will present an impediment to achievement of the goal. For the two countries surveyed that have already achieved MDG 4 (China and Thailand), given that drowning is responsible for a large proportion of deaths among children it will be difficult to continue to drive down early child mortality rates rapidly until it is addressed.

Figure 8: Mortality among children 0-17 years old, by cause and age group



Source: Data from the countries included in surveys: Bangladesh Health and Injury Survey 2002, Cambodia Accident and Injury Survey 2006, Jiangxi China Injury Survey 2005, Thailand National Injury Survey 2003; population weighted for composite.

Figure 8 combines data from the surveys and shows the prominence of drowning as it relates to overall child mortality in the countries surveyed. However, there are a number of caveats related to this composite:

- Sample surveys were used and sampling introduces uncertainty in the results.
- There is increased uncertainty in the results obtained for each cause of mortality because the pooling techniques used introduce additional uncertainty when combining the individual surveys.
- The composite is more representative of East Asia than South Asia due to the countries surveyed.

For China and India, the two largest countries in Asia, only China (one province) is included in the composite. Jiangxi Province, a middle tier province in China, was selected to be representative of the country over all. Jiangxi, with a population of 44 million people, makes up only 4 per cent of the country's population. India, which has an under-18 population of 447 million,²⁴ is not included and makes up a large proportion of the child population of the Asian region. However, the patterns and levels of drowning mortality for the composite closely match what is seen in China's Disease Surveillance Points (DSP) system and India's Million Death Study (MDS). Both of these use representative population-based national samples.

One conclusion is that in Asian LMICs, which contain almost two-thirds of the world's children, drowning needs to be an urgent health policy priority. It would help achieve progress in reducing mortality among children under five, and accelerate progress in improving mortality for children of all ages.

²⁴ United Nations Children's Fund (2012). *The State of the World's Children 2012*. New York: UNICEF, table 6, p. 109.

A second conclusion is that the current system for determining and reporting drowning does not work well. The need to count deaths with reasonable precision and accuracy is a fundamental requirement for properly informing health policy and resource-allocation decisions. The available evidence shows large differences in results according to how a drowning is counted. Some differences are related to the place of detection and report, whether in the community or through a facility-based system. Some are due to the ICD classification system used, which performs best in HICs and is unsuited to LMICs. Both of these result in the need to correct the data reported to fill in the many large gaps, impute data that are not available and adjust the results. The complexity involved and the multiple non-linear sources of bias make this a difficult task with large potential for error. The sum of all the biases and uncertainties have masked a fundamentally important factor in child health: drowning is a leading cause of child death in LMICs in Asia. Any cause of mortality of this magnitude requires attention and intervention.

2. HOW AND WHY CHILDREN DROWN IN LMICS IN ASIA

For the sake of brevity, this paper addresses the proportion of child mortality in Asian LMICs caused by drowning. It does not include non-fatal drowning. Non-fatal drowning occurs at approximately the same rates as fatal drowning, in similar circumstances and with similar causes. Non-fatal drowning is included in several of the figures in this section to highlight the fact that the overall drowning burden is twice as large as that of fatal drowning.

2.1 HOW CHILDREN DROWN IN LMICS IN ASIA AND IMPLICATIONS FOR PREVENTION

There are many similarities for drowning among children aged 0-17 years in all the countries surveyed. The following apply to all the countries:

- Most children drown before age four.
- Most children drown in rural areas.
- More males drown than females, especially after age five.
- Before age four, 80 per cent of children drown at or within 20 metres of the home.
- After age four, more than 90 per cent of children drown 100 metres or more from home.
- For children of all ages, 75 per cent drown between the hours of 8 a.m. to 4 p.m. Less than 5 per cent drown at night between 8 p.m. and 6 a.m.
- For children of all ages, 90 per cent drown in sunny weather, 5 per cent during rainy weather, and 5 per cent during flooding from monsoons.
- For children over age four, 95 per cent drown while engaging in non-recreational activities or daily activities, 5 per cent during recreation and less than 2 per cent in pre-planned swimming activity.
- Ship/ferry accidents are not a substantial factor in overall child drowning deaths.
- Swimming pools are not a factor in child drowning deaths.

Table 5: Median age of drowning by country surveyed

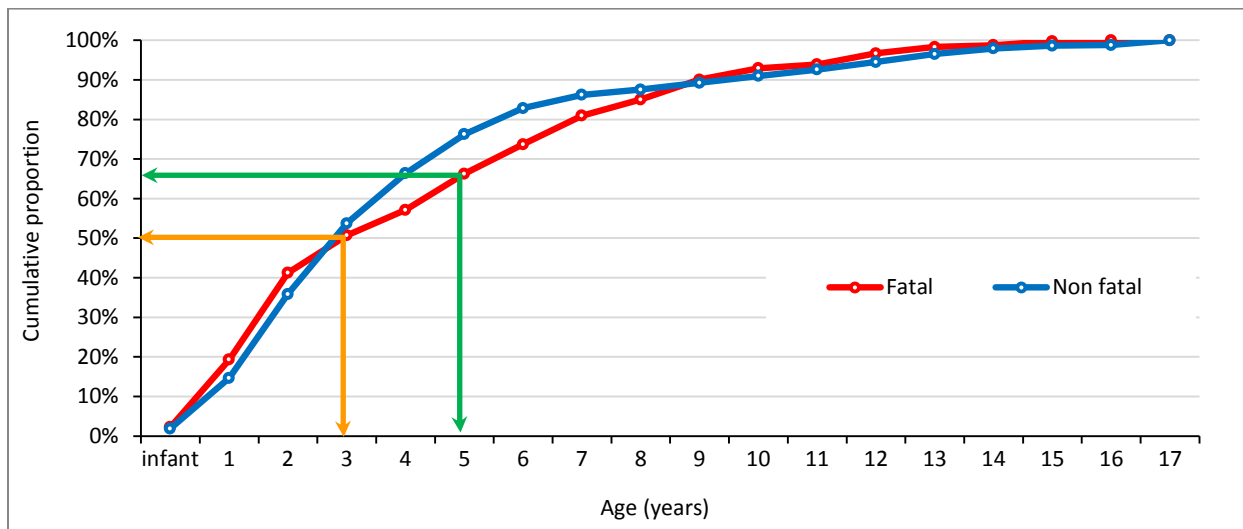
Country	Bangladesh	Cambodia	Jiangxi, China	Thailand	Viet Nam
Median age at drowning (years)	2.3	3.7	3.5	3.8	3.9

Source: Authors calculations from the data.

Table 5 shows the age by which half of all child drowning has occurred. Most drowning occurs very early in childhood. To make a major reduction in fatal drowning, interventions need to begin as early in a child's life as possible.

Figure 9 shows the proportion of drowning, both fatal and non-fatal, that occurs among children of different ages.

Figure 9: Cumulative proportion of fatal and non-fatal drowning among children, by age

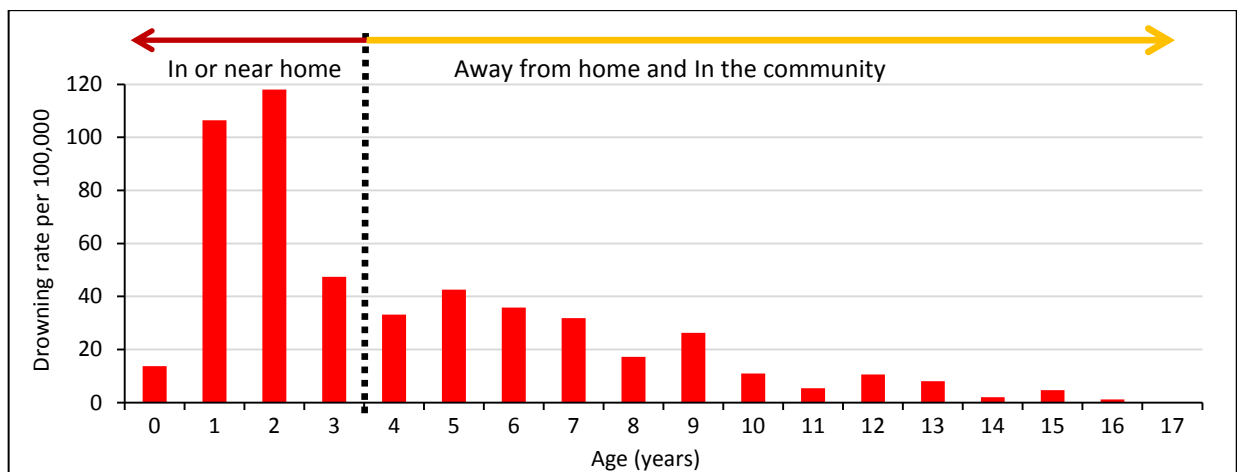


Source: Data from composite of survey countries: Bangladesh 2002, Cambodia 2006, China (Jiangxi Province) 2005, Thailand 2003 and Viet Nam 2001.

The distribution of fatal drowning is mirrored in distribution of non-fatal drowning. One clear message of the graph is the later in childhood intervention is begun, the less effective it will be in addressing all children at risk of drowning. The yellow line shows that the median age of drowning under which half of all fatal child drowning occurs is three years old. The green line shows that two thirds of all fatal drowning in childhood has occurred by five years of age. Since interventions are different for very young children and older children, from a prevention perspective there are two different scenarios to address.

Figure 10 shows the distribution in the two age groups.

Figure 10: Fatal drowning rates among children, by age and place of occurrence



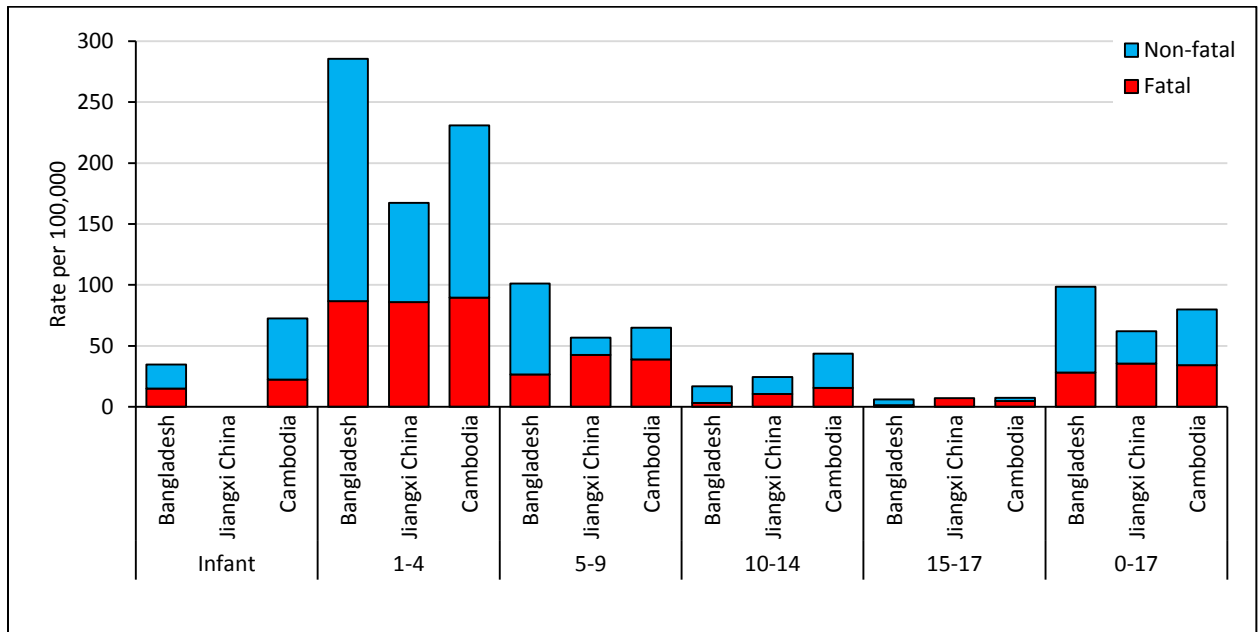
Source: Survey data, population weighted composite of Bangladesh 2002, Cambodia 2006, China (Beijing 2004, Jiangxi 2005), Thailand 2003 and Viet Nam 2001.

Drowning occurs throughout childhood. However, there are two separate epidemics: one affects children under four years of age and accounts for the majority of drowning. It occurs because very young children escape caretaker supervision and drown in unprotected water sources within 20 metres of the home. Their caretakers are often unaware of the drowning for an hour or longer. The second is for older children who drown further from home, 100 metres or more, where they swim alone or with a

same-aged peer who does not have swimming, rescue or resuscitation skills. They drown in the community, but without any rescue from community members.

The two scenarios require different intervention approaches. For the children who escape supervision and drown close to home, the interventions must focus on parents, caretakers and the home environment. The intervention for older children who drown further from the home must focus on children themselves as the drowning occurs when they are without caretakers and alone or with same-aged peers in the community.

Figure 11: Rates of fatal and non-fatal drowning among children, by country and age group



Source: Data from the countries included the Bangladesh Health and Injury Survey (BHIS) 2002, Cambodia Accident and Injury Survey (CAIS) 2006 and Jiangxi (China) Injury Survey (JIS) 2005 and weighted composite based on the size of child population.

Figure 11 shows drowning rates, both fatal and non-fatal, by country and stage of childhood. The ratio of fatal to non-fatal drowning averaged over the three countries is approximately 1:1.

It is very different in HICs like Australia where the ratio is 1:4. The difference in the ratio is because in Australia, as well as other HICs, many drowning events are prevented from becoming fatal. This is in part due to large numbers of lifeguards in high-utilization recreational areas, a high prevalence in the community of bystanders with training in rescue and resuscitation skills and the immediate availability of emergency medical services in the community.²⁵

²⁵ Kreisfeld, R. and G. Henley (March 2008). 'Deaths and hospitalisations due to drowning, Australia 1999-00 to 2003-04', in *AIHW Injury Research and Statistics Series No. 39*. Canberra.

Table 6 shows the severity of the non-fatal drowning events in Bangladesh, Cambodia, China (Jiangxi Province) and Thailand.

Table 6: Severity of non-fatal child drowning events, by country, children 0-17 years old

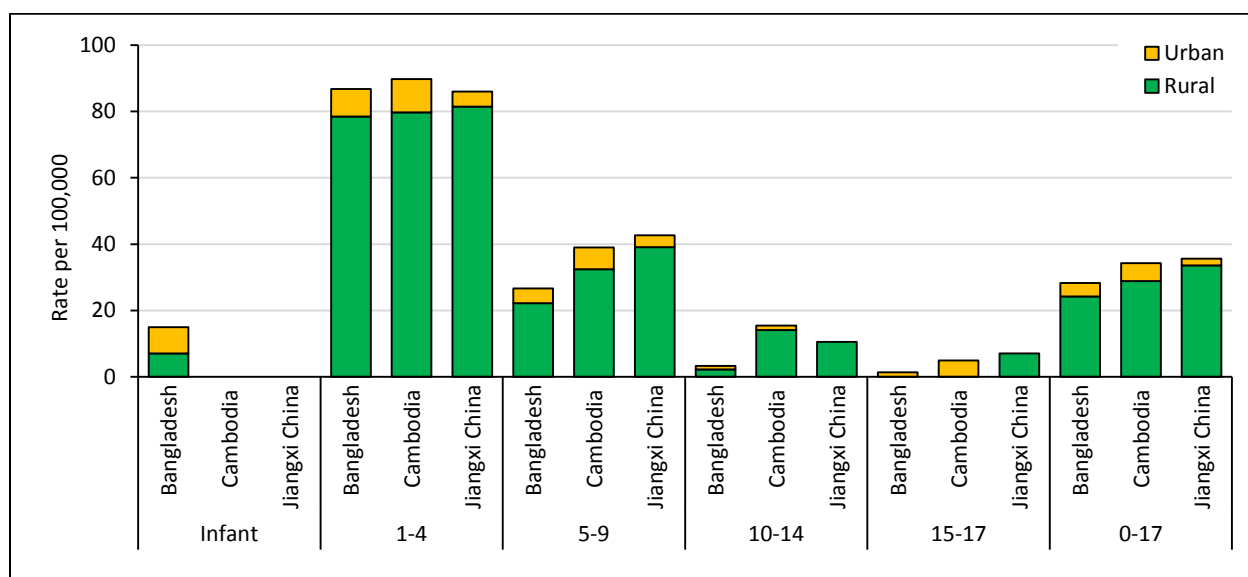
Country Surveyed	Injury Severity Levels				Proportion of non-fatal drowning in total injury morbidity
	Moderate: Sought medical care/missed at least one day school or work	Major: Hospitalized 1-9 days	Serious: Hospitalized more than 9 days	Severe: Permanent physical disability	
Bangladesh	94%	6%			7.2%
Cambodia	79%	15%	4%	2%	1.0%
Jiangxi, China	81%	15%	4%		0.5%
Thailand	62%	31%	7%		1.4%

Source: Survey data from the countries included, Bangladesh Health and Injury Survey (BHIS) 2002, Cambodia Accident and Injury Survey (CAIS) 2006, Jiangxi (China) Injury Survey (JIS) 2005 and Thailand National Injury Survey (TNIS) 2003.

In all the countries surveyed, the overwhelming majority of non-fatal drowning cases were classified as moderate, which is the least severe category. This underscores the nature of child drowning in LMICs where drowning either kills children or leaves them relatively unharmed. This is primarily due to the lack of trained responders in the community, which means that no rescue and resuscitation occurs and a drowning child is left to rescue him or herself.

It is notable that in Thailand the severity distribution is different, with less than two thirds (62 per cent) of non-fatal drowning in the moderate category, and with almost one third (31 per cent) in the major category and 7 per cent in the serious category. In contrast to Bangladesh, Cambodia and Jiangxi Province, China, which are categorized as low income, Thailand is now a middle-income country. That stage of development is characterized by an education system that may allow more community members to be first responders and a development level has expanded emergency response outreach capacity from hospitals into communities.

Figure 12: Rate of fatal drowning by country, age group and urban or rural location



Source: Survey data from countries included, Bangladesh Health and Injury Survey (BHIS) 2002, Cambodia Accident and Injury Survey (CAIS) 2006, and Jiangxi (China) Injury Survey (JIS) 2005.

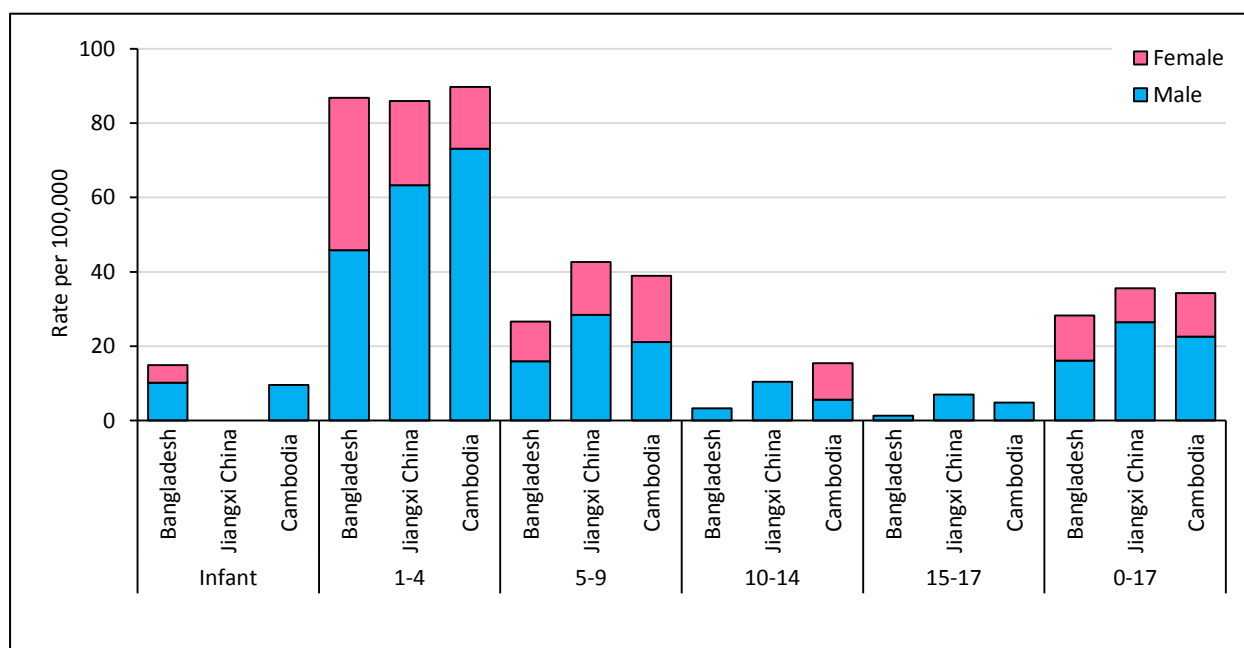
Figure 12 shows drowning rates are higher in rural areas than in urban areas. Yet the difference is not as large as the figure suggests since in each country the proportion of rural population is also quite high. For example, in Cambodia only 14 per cent of the population is urban and 14 per cent of drowning occurs among urban residents; Bangladesh is 24 per cent urban and 15 per cent of drowning occurs among urban residents.

While drowning rates are higher among rural children, the surveys show that urban children are at high risk of drowning. The need for convenient water sources for daily life means that drowning hazards are prevalent throughout urban environments. Where running water is available indoors, bathtubs, buckets and water storage containers place young children at risk, especially when their caretaker is an older sibling and not an adult. Where running water is not available, families are forced to store large volumes of water to meet their daily needs, and these storage containers become drowning hazards for very young children. Outside the home, urban children are at risk from the many drains, ditches, construction sites and other water hazards that are ubiquitous in the environment.

In Beijing, China, the Beijing Injury Survey conducted in 2004, found drowning as the leading cause of death in childhood.²⁶ The prevention implication is that children of all ages, whether urban or rural, are at risk of drowning and are in need of intervention programmes.

²⁶ Beijing Injury Survey, child injury report. September 2004; National Working Committee for Women and Children, Department of Disease Control, Ministry of Health and Chinese Field Epidemiology Program, China Centers for Disease Control.

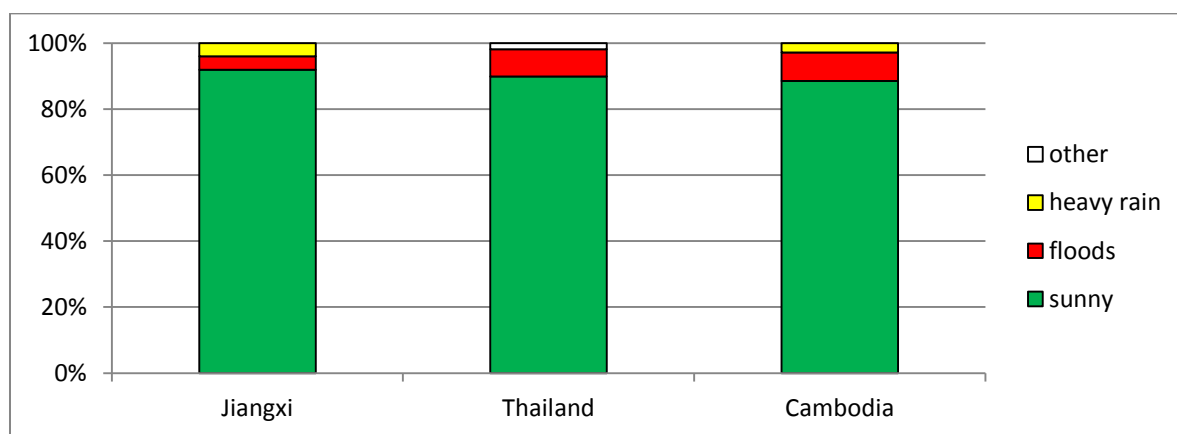
Figure 13: Fatal drowning rates by country, age group and gender



Source: Survey data from countries included, Bangladesh Health and Injury Survey (BHIS) 2002, Cambodia Accident and Injury Survey (CAIS) 2006 and Jiangxi (China) Injury Survey (JIS) 2005.

The majority of fatal drowning occurs among males, as seen in Figure 13. (This is also the case for non-fatal drowning, which is not shown in the chart.) Male predominance is seen in virtually all population studies of drowning, whether in HICs or LMICs. As a result, being male is often referred to as a risk factor for drowning. However, while males are at higher risk, drowning rates are also high in females and interventions therefore need to target children of both sexes.

Figure 14: Drowning among children 0-17 years old and weather conditions at time of fatal drowning, by country



Source: Survey data from countries included, Cambodia Accident and Injury Survey (CAIS) 2006, Jiangxi (China) Injury Survey (JIS) 2005 and Thailand National Injury Survey (TNIS) 2003.

Figure 14 shows for children of all ages, 90 per cent of drowning occurs in sunny weather, 5 per cent in heavy rains and 5 per cent in floods due to annual seasonal rains (monsoons). There is a common belief that drowning rates are higher in the rainy season because of floods from monsoons or prolonged rains.

In the countries surveyed, drowning rates did vary seasonally, with the highest rates occurring during the rainy season. However, most drowning occurs in the non-rainy season, which typically occupies over two thirds of the calendar year and therefore lasts much longer than the rainy season, which occupies one third or less of the year. The surveys also showed that most drowning during the rainy season occurred in sunny weather. The rains did not cause actual flooding, but increased the amount of standing water in ditches and ponds, and resulted in many more water hazards in the environment. Children were able to play outside the house during sunny weather, which exposed them to the risk of drowning. From a prevention perspective it is necessary to target drowning as a year-round event rather than a cyclical one and to tailor interventions accordingly.

2.2 DISASTERS MAKE HEADLINES, BUT ARE NOT THE CAUSE OF THE MAGNITUDE OF CHILD DROWNING

A common misconception is that aquatic disasters, such as tsunamis, flooding or ship/ferry accidents are a leading contributor to child drowning deaths in Asian LMICs. The surveys showed this is not the case. Aquatic disasters can have a significant regional impact but are rare events such as the Indian Ocean tsunami in 2004. While tsunamis can involve many tens of thousands of children drowning as was the case in Aceh, Indonesia, the rare occurrence of a disaster of this magnitude (usually less than once every 20 years) means the everyday drowning that occurs each year is responsible for the great majority of drowning deaths.

More recently, the devastating monsoon floods across south-east Asia from June to November 2011 provide a similar example. The regional total was almost 1,500 deaths with a large proportion of them children.²⁷ However, the surveys show that many times this number of children drown every year in each of the countries affected by the flooding. The surveys found that ferry disasters, which often occur multiple times a year, were responsible for less than 1 per cent of child drowning deaths. These types of mass casualty accidents generate significant media attention but are not a substantial cause of child drowning deaths.

The impression that aquatic disasters cause most drowning is directly related to what is perceived to be newsworthy. Journalists rarely hear about individual drowning deaths; yet when a ferry capsizes, a large area floods or a tsunami occurs, a full-scale rescue and recovery operation is mounted, which draws the attention of the press. As opposed to the fatal drowning of a child, which is immediate, these events tend to be drawn out over time, so journalists have time to reach the site to cover the event as it occurs. The death of a child in a drowning incident is tragic for the family and their community, but there are rarely political or broader social implications that would be considered newsworthy.

The surveys showed the vast majority of the annual drowning deaths among children occur during their daily life. Since these child drowning deaths occur individually, they rarely attract media attention. Yet the numbers are so great that over the course of the year, they account for the largest number of drowned children.

2.3 NOTABLE ISSUES FROM THE COUNTRY DATA

The data from the multiple country surveys highlighted several issues regarding child drowning in LMICs in Asia. These include:

²⁷ International Disaster Database, Centre for Research on Epidemiology of Disasters, [www.emdat.be/result-disaster-profiles?disgroup=natural&dis_type=Flood&period=2011\\$2011](http://www.emdat.be/result-disaster-profiles?disgroup=natural&dis_type=Flood&period=2011$2011); accessed 2 January 2012.

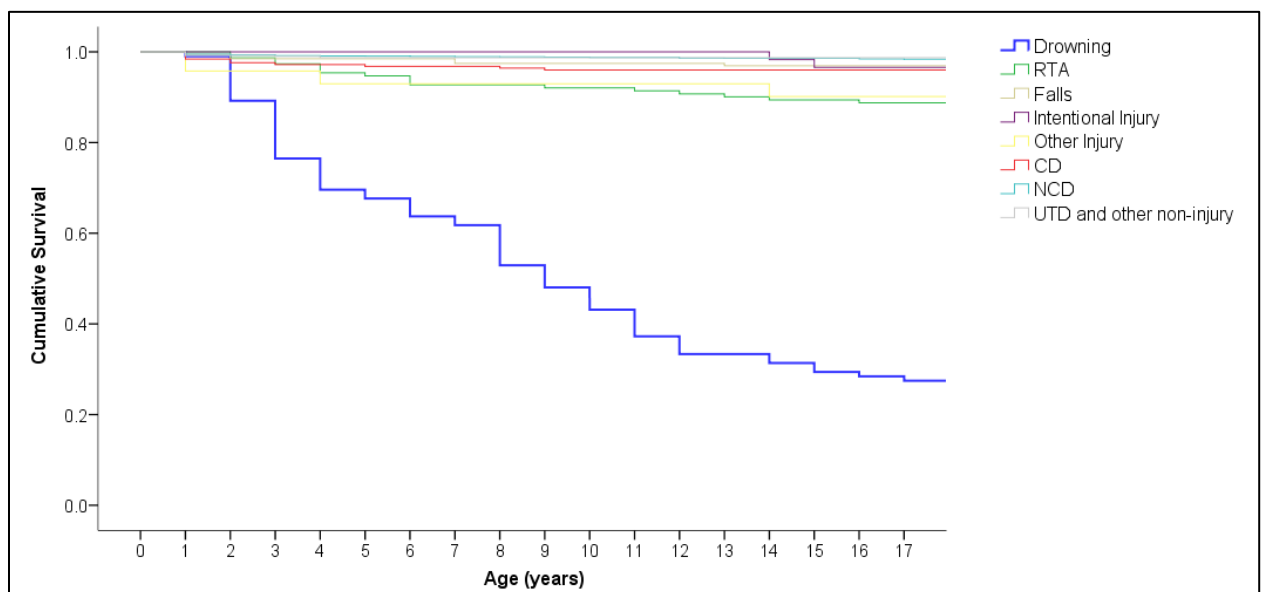
1. Drowning risks are higher when children are left in the care of grandparents in the absence of their parents.
2. Drowning mortality rates are high regardless of the level of childhood mortality.
3. There may be important regional differences related to pre-school practices.
4. There are very few swimming pools in LMICs so drowning in pools is not a factor.
5. Traditional resuscitation practices are often harmful to children.
6. Significant health and social investments are lost when a child drowns.
7. While floods are only responsible for a small proportion of drowning, drowning is an unrecognized cause of child mortality in floods.

Each of these issues is discussed in detail in the following section.

Drowning risks increase when parents are migrants

Economic development may be a risk factor for drowning when it leads to high urban migration by parents, who often leave their children behind in the care of their grandparents.

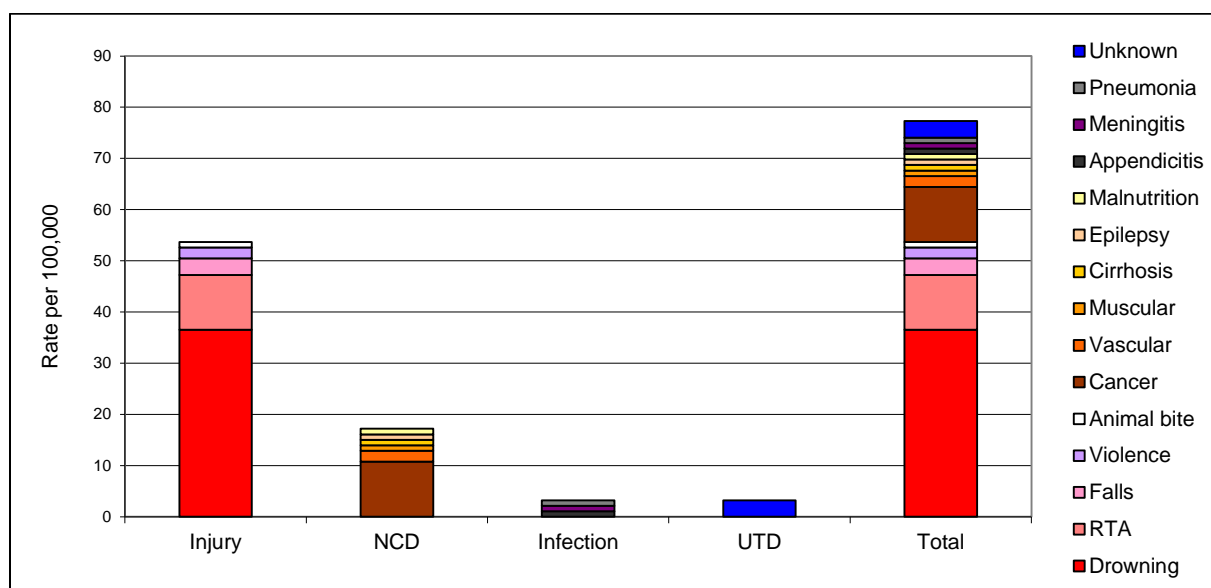
Figure 15: Survival plot for children 0-17 years old in Jiangxi Province, China, 2005



Source: Authors' calculations from the Jiangxi Injury Survey (JIS) 2005.

Figure 15 shows survival according to the age of child and cause of death in the Jiangxi Injury Survey (JIS). Jiangxi has high migration rates as parents seek economic opportunities in wealthy coastal cities, leaving their children behind in the care of grandparents. Large numbers of these children are at particular risk of drowning because older, often infirm grandparents are unable to provide the appropriate level of supervision. A little more than one out of four homes in the JIS sample were homes with children left behind (29 per cent) but these children made up more than half (53 per cent) of the child drowning deaths. Figure 16 shows injury was responsible for half of 1-17 year old deaths and drowning was responsible for over two thirds of the injury deaths.

Figure 16: Mortality by cause among children 1-17 years old, Jiangxi Province, China



Source: Authors' calculations from the Jiangxi Injury Survey (JIS) 2005.

The increased drowning rate in children left in the care of grandparents was a large portion of the drowning burden among children in Jiangxi Province. For children 1-17 years old the relative risk of dying from drowning was two thirds less (0.36) when living with a parent compared to not living with a parent.²⁸ Relative to children living with their parents, children left in the care of their grandparents were 2.8 times more likely to die of drowning.²⁹

Drowning mortality rates are high regardless of the level of childhood mortality

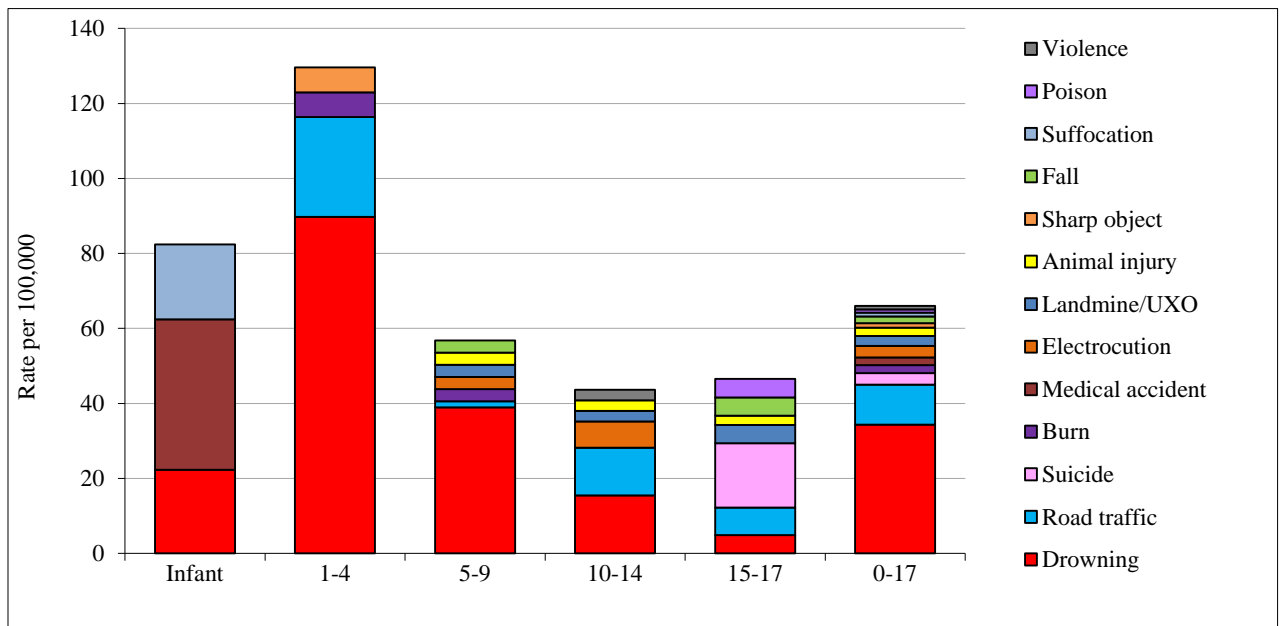
There is a common misconception that injury death rates (including drowning) are high only when overall levels of child mortality are low. At current development levels in the countries surveyed, drowning rates are high regardless of level of child mortality. The figures above show high drowning rates in Jiangxi, China where the overall level of child mortality is low. The IMR in the Jiangxi survey was 19.2/1,000 live births and the U5MR was 25.4/1,000 live births, both considered low child mortality levels for LMICs.

Figure 17 below shows that drowning rates are high as well in Cambodia, one of the few east Asian LMICs that are still considered to have high levels of child mortality. The IMR in the Cambodia survey was 52.9/1,000 live births and the U5MR was 74.4/1,000 live births.

²⁸ Linnan, M., R.W. Jing and T. Reinten-Reynolds (August 2007). 'An In-Depth Analysis of the Health Aspects of Children Left Behind in the Jiangxi Injury Survey', Report to UNICEF China, Bangkok: The Alliance for Safe Children.

²⁹ Linnan, H., et al. 'Drowning rates in children left behind, Jiangxi Province, China'. In: Scarr et al (eds.), World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p. 74, accessed at: www.worldconferenceondrowningprevention2011.org

Figure 17: Cause of injury death in Cambodia among children aged 0-17



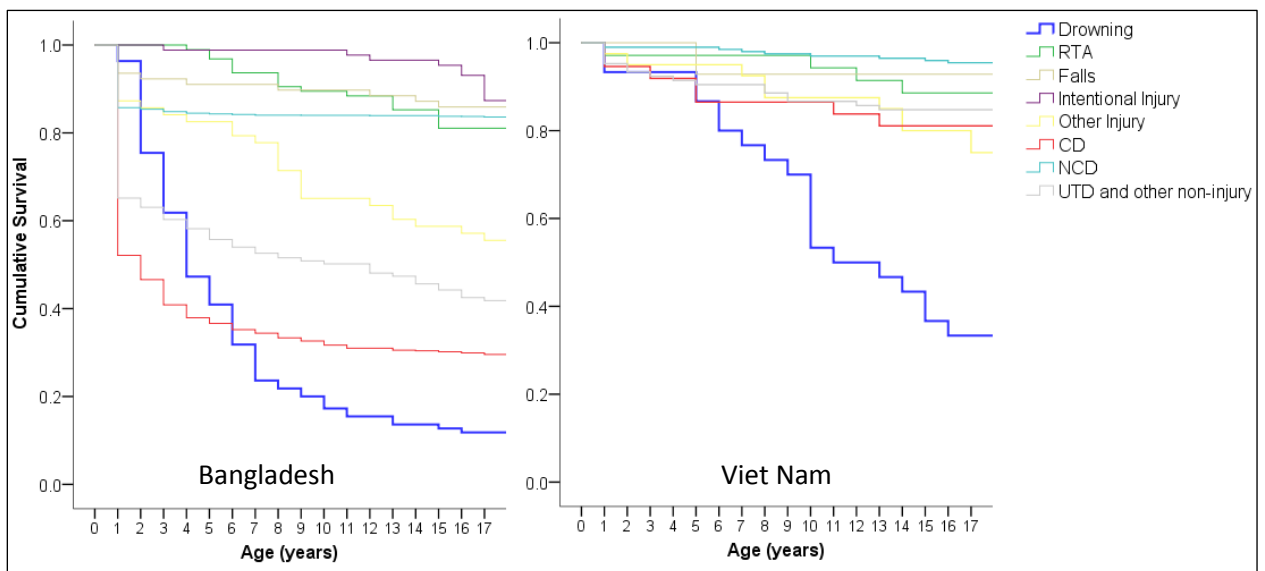
Source: Authors' calculations from the Cambodia Accident and Injury Survey (CAIS) 2006.

It is clear that in Cambodia, which has high child mortality, drowning death rates are high.

In the surveys, drowning was a leading cause of death for children regardless of overall levels of child mortality.

Regional differences in child drowning

Figure 18: Survival plots of childhood (ages 0-17) in Bangladesh and Viet Nam



Source: Authors' calculations, Bangladesh Health and Injury Survey (BHIS) 2002 and the Vietnam Multi-Center Injury Survey (VMIS) 2001.

The two survival plots above from Bangladesh and Viet Nam illustrate a point of difference for childhood drowning between South Asia and East Asia. In Bangladesh, drowning mortality (the blue line) starts at an early age and reflects highest rates (i.e. falls most rapidly) between the ages of 2 and 7. The median age of drowning is very early in childhood, at 2.3 years. In contrast, in Viet Nam drowning occurs at about the same rate as other causes of death until age 5, when drowning rates begin to increase. This results in an older median age of drowning of 3.9 years.

The difference in rates is associated with children's external environment during early childhood. In Bangladesh, very few children attend pre-school, while in Viet Nam most children do attend. This has a large impact on drowning rates in early childhood as children typically drown during the same hours as they would have attended pre-school. Since Vietnamese children are at school, they are in a safe haven under the constant supervision of adult caretakers and protected from exposure to water hazards. In contrast, in Bangladesh, few children attend preschool and drowning rates are high during these hours as children are often left unattended while their caretakers do household chores.

This pattern may represent important regional differences. Countries in East Asia tend to have higher pre-school attendance for children in early childhood than countries in South Asia, possibly due to the high levels of development that have occurred across East Asia over the past several decades. While it can be a useful generalization in comparing regional differences in child drowning, the pattern is not universal. There are still East Asian countries that have lower rates of development and high rates of early child mortality, such as Cambodia, where preschool attendance rates are low.³⁰

The findings indicate that the pre-school environment provides a safe haven from drowning. It also extends a protection umbrella for other forms of injury. Accelerating efforts to introduce pre-school in the countries where it does not yet exist can be an effective strategy to prevent early child drowning, in addition to conferring other educational, social and cognitive benefits on young children.

In LMICs, children do not drown in swimming pools

It is notable that despite the very large survey sample sizes and the multiple years of recall, no child was found to have drowned in a swimming pool. Pools are very rare in LMICs in Asia. They are usually present in the capital city for use by the national swimming team, in private schools or in hotels that cater to tourists. Given the scarcity of pools, an extremely small fraction of the child population is at risk of drowning in a swimming pool.

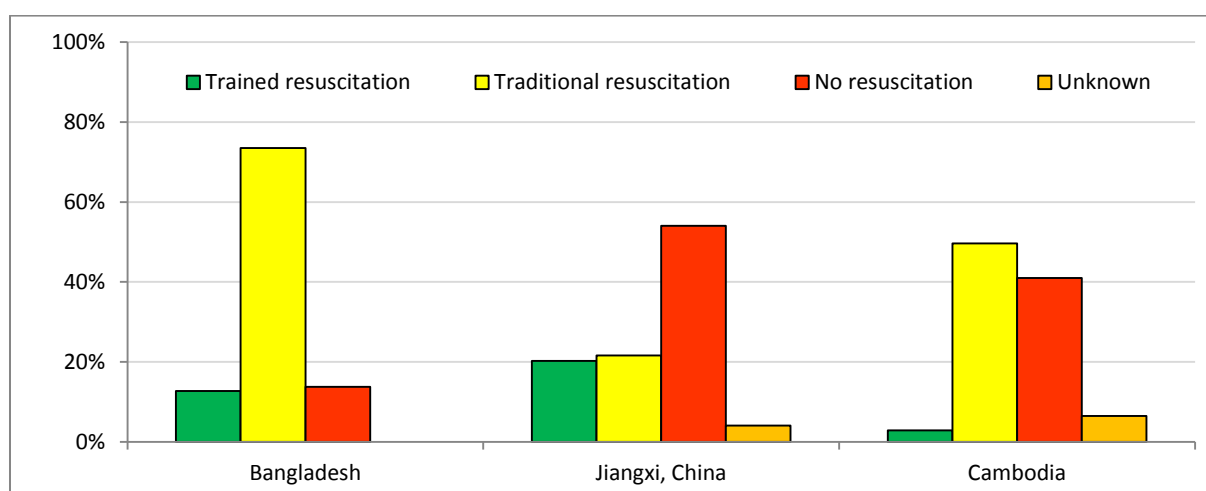
Consequently, drowning prevention strategies for HICs that rely on the presence of lifeguards and pool fencing will be ineffective in LMICs since the vast majority of child drowning occurs during non-recreational activity and in the normal course of their daily lives.

Traditional resuscitation practices are often harmful to children

In contrast to HICs, resuscitation skills at community level are rare in the LMICs surveyed. Figure 19 below shows the proportion of drowned children who received resuscitation.

³⁰ Linnan, M., J. R. Wei and T. Reinten (March 2009). 'Technical Report on Child Injury in Cambodia', Report to UNICEF Cambodia. Bangkok: The Alliance for Safe Children.

Figure 19: Resuscitation received by drowning children (aged 0-17 years)



Source: Survey data from the countries included: Bangladesh Health and Injury Survey 2003, Cambodia Accident and Injury Survey 2006 and Jiangxi (China) Injury Survey 2005.

On average, less than 10 per cent of drowning victims received resuscitation from a trained responder. This reflects both the lack of widespread resuscitation skills in the population and the fact that most drowning occurred in settings where resuscitation was not possible. The majority of drowning occurred among very young children who escaped supervision and drowned. Their caretakers were unaware of the drowning for lengthy periods of time and resuscitation was not an option. The majority of the drowning incidents among older children occurred when they were alone, or with a peer that lacked swimming, rescue or resuscitation skills.

For every country studied, when traditional resuscitation was given, the methods used were ineffective and harmful, and may have contributed to the drowning fatality. These methods generally fell into three categories:

1. Attempts to expel water from the drowned child's body by physical force (e.g. whirling the child overhead, pressing or jumping on the child's chest and stomach).
2. Attempts to expel water from the drowning child by inciting vomiting or coughing (e.g. forcing rotten food or other noxious substances into the child's mouth to induce vomiting, or inserting sticks or other objects into the child's trachea to induce coughing), and:
3. Attempts to expel water from the drowned child's body through physical means that involved drying (e.g. covering the child in ashes or in mud, heating the child's body over a warm fire).

These practices were found across the different cultures in the surveys. They were widely cited by respondents, regardless of level of educational attainment or rural or urban location. As such, they represent broad social norms in response practices to drowning in children. To be effective, drowning interventions will need to take into account the deeply embedded nature of these behaviours and to design appropriate strategies to counteract them.

The lessons learned from combating diarrhoeal diseases may be useful in this regard. Many of the early interventions focused on stopping deeply ingrained harmful behaviours, such as ceasing breastfeeding when the child had diarrhoea, or feeding the child solids in an attempt to decrease the diarrhoea. Changing these pervasive behaviours required extensive and long-term behavioural change interventions. Given the rural concentration and generally low educational attainment of mothers,

interventions required a variety of communications channels and a focus on trans-generational behavioural change.

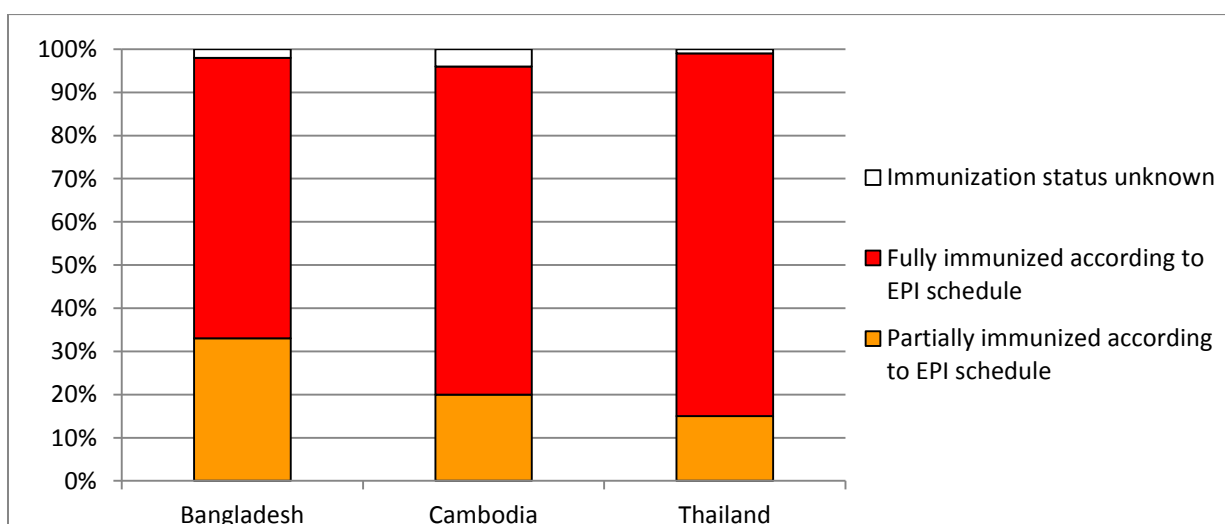
Changing harmful resuscitation responses will require the same scope and scale of investment. Increasing access to primary education, embedding health messaging in educational curricula and broader penetration of new communication technologies will be helpful; however changing behavioural norms is a difficult and time-consuming process and will require a lengthy and comprehensive effort.

Significant health and social investments are lost when a child drowns

Drowning rates are highest in early childhood, at which stage most health investments for the young child have already been made. Examples are antenatal care and immediate postnatal care delivered to mothers and infants, and vitamin A, zinc and other micronutrient supplementation. At the point where child drowning rates are highest in the countries surveyed (16-24 months), a young child has received almost all immunizations and many have benefited from early child development and other child enrichment programmes.

Figure 20 shows the percentage of children 1-4 years old in Bangladesh, Cambodia and Thailand who had been immunized prior to their fatal drowning.

Figure 20: Immunization status of drowned children (aged 1-4) in Bangladesh (2003), Cambodia (2007) and Thailand (2004)



Source: Authors' calculations from the Bangladesh Health and Injury Survey 2003, the Cambodia Accident and Injury Survey 2007 and the Thai National Injury Survey 2004.

The loss of the health and social investments made in these young children by their drowning deaths represents a major indirect cost, as well as the loss of their future potential. Given that drowning is also a leading cause of child death among primary and secondary school-aged children, educational investments are also lost when older children drown.

Drowning during floods is an unrecognized or unstated cause of mortality

While it might seem self-evident that drowning is a cause of child death in floods, commonly drowning is not mentioned as a cause of death. Usually the major health threats identified with floods are infectious diseases. Even UNICEF has been somewhat short-sighted in its coverage of this issue. An example is the story in the *The State of the World's Children 2011* report on climate change in Pakistan where the threat of infectious disease following flooding is discussed but there is no mention of

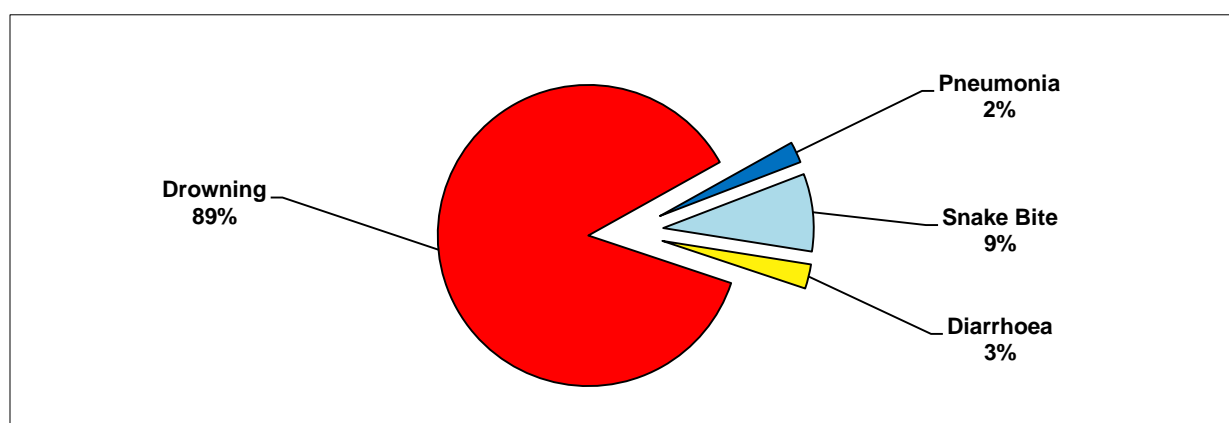
drowning. It states: “Unprecedented heavy rains gave way in July 2010 to devastating floods. The initial death toll was approximately 1,600 people, but many more are unaccounted for. An estimated 20 million men, women and children have been affected by the floods, and huge numbers are stranded, waiting for help....This drowning nation now faces a further disaster: The floods are threatening to decimate Pakistan’s youth. One of the biggest threats is the outbreak of water-borne diseases such as cholera and diarrhoea.”³¹

Similarly, guidance for staff in flood emergencies in the UNICEF *Emergency Field Handbook* states:

“The most common health threats for flood-affected populations will be diarrhoea from dysentery or cholera, acute respiratory infections, fever, eye or skin diseases, and conjunctivitis...In tropical and sub-tropical regions, floods can easily lead to an increase of malaria and other diseases associated with still water, such as dengue fever.”³²

In fact, drowning is a leading cause of child death in floods and other natural aquatic disasters, both in the acute stages and in the aftermath. Figure 21 shows the causes of child death during severe flooding in Bangladesh in August and September 2007, with drowning the primary cause of mortality.

Figure 21: Causes of death among 0–17 year old children in severe floods, Bangladesh 2007



Source: Disaster Monitoring Cell, Directorate General of Health Services, Ministry of Health and Family Welfare, Bangladesh.
Note: Due to rounding, the total percentage is greater than 100.

Drowning was responsible for almost 9 out of 10 child deaths in the floods, with the breakdown of causes of death as follows:

- Drowning caused 729 of 820 child deaths (89 per cent), all of which were among very young children.
- Snake bites caused 70 of 820 child deaths (9 per cent). Rising waters force people and animals to share the remaining dry ground, thus bringing them in close proximity to snakes. Young children are at greater risk of bites as they do not understand the danger posed by snakes, have higher contact rates, and have a low body mass that makes them more vulnerable to snake venom than adults. Moreover, flood relief efforts do not include provision of snake anti-venom.

³¹ United Nations Children’s Fund (2011). *The State of the World’s Children 2011*. New York: UNICEF, p. 76.

³² United Nations Children’s Fund (July 2005). *Emergency Field Handbook: A guide for UNICEF staff*. New York: UNICEF, p. 81.

- Diarrhoea caused 22 of 820 child deaths (3 per cent) and pneumonia caused 19 of 820 child deaths (2 per cent). The low percentage of both conditions is a validation of the effort made in provision of clean water, sanitation and antibiotics in the flood-relief efforts. Similar efforts need to focus on injury causes of death in floods.

The disaster risk management sector needs to recognize the contribution of drowning (and other injuries such as snake bites) to the child mortality and morbidity burden associated with aquatic disasters. There is a clear need to integrate drowning prevention into disaster risk management programmes. An anticipated benefit would be a reduction of drowning in both disasters and everyday life, due to a commonality of prevention measures such as community-based response skills that will be beneficial in both scenarios.

2.4 CHILD DROWNING IN ASIAN LMICS COMPARED TO DROWNING IN HICS

Many common circumstances contributed to the high rates of child drowning in the countries surveyed. These differ substantially from those surrounding child drowning in HICs. The main differences include:

(i) Drowning in early childhood:

Drowning in early childhood in LMICs occurs primarily from daily exposure to water, which is everywhere in the child's environment. Contributing factors are that homes generally have only one room and lack space where children can be separated from water hazards; homes do not have piped water and rely on nearby water bodies such as ponds and wells; bodies of water are rarely fenced or covered to facilitate ease of access; and children's direct caregivers are mothers with many household chores to accomplish and little help. Since household sizes are generally larger in LMICs, mothers often assign supervision of younger children to older siblings, who may not be capable of active supervision. The combination of the factors above was the most common risk scenario found for early child drowning across the countries surveyed.

In Jiangxi Province, China, where family sizes are small, the same phenomenon was seen, differing only in two factors: 1) the one-child family policy resulted in a child not have siblings, and alternative caretakers were primarily grandparents; 2) a child's parents had often migrated for economic reasons. As a result, the child was left behind with grandparents whose age and poor health status made active supervision of the young child difficult. In both cases, the end result was a very young child escaping supervision and drowning in a water body very near the home.

In HICs the environment that a child inhabits is dramatically different. Zoning ordinances, building codes, laws requiring swimming pools to be fenced and other safety regulations mean that children are rarely exposed to drowning hazards, whether in and near their homes. Some young children are able to escape active supervision and drown, but such cases are rare. They result from a secondary failure of barriers in place to prevent drowning. These often include fence gates left open around a pool, toilets with lids left open, or normally used covers on a diaper bucket being left unlocked or open. Thus the drowning in HICs requires two sequential 'system failures' – that which allows the child to escape close supervision, and that which defeats the barrier between the child and the water source.

(ii) Drowning among older children:

Older children in LMICs are in constant proximity to water. Water sources are always nearby homes, as water is necessary for drinking, bathing, cooking and other household uses, as well as watering livestock and other animals. In rural areas, the need for convenient access as well as the large number of water sites makes fencing and other barriers inappropriate and inconvenient in the context of daily life. As a

result, children fall in and drown, or get into trouble while playing in the water. Usually they are alone or with peers who also cannot swim and lack safe rescue skills. Attempted rescue by peers frequently leads to a multiple drowning where the rescuer and the child whose rescue is attempted both drown.

The context as well as place of water recreation differs between LMICs and HICs. Aquatic recreation and recreational settings in both groups of countries have a formal component (e.g. going to beaches, swimming pools, water parks, marinas) where recreation is planned in advance. There is also an informal component (e.g. playing in a pond, or swimming in a river) that is spontaneous. The relative proportion of each is very different in each setting – HICs have much larger formal components and LMICs have much larger informal. In formal recreational settings, the ability to plan ahead provides prevention measures that are not available or feasible in informal settings. For example, parents who plan to send their children boating are able to ensure they wear life jackets; those who know their children are going to the beach can ensure a lifeguard is on duty and there is nearby adult supervision. When recreational activities are unplanned and spontaneous, as is usually the case for recreation in LMICs, there is no opportunity to take such precautions as the child spontaneously decides to play near or in the water and the parents are not aware of it. Even when recreation is planned ahead in LMICs, there are other basic differences: parents are usually unaware of the risks of drowning as well as what precautions should be taken; even if parents are aware, there are often no lifeguards at beaches or other swimming sites, no life-jackets on boats, and adults who supervise children often do not know how to swim, conduct a safe rescue or conduct cardiopulmonary resuscitation (CPR).

(iii) Supervision, alcohol use and training in rescue and resuscitation

There are other differences in recreational settings as well. In LMICs, primary school-aged children (six to nine years old) and older children are commonly not supervised by adults. It is the norm in most LMICs for school-aged children to play alone or unsupervised by adults. In contrast, in most HICs children are usually supervised by adults well into adolescence.

Alcohol is commonly a contributing factor in recreational drowning incidents in HICs. However, in LMICs, the ages of drowned children (most are under five and would not be using alcohol) and cultural factors such as religion (many LMICs are predominantly Muslim) mean that alcohol is rarely a contributing factor.³³

Another major difference is the very low prevalence of peers or bystanders with rescue and resuscitation training, as well as the total lack of emergency medical response in rural LMIC communities. A child who drowns in an HIC is much more likely to be rescued or resuscitated, or both, than a child who drowns in the LMICs surveyed.³⁴

³³ Wintemute, G.J. et al. (1990). 'Alcohol and Drowning: An analysis of contributing factors and a discussion of criteria for case selection'. *Accident Analysis and Prevention*, 22:291-296; Howland J. and R. Hingson (1988). 'Alcohol as a Risk Factor for Drowning: A review of the literature (1950–1985)'. *Accident Analysis and Prevention*, 20(1):19-25.

³⁴ Kyriacou, D.N. et al. (1994), 'Effect of immediate resuscitation on children with submersion injury'. *Pediatrics*, 94:137–142; Wigginton J. 'The key role of layperson actions in drowning incidents'. In: World Congress on Drowning, Amsterdam, 26–28 June 2002. Amsterdam, Consumer Safety Institute, 2002; Marchant J. et al. (2008). Bystander basic life support: an important link in the chain of survival for children suffering a drowning or near-drowning episode, *Medical Journal of Australia*, 189 (1):56; Venema A, et al (2010), 'The role of bystanders during rescue and resuscitation of drowning victims'. *Resuscitation*, Volume 81 Issue 4, pages 434-439.

2.5 PREVENTION CHALLENGES IN LMICS

HICs became rich before they became safe. They had already developed, which provided the capacity to become safe with regard to water safety and drowning prevention. When they began to focus on safety, they had already achieved:

- Low fertility rates and thus small family sizes.
- High primary and secondary school graduation rates with literate populations.
- Well-developed civil governance structures.
- Enforced building codes and zoning ordinances.
- Large civil services and well-staffed public safety institutions.
- Predominantly urban populations.
- Access to day-care facilities for working parents
- Water exposure primarily limited to recreational settings.

These already developed countries built a culture of water safety on those foundations, using the wealth of financial and social capital they possessed. Introducing drowning prevention and the creation of a culture of water safety was a natural progression in the process of developing strong public health and public safety institutions connected to effective civil governance and enforcement structures. Sweden serves as an example: the factors noted above have been identified as being associated with Sweden achieving the distinction of having the lowest child injury mortality rate, including drowning, in Europe.³⁵

However, compare this with Asian LMICs. They are predominantly rural. Water and other environmental hazards are ubiquitous around the home and throughout the community. Building codes and zoning ordinances are lacking or unenforced. Universal primary education is a goal, not a reality resulting in high levels of illiteracy across large segments of the population. Parents often have 4 or 5 children and must rely on older children to supervise younger ones. There are few, if any, social services, such as emergency medical and rescue services that extend life-saving services outside the hospital, or any other safety infrastructure.

These countries lack an abundance of financial and social capital. Without these resources they are unable to develop environmental, social and governmental structures that promote a culture of water safety. In such countries, interventions cannot rely on the passage of laws and regulations, as the governance structures for implementation and the financial and human resources required are inadequate to ensure effectiveness. In fact, laws and regulations are often already on the books but are widely ignored and are rarely, if ever, enforced.

This presents a challenge to drowning prevention efforts. It is a reality that will guide the development of effective interventions. It is useful to note that in LMICs, the same challenges were experienced in the development of the effective child health interventions that underpinned the child survival revolution over the past thirty years. Many of the key lessons from that experience can be applied to accomplish a similar revolution in child drowning prevention.

³⁵ Jansson B., et al. (July 2006). 'Why does Sweden have the Lowest Childhood Injury Mortality in the World? The roles of architecture and public pre-school services'. *Journal of Public Health Policy*. 27(2): 146–165.

2.6 LEVELS OF EXPOSURE TO WATER HAZARDS ARE MUCH HIGHER IN LMICS THAN HICS

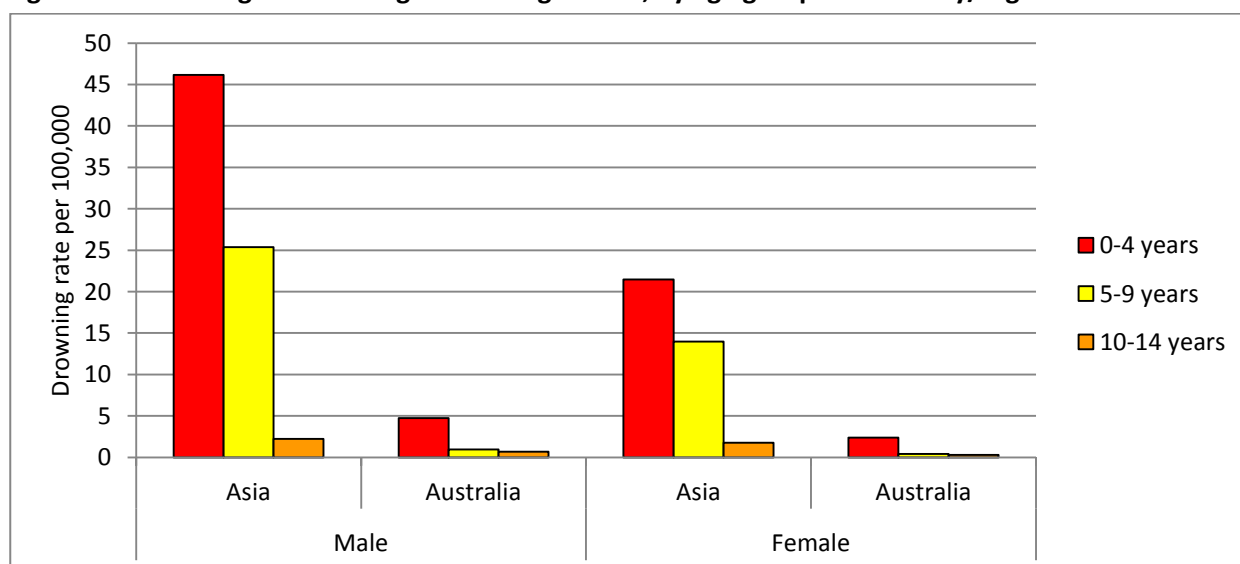
The omnipresence of water sources and consequent water hazards and the daily risk of drowning deserve a separate note. This is a key point of difference between LMICs and HICs. It is likely the single most important determinant of the large difference in drowning rates between the types of countries.

The surveys gathered information on proximity from the home to the nearest water body that was a drowning hazard. On average, almost 9 out of 10 children in rural homes (77 per cent in Jiangxi, China, 86 per cent in Cambodia, and 90 per cent in Bangladesh) lived with an unprotected water hazard within 20 metres of the home. They were continuously exposed to a potential drowning hazard in their environment while engaging in regular daily activities. This represents one of the most hazard-filled environments a child could inhabit, and places them at high risk of drowning.

The success of drowning reduction efforts in HICs has largely been related to the elimination of a hazardous environment through the societal tools previously noted. However, these mechanisms are for the most part unavailable in LMICs. In order to counter the extreme levels of exposure, effective interventions will need to rely on implementation at the level of the individual child, the child's family and community. This approach of targeting those immediately responsible for the safety of the child has proven effective when used for health interventions in child survival programmes.

The challenge in drowning prevention in LMICs is highlighted by the disparity in drowning rates between LMICs and HICs. Children in the Asian LMICs surveyed drown at much higher rates than children in Asia-Pacific HICs such as Australia. This was common among children of all age groups and for both sexes, as seen in Figure 22. The disparity in drowning rates is stark; when standardized to the world standard population for comparison, the difference in rates is between 10 and 25 times higher in early and middle childhood, depending on age group and gender.³⁶

Figure 22: Drowning rates among children aged 0-14, by age group and country/region



Source: Survey data from Viet Nam (Vietnam Multicenter Injury Survey, VMIS 2001), Bangladesh (Bangladesh Health and Injury Survey, BHIS 2003), Thailand (TNIS 2004, Jiangxi China (Jiangxi Injury Survey, 2005) and Cambodia (Cambodia Accident and Injury Survey, CAIS 2007) and data from Australia Institute of Health and Welfare Report, Flinders University, March 2008.³⁷

Note: Data for children aged 15-17 are unavailable for Australia; the graphs therefore cover only children aged 10-14.

³⁶ Ahmad O. et al. (2001). *Age standardization of rates: A new WHO standard*. Geneva: World Health Organization.

³⁷ Australian Institute of Health and Welfare: Kreisfeld R. and G. Henley (2008). Deaths and hospitalizations due to drowning, Australia 1999-00 to 2003-04. *Injury Research and Statistics Series Number 39*.

The dramatic difference in drowning rates between HICs and the LMICs surveyed is clear evidence that interventions are effective when consistently applied over decades. Therefore, a fundamental question is whether interventions such as those used in HICs are appropriate for use in LMICs.

3. EVIDENCE FOR PREVENTION

It is often stated that the principles of prevention are the same among all population groups, whether in LMICs or HICs, and that it is only a matter of adapting what works in HICs to the context of LMICs. However, adaptation must be both thoughtful and extensive given the different societal contexts and norms. Given the many significant differences, it may not be possible. Examples of these differences are as follows:

- In LMICs, interventions that seek to reduce the scale of water hazard exposure by changing the external environment are likely to be unsuccessful. Because social and behavioural norms have evolved over time, water bodies are not viewed as hazards. They are seen as necessary and convenient water sources for daily activities such as bathing, drinking and cooking. The changes required both in terms of raising awareness of risk and in implementing drowning prevention measures such as teaching survival swimming³⁸ and safe rescue skills, will need to be on a societal scale, but the necessary human and financial resources are lacking.
- For the most part, LMICS do not have strong civil governance structures. Interventions that are dependent on these structures, which include laws, regulations and enforcement, will be unsuccessful. Examples of successful interventions in HICs are zoning residential areas to restrict access to water hazards; and removal of water hazards through declarations of public nuisance/hazard.
- Interventions that depend on emergency medical response to the drowning child are not possible as such systems do not exist in the rural areas where the vast majority of child drowning occurs. An adapted response could possibly entail providing emergency medical services outreach from hospitals, or other first response systems tied to health facilities in some middle income countries. However, the vast majority of the rural population lives far from available facilities. The need for very rapid responses to drowning means these adaptations will not provide significant coverage to the populations at risk of drowning.
- Rural communities lack sufficient capacity to provide resuscitation such as bystander-provided CPR for drowning children. In low income countries, illiteracy is common and low educational attainment among the majority of the population presents major barriers to developing CPR skills. Additionally there are fundamental differences in the contexts of child drowning. Children are most often alone or with a peer who also lacks survival swimming and safe rescue skills. This differs markedly from HICs, where peers and bystanders are often trained in rescue and resuscitation of drowning victims.

Much of the progress in reduction of drowning rates in HICs has resulted from a multisectoral approach that depends on established human and institutional capacity. This is not present in LMICs. The question then becomes whether drowning interventions that are effective in HICs can be adapted to be effective, low cost and sustainable while providing population coverage in LMICs and is addressed in the next section.

³⁸ Survival swimming as used in this paper means a minimum level of swimming ability, i.e. the ability to move through the water unassisted for a distance of 25 metres, float for 30 seconds.

3.1 ADAPTING PROVEN HIC INTERVENTIONS TO LMIC SETTINGS

The 2008 WHO/UNICEF *World Report on Child Injury Prevention* identified four interventions that were deemed to have sufficient evidence for effectiveness, or were judged to be promising in the context of HICs. The four key strategies that were listed as effective were:³⁹

- Removing (or covering) water hazards.
- Requiring isolation fencing (4-sided) around swimming pools.
- Wearing personal flotation devices.
- Ensuring immediate resuscitation.

Only the first, removing or covering water hazards, is potentially feasible in the setting of an LMIC. The experience gained from intervention research carried out so far in Bangladesh, Thailand and Viet Nam predicts that such steps will only be feasible in urban areas and that they will not work in rural areas where ponds are ubiquitous and in frequent daily use. The second strategy of installing fences is not viewed as a viable solution in LMICs. Fences are expensive, subject to theft, require maintenance and create inconvenience. They require opening gates or relocating access paths, thus impeding convenient access to water sources. Many bodies of water are too large to fence, and others such as rivers cannot be surrounded by a fence.

The other three strategies are unlikely to be feasible or sustainable in the low-resource settings of the countries surveyed.

- Four-sided fencing of swimming pools: For the most part swimming pools do not exist in LMICs outside the capital city and in private settings. The equivalent recreational venue in LMICs would be a pond, lake or river, where fencing is impractical and has several negative associations that reduce their use and level of effectiveness.
- Personal flotation devices: These are rarely available as they are viewed as inconvenient, costly and are likely to be stolen.
- Ensuring immediate resuscitation: The surveys document that effective bystander CPR skills are essentially non-existent in LMICs, and that there are significant barriers to training and use, especially in low-literacy environments.

Two additional interventions were deemed to be promising in the World Report on the basis of evidence available:

1. Ensuring the presence of lifeguards at swimming areas.
2. Conducting targeted awareness-raising on drowning.

In the countries surveyed, due to both the number and type of water bodies used for swimming (thousands of ponds in close proximity to rural homes) the use of lifeguards is not feasible. Also lacking are water safety professionals to train the lifeguards, and funds to pay them even if such training were possible.

Only the second strategy, targeted awareness-raising on drowning, may be appropriate for use in LMICs. However in order to be implemented, the health community first needs to recognize that child

³⁹ Peden, M. et al. eds. (2008). *World Report on Child Injury Prevention*. Geneva: World Health Organization, p. 73, table 3.4.

drowning is a leading but preventable cause of death. This is not the case currently as the epidemic of child drowning has been invisible. In all the countries surveyed, there was a lack of awareness of the magnitude of the issue before the surveys were completed. Universally, the child health community thought that infectious diseases and nutritional causes were alone as the leading causes of child death. There was a virtual lack of awareness that drowning was also a significant contributor to mortality.

Given the lack of feasibility of drowning prevention interventions based on HIC approaches, as well as lack of evidence of impact for many other interventions listed in the World Report, the question arises as to whether the principles on which they are based can be effectively applied in LMICs. The surveys in the Asian LMICs collected data on risk factors and potentially protective factors, which are described below.

3.2 EVIDENCE FOR PREVENTION IN THE SURVEYS AND SUBSEQUENT RESEARCH

The 2001 survey in Viet Nam showed drowning was a significant cause of death among children of all ages, and was a leading cause of death in children after infancy.⁴⁰ As a result, the survey in Bangladesh (BHIS 2003) contained a nested case-control study to examine risk and protective factors for child drowning. The study showed there was a significant association between a child drowning and the several factors shown in Table 7 below.

Table 7: Risk factors for child drowning in Bangladesh among children 0-17 years old

Factors compared between drowned child vs. matched control	Odds Ratio
Having an illiterate mother	1.7
Number of children in family five or more	2.0
Birth order of child sixth or higher	2.2
In care of person other than mother when drowned	25.4
Usual caretaker of child someone other than mother	74.5
Lack of swimming ability of child 4 years and older	4.5

Source: Bangladesh Health and Injury Survey, 2002. OR significant at P=0.05.

The first five factors in Table 7 increase the likelihood of the child being cared for by an older sibling. Maternal illiteracy is associated with larger family size, which increases the likelihood that an older sibling will become a caregiver to a younger sibling.⁴¹ The higher odds of drowning suggest that drowning is associated with a failure in active supervision, which has been shown to be a cause of early child drowning in both LMIC and HIC settings.⁴² These results point to the need for interventions to include processes that increase active supervision, or help protect the child in its absence.

⁴⁰ Linnan, M. J. et al. eds. (March 2003). *Report to UNICEF on the Vietnam Multi-Center Injury Survey*; Hanoi: Center for Injury Policy and Prevention Research, Hanoi School of Public Health.

⁴¹ Rahman A., et al. (2005). *Bangladesh Health and Injury Survey: Report on children*. Dhaka: Government of the People's Republic of Bangladesh, Institute of Child and Mother Health, United Nations Children's Fund and The Alliance for Safe Children.

⁴² Quan L., E. E. Bennett and C. M. Branche, 'Interventions to prevent drowning', in: Doll L.S. et al., eds. (2007), *Handbook of injury and violence prevention*. Atlanta:Springer, pp. 81–96; Petrass L. A., J. D. Blitvitch and C. F. Finch (2011), 'Lack of Caregiver Supervision: A contributing factor in Australian unintentional child drowning deaths', *Medical Journal of Australia*; 194(5): 228-231; Morrongiello B. A. et al. (2006). 'Understanding unintentional injury risk in young children II: The contribution of caregiver supervision, child attributes and parent attributes'. *Journal of Pediatric Psychology*, 31(6):540-551; Landon M, G., U. Bauer and M. Kohn (2003). 'Inadequate supervision as a cause of injury deaths among young children in Alaska and Louisiana', *Pediatrics* 111(2): 328-331.

In the case-control study, swimming ability was defined as whether a child was able to swim 25 metres across a pond, using any stroke or motion. The association with swimming ability raised the possibility that if children are taught to swim once old enough they may be protected from drowning. However, the data came from a single case-control study that showed only an association with protection and not a causative relationship between swimming and protection from drowning. The inability to show a cause and effect relationship is a methodological limitation of case control studies. A review of the drowning literature in HICs did not provide an answer to the question of whether swimming ability reduced drowning in children: studies showed an association, none showed a causal relationship. Moreover, the studies with an association had significant limitations such as small sample sizes, questions of recall validity and different definitions of swimming ability. Most of the studies were carried out among populations with very different water exposure rates than populations in the LMICs surveyed.⁴³

Case control studies examining swimming ability (with the same 25 metre definition) as a protective factor were repeated in Cambodia and Thailand, with the results shown in Table 8.

Table 8: Odds ratios for association of swimming ability and drowning protection, children aged 5-17

Survey country, name and date	Odds Ratio	(95% confidence interval)
Bangladesh (BHIS 2003)	4.5	(1.3-19.2)
Thailand (TNIS 2004)	3.4	(1.3-8.8)
Cambodia (CAIS 2007)	3.1	(0.6-16.2)
Combined (BHIS, TNIS,CAIS)*	2.7 [†]	(1.3-5.5)

Source: Survey data from countries included in the surveys.

*Wald chi square confidence intervals significant to the 5 per cent level.

[†] Odds ratio has been adjusted for the survey.

The elevated odds ratios for the studies was significant ($p < 0.05$), showing that naturally acquired swimming ability for children aged 5 years and over was associated with protection from drowning. One additional survey conducted in Aceh, Indonesia after the 2004 Indian Ocean tsunami provides evidence for the association of swimming ability and protection from drowning.⁴⁴

⁴³ Brenner R. A. et al. (March 2009). 'The association between swimming lessons and drowning in childhood: A case-control study'. *Archives of Pediatrics and Adolescent Medicine*, 163(3):203-210; Gilchrist J, J. Sacks and C. Branche (1994). 'Self reported swimming ability in adults', 1994, *Public Health Reports*, vol. 115, 110-111; Yang L et al. 'Risk factors for childhood drowning in rural regions of a developing country: A case-control study'. *Injury Prevention*, 13(3):178-182.

⁴⁴ The Aceh Tsunami Study was a retrospective cohort study. A total of 3,568 households, with a population of 16,240 members located within 5 kilometres from the beach where the tsunami wave/s swept ashore were enrolled. Swimming ability of the household residents, including caretakers of young children, was determined along with their survival status (dead or alive) after submersion in the tsunami wave/s. The study is a subject of a separate working paper in this series.

Figure 23: Mortality rates by age group and swimming ability in the 2004 tsunami, Aceh, Indonesia



Source: Authors' calculations from Aceh Tsunami dataset.

On average across the age groups in 14,299 persons who were inundated and completely submerged by the tsunami, mortality rates in those able to swim were half those found in same-age respondents who were unable to swim. The elevated odds-ratio was statistically significant.⁴⁵ This added strength to the association of swimming ability and protection from drowning. The tsunami was a much different environment than seen in the other studies with more sudden, tumultuous and direct water exposure, decreasing the potential for confounding factors.

The consistent association between natural swimming ability and decreased risk of drowning in children four years and older across the four countries surveyed, and the results of the Aceh Tsunami Survey pointed to the need to confirm the causal nature of the relationship. This was done with a large scale cohort trial in rural Bangladesh, described below.

3.3 NEW EVIDENCE ON THE COSTS AND COST-EFFECTIVENESS OF PREVENTING CHILD DROWNING

Between 2006 and 2010, a child injury prevention research programme was implemented in Bangladesh, Prevention of Child Injury through Social-intervention and Education (PRECISE). The PRECISE programme covered over three quarters of a million people in villages in rural Bangladesh, in three separate, sub-district intervention areas.

The project implemented specific interventions to address the differing causal factors in drowning in children under four and children aged over four. The research design was a comparison trial between very large cohorts of children participating in the interventions compared with non-participating children who were matched for age, sex, and location of residence. Summaries of the research were presented at the International Lifesaving Federation's World Conference on Drowning Prevention and are summarized below.

In PRECISE, for children aged 1-5 years, a village crèche programme called Anchal was established to provide a safe-haven where their mothers could drop their children off for 4 hours a day while they tended to domestic work in the household. Children four years and older received training in a

⁴⁵ Linnan, M. et al. (forthcoming in 2012). 'Mortality of Children and their Caretakers in the Asian Tsunami: Implications for disaster preparedness' *Office of Research Working Paper*. Florence: UNICEF Innocenti Research Centre.

programme called SwimSafe,⁴⁶ which taught water safety, safe rescue and survival swimming in the village pond, which had been converted into a safe training site.

Both programmes sharply reduced drowning deaths in each age group. Drowning death rates in children who attended the Anchal crèche were 82 per cent lower than non-attending control children. Fatal drowning rates in children who participated in the SwimSafe intervention were 93 per cent lower than non-participating children in the control group, both large and statistically significant reductions.⁴⁷

Cost-effectiveness was calculated according to WHO-CHOICE guidelines (CHOosing Interventions that are Cost Effective) by determining the numbers of deaths averted, the number of disability adjusted life years averted (DALY) and the cost associated with preventing the deaths. Implementing both the community crèche and SwimSafe programmes together in rural Bangladesh would result in over 196,000 deaths prevented at a cost of \$12,596 per death prevented and \$362 per DALY averted. These costs compare favourably with the costs of preventing other causes of child mortality such as respiratory infections and diarrhoeal disease in the same region.⁴⁸

3.4 KEY RELATED EVIDENCE FOR PUBLIC HEALTH INTERVENTIONS

The PRECISE cohort study of survival swimming was designed to provide evidence that equipping children with survival swimming skills reduced drowning mortality. It was designed to provide evidence on four key questions; one regarding effectiveness and three regarding safety. The findings below represent preliminary answers from the ongoing research:

1. Is the protection from drowning effective across all ages and both sexes for the drowning environment normally encountered in a rural LMIC?

The case control studies done earlier included only specific age groups and had relatively small sample sizes. Because of the study design, the drowning cases were children with the highest likelihood of drowning, which meant that factors that increased the risk of drowning, such as younger age, being male and being at highest risk of water hazard exposure, would be over-emphasized. A different research design was therefore required to provide better answers to the question.

The PRECISE cohort study in rural Bangladesh had three separate geographic sites to include the broadest range of water hazard exposures encountered in daily life. These were similar to the rural drowning environments in the other countries surveyed. The large size of the cohorts (66,000 children), the long duration (four years) and the criteria for inclusion of all children in the three areas, ensured that children of all ages, both boys and girls, and the spectrum of daily water hazard exposures were included.

⁴⁶ SwimSafe is a regional programme developed by TASC, RLSSA and local partners in Bangladesh, Thailand and Viet Nam. Details are available at <http://swimsafe.org/about-swimsafe/swimsafe-history/>. SwimSafe Bangladesh was developed in 2005 by the Centre for Injury Prevention, Bangladesh, RLSSA, and TASC with assistance from the Bangladesh Swim Federation. UNICEF Bangladesh funded the inclusion of SwimSafe as the survival swimming component of PRECISE. Following completion of the PRECISE project, SwimSafe Bangladesh has continued as a joint programme overseen by CIPRB with TASC and RLSSA assistance and with UNICEF Bangladesh providing funding for continued training.

⁴⁷ Linnan, M. et al. 'Child Drowning in Asia – from evidence to action' in: Scarr et al (eds), World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p 29; accessed at: www.worldconferenceondrowningprevention2011.org.

⁴⁸ Finkelstein E. et al. 'The cost of reducing drowning in rural Bangladesh and implications for governments, policy makers and donors'. In: Scarr et al (eds), World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p 30; accessed at: www.worldconferenceondrowningprevention2011.org.

The analysis allowed examination of fatal drowning rates disaggregated by age. For each year of age in the children participating, there were significant reductions in drowning rates among children in the SwimSafe intervention group compared to the control group. Both boys and girls were protected at the three sites. This evidence shows SwimSafe is effective among all ages receiving the training and protects both sexes in the normal drowning environments of rural LMICs in Asia.

From a public health perspective, it was important to show that SwimSafe is effective in the most common drowning environments encountered by children in Asian LMICs, and that swimming techniques could be taught in all settings available, such as ponds, lakes, reservoirs, rivers and beaches as well as pools. From an implementation perspective, it was important to show that it could be taught in the shortest time period possible, given the resource-constrained environment.

It was important to define the norms of protection, the time required for training and venues for the training. However, some drowning scenarios could not be tested in PRECISE. For example, would SwimSafe training protect a participant on a ship sinking several kilometres from shore? The surveys were conducted among representative populations and designed to cover 95 per cent of drowning scenarios in Asian LMICs – of which the above scenario was never encountered. The public health approach balances the need for protection with the equally important need for a short implementation time and low implementation cost. To protect the millions of children at risk of drowning, protection needs only to be sufficient for the great majority of drowning environments and to be cheap and simple enough to facilitate the large training volumes required.

The design criteria used for the SwimSafe intervention was consistent with that of the tsunami study cited earlier. It is therefore likely that SwimSafe may protect participants against cataclysmic flooding. In the survivor interviews from Aceh following the tsunami, there were no reports of needing to swim long distances. The only swimming that was required was to reach floating debris or a nearby structure.

2. Is the intervention safe?

Safety was a major concern, given the circumstances in which SwimSafe would be implemented. Hundreds of ponds in rural villages were used to teach tens of thousands of very young children how to swim, potentially putting very young children in a hazardous environment.

To develop the SwimSafe training curricula, an anthropologic study examined the process of acquisition of natural swimming ability.⁴⁹ The process was categorized into practices used to teach individual skills and the chaining process used to link the individual skills into natural swimming competence. International experts in swim teaching and water safety classified the processes according to whether they met the criteria for good practice, best practice or harmful practice. The structured SwimSafe curriculum was developed to provide children aged four and above with swimming ability and with basic knowledge of water safety and safe rescue. Risk management, quality assurance and objective validation were built into the process.⁵⁰

The programme was found to be safe. Over the four-year operational research activity, SwimSafe in Bangladesh scaled up from 2 to 650 ponds, currently with over 200,000 graduates aged 4-17 years,

⁴⁹ Harun, A. et al. 'The Process of Learning Natural Swimming'. In: Scarr et al (eds) World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p 78 accessed at: www.worldconferenceondrowningprevention2011.org

⁵⁰ Rubin, T. et al. 'SwimSafe – A survival swimming curricula'. In: Scarr et al (eds) World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p 86 accessed at: www.worldconferenceondrowningprevention2011.org.

implemented across collaborating institutions. There have been no injuries to date.⁵¹ The PRECISE intervention development illustrates a number of these issues in relation to the safety of large-scale drowning prevention programmes, as discussed below.

Placing large numbers of young children in the water when they cannot swim places them in jeopardy. Evidence-based methods allowed calculation of actual risks per child. An example is the method of setting the age of entry to SwimSafe. Growth and development curves for rural children were used to assess height and motor skills development by year of age. As a group, four-year-old children had achieved sufficient height to be able to stand and have their heads above the platform depth for the training ponds. Three-year-old children were not uniformly able to do so. Significant numbers were well below growth curve medians for both sexes and stunting was an issue regarding the standard platform height for the ponds. That resulted in the age cut-off for entry at 4 years.⁵² Other evidence-based processes were used to estimate risk from other known conditions (such as epilepsy or congenital heart disorders) that lead to increased risk of drowning that were related to the children themselves.

Principles of risk management set the training standards and certification for swimming teachers and teaching assistants, the maximum class size for children and minimum health standards for children at entry (e.g. no previous history of seizures or epilepsy). Best practices appropriate for rural Bangladesh set water quality standards and the length of training sessions. Supervisors for swimming trainers received specific training for effective supervision. Monitoring visits were recorded and reports reviewed periodically.

The risk management approach recognized the potential for unintended adverse consequences due to the volume of children that would participate. While PRECISE was an operational research programme, it was structured to provide information on safety and hazard at high training volumes. Table 9 shows the number of children needed to be enrolled in SwimSafe over five years to achieve 50 per cent coverage of at-risk children in the countries surveyed.⁵³ It also shows the estimated number of deaths that would occur at different fatal adverse event rates.

⁵¹ Rahman A et al Survival swimming – Effectiveness of SwimSafe in preventing drowning in mid and late childhood. In: Scarr et al (eds) World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p 49 accessed at: www.worldconferenceondrowningprevention2011.com; Rubin, T. et al. 'SwimSafe – A survival swimming curricula'. In: Scarr et al (eds) World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p 86 accessed at: www.worldconferenceondrowningprevention2011.org
⁵² Biswas, A. et al. Optimal Age to Learn Survival Swimming in Bangladesh. In: Scarr et al (eds) World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p 50 accessed at: www.worldconferenceondrowningprevention2011.org

⁵³ The 50 per cent coverage level is the current estimate of the coverage levels needed for rapid and sustained reduction in drowning rates in children. It was arrived at by modeling the effects on country-specific drowning rates for the protection conferred by swimming to the child, the protection conferred on peers through the ability of the child to provide rescue (similar to the herd effect in immunizations) and the impact of parental knowledge from SwimSafe orientations and the social autopsy process for drowning deaths in older children.

Table 9: Number of children needed to achieve 50 per cent coverage of children at risk of drowning

	5-17 population	50% SS coverage over 5 years	No. of training deaths per year @		
			1:100,000	1:500,000	1:1,000,000
Bangladesh	41,231,000	4,123,100/year	41	8	4
Cambodia	4,068,000	406,800/year	4	1	-
China	240,567,000	24,057,000/year	240	48	24
Thailand	12,964,000	1,296,400/year	12	2	1
Viet Nam	18,795,000	1,879,500/year	18	4	2
Total	317,625,000	31,762,500/year	317	63	31

Source: Population numbers for children aged 5-17 from *The State of the World's Children 2012*, UNICEF, February 2012, p. 108, table 6. Note: SS refers to the SwimSafe programme.

It is clear that at high training volumes, even very low adverse event rates result in substantial numbers of children fatally injured. This mandates a process of evidence-based risk estimation followed by risk-reduction approaches to all aspects of swim teaching. The operational experience gained in SwimSafe may provide such evidence for risk management.⁵⁴

3. Are the rescue skills taught effective and are they safe when used?

The safety and effectiveness of the rescue skills provided to the children was a key concern. Evidence from drowning investigations in the surveys showed that traditional methods for rescue were potentially harmful for the rescuer and that traditional methods of resuscitation were ineffective and potentially harmful for the person resuscitated. The SwimSafe curriculum incorporates training in skills necessary for safe rescue and also teaches children not to use harmful resuscitation practices.

A separate cohort study, the Risk and Rescue Study, has been underway. In July 2010 and April 2011, monitoring cohorts made up of SwimSafe graduates of varying ages and both sexes were examined for use of the rescue skills taught in the programme. They were asked for details of rescue activities done after they graduated. For the July 2010 cohort, children taught safe rescue techniques reported having used them at high rates. The rates were 6 per cent of children having engaged in a rescue since graduation from SwimSafe, an average length of 1.7 years. This rate is substantially higher than children graduating from swimming and water safety courses in HICs.⁵⁵ The majority of the rescues were in-water rescues because the graduate was already in the water with the person in distress when the rescue was conducted. Based on the evidence from this cohort, it appears that children in an LMIC who are trained in rescue make use of the skills at significant rates and are able to conduct successful rescues.⁵⁶

4. Does the completion of SwimSafe training lead to increased risk-taking in the water?

The protection of the programme from moral hazard was a key issue. In terms of drowning prevention, moral hazard occurs if children who have learned survival swimming think they are completely protected from drowning and consequently engage in high-risk behaviours that actually increase their

⁵⁴ Rahman, A et al. 'SwimSafe teaching tools: guidance for survival swimming to children in low and middle income countries'. In: Scarr et al (eds) World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p. 76 accessed at: www.worldconferenceondrowningprevention2011.org.

⁵⁵ Personal communication, Drowning Commissioner, International Lifesaving Federation.

⁵⁶ Rahman, A. et al. 'Rescue Rates following SwimSafe Training'. In: Scarr et al (eds) World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p. 75 accessed at: www.worldconferenceondrowningprevention2011.org.

risk of drowning. In an intervention that would train very large numbers of children in survival swimming, it is a significant theoretical risk that has been raised previously.⁵⁷ As part of the SwimSafe programme – which aims to cover millions of children – there is ongoing research to monitor the potential of this risk occurring.

The available epidemiologic evidence from the surveys supports the premise that moral hazard is not a significant issue. The lower drowning rates in children who have swimming ability suggest that teaching them to swim does not lead to large increases in high-risk behaviours that in turn lead to drowning fatality. If this was the case, drowning rates would be higher among children with swimming ability, reflecting the increased risk.

In the Risk and Rescue Study, cohorts of 30,000 children were examined for details of water exposure in the previous 48 hours, for swimming, playing in the water and time spent in the water. The cohorts consisted of children who had graduated from SwimSafe, children who had natural swimming ability but who had not attended SwimSafe, and children who were unable to swim. Different water exposures were compared between the three groups. Exposure rates in SwimSafe participants were found to be lower than natural swimmers. Present data show SwimSafe graduates do not have increased levels of water exposure or engage in high-risk activities related to swimming (e.g. more frequent swimming or swimming alone). The monitoring will continue with sequential samples enrolled until a minimum of 50,000 children have been assessed for high-risk behaviours and increased water exposures.⁵⁸

3.5 TAKING INTERVENTIONS TO SCALE

Asia contains the majority of children globally, and almost all of these live in LMICs. Five countries with very large child populations are part of the Asian region (China, India, Indonesia, Pakistan and Philippines). Between them, they contain over a billion children.⁵⁹ This large number of children at risk of drowning presents major operational challenges for delivery of interventions. Many of these have already been encountered while implementing early childhood development programmes, including crèches and other forms of day care.

The Anchal crèche programme at its most basic level is an early childhood safe haven that incorporates instruction on general safety hazards, protection from drowning and other types of injury, while providing access to other child-centred interventions such as nutrition, sanitation and general health promotion. It is unique in that it incorporates injury prevention education and has a direct link to the homes of children through the Anchal mother's home-centred activities.⁶⁰ A body of risk management experience, accumulated through years of work on early childhood development programmes in Bangladesh, has informed the Anchal programme and has helped participants deal with the large numbers of children involved.

For very young children, spending four hours a day in a crèche raises issues of children being inadvertently exposed to potential risks from infectious disease as well as injuries from play activities.

⁵⁷ Smith G. S. (1995). 'Drowning Prevention in Children: The need for new strategies', *Injury Prevention*, 1(4):216-217.

⁵⁸ Mecrow, T. 'Risk Taking Behaviors concerning Water in Early Childhood, Bangladesh'. In: Scarr et al (eds) World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven p. 69, accessed at: www.worldconferenceondrowningprevention2011.org. Hossain, J. et al. 'Moral Hazard and SwimSafe: The early results are in and it does not increase risk-taking' (oral presentation), ID 1410, Paper 432, World Conference on Drowning Prevention, Danang, Vietnam, accessed at: www.worldconferenceondrowningprevention2011.org.

⁵⁹ United Nations Children's Fund (2012). *The State of the World's Children 2012*. New York: UNICEF, table 6.

⁶⁰ Rahman Mashreky, S. et al. 'Anchal – An integrated child survival and development center: A promising initiative for prevention of drowning among young children'. In: Scarr et al (eds), World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p. 66 accessed at: www.worldconferenceondrowningprevention2011.org.

The intervention developed a formal set of processes for training, certification and supervision of all involved as well as use of best practices appropriate for the setting of rural Bangladesh. Some examples are:

- Children in the crèche were taught hygiene and sanitation (e.g., hand washing and use of latrines) and were required to practice it.
- Anchal mothers and assistants were trained in injury risk reduction for children, trained in first aid and first aid kits were provided. Supervisors monitored the conduct of the crèche and visit reports were filed and monitored.
- Crèche locations were selected to avoid injury hazards and were required to have sanitary latrines.

Programmes that teach children to swim cannot rely on a similar body of experience. As noted, placing millions of very young children in water to teach them to swim also potentially places them in harm's way.⁶¹ Great efforts are therefore needed to minimize risk while maximizing coverage of swimming classes.

Operational research has been underway for four years to resolve the issue of how to safely provide survival swimming instruction in the available swimming venues. This represents a major limiting factor in achieving the needed coverage levels. The research has focused on the required adaptations of the SwimSafe curricula for the different natural water bodies across the region, with safety as the primary concern.⁶² There is an accumulating body of evidence from SwimSafe Thailand and SwimSafe Danang that provides information for safety and risk management as well as necessary programme adjustments that take into consideration the different socio-cultural norms regarding water safety across the region.

Research undertaken in the PRECISE project has shown that village ponds can safely and effectively be used to teach survival swimming in rural areas. However, the ponds are only suitable for use during the rainy season and have problems with maintenance and water quality. These limit the potential coverage levels achievable in rural areas of Bangladesh. In addition, ponds are unavailable in urban areas. Many LMICs in Asia do not have the same pond density as Bangladesh in their rural areas, making access to suitable water bodies an issue.⁶³ Given this experience, one focus of research has explored alternatives to natural water bodies.

Research has been underway for four years in Thailand (SwimSafe Thailand) and Viet Nam (SwimSafe Danang), and recently in Bangladesh, to test, modify and develop portable pools for survival swimming training. The programme has focused on safety aspects of teaching, suitability for use in different environments, costs, durability and developing operational experience in urban and rural settings. The research has shown that portable pools are effective and safe for teaching children to swim. They have a number of advantages: controlled water depth, excellent water quality when properly maintained and a very safe training environment. They cost significantly less than in-ground pools and last up to five years. When installed in primary schools with large numbers of children as they are with SwimSafe

⁶¹ Scarr, J. et al. 'The Scale Required for Impact on Child Drowning in Middle and Late Childhood and Implications for Safety'. In: Scarr et al (eds), World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p 77 accessed at: www.worldconferenceondrowningprevention2011.org.

⁶² Rubin, T. et al. 'SwimSafe – A survival swimming curricula'. In: Scarr et al (eds) World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p. 86 accessed at: www.worldconferenceondrowningprevention2011.org.

⁶³ Hussain, J. et al. 'Limitations of Ponds and Natural Water Sources for Swimming Teaching'. In: Scarr et al (eds), World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven p. 60 accessed at: www.worldconferenceondrowningprevention2011.org.

Thailand and SwimSafe Danang, the research shows it is possible to use portable pools to safely train large volumes of children at low cost.⁶⁴

Portable pools can be adapted to cater to the specific health conditions experienced by children in LMICs. For example, due to their small stature, children with growth retardation may be at increased risk while in the water. The pools allow the water level to be varied to ensure a child's head remains out of water. Physiological conditions such as epilepsy and other seizure disorders, as well as cardiac rhythm disorders such as Long QT syndrome also place children at increased risk of drowning. Both types of conditions have prevalence rates in the range of 1 per 1,000 to 5 per 1,000 or higher.⁶⁵ The scale required in a national survival swimming programme will mean that hundreds to thousands of children with those conditions will be enrolled and will need special measures in place to ensure their safety.

These conditions present significant risks when the teaching venues involve opaque water as is the case in ponds. Children may lose consciousness due to the condition, and are likely to slip under the surface of the water while unconscious. Unless the water is clear and supervision is very close by, they cannot be seen and may drown as a result. The issue has been identified in HICs and recommendations have been made that swimming should be done in clear, shallow water with supervision close at hand.⁶⁶ Portable pools with sand filtration systems provide clear water teaching venues. The use of portable pools which are 6 metres across and 12.5 metres long ensures that a supervisor is always very close to the children being taught.

The operational experience of the SwimSafe Danang Programme in Viet Nam has provided data on potential throughputs that can be achieved with portable pools at primary schools with large volumes of children. A class-based approach allows teaching cohorts of children all of the same age and approximate physical stature. Using skilled teachers at the school as survival swimming instructors provides instructors who are trained and have experience with other discipline and safety issues in young children. This approach has shown to be efficient and suitable for achieving the scale necessary in countries with high primary school enrolment rates.

3.6 ISSUES REGARDING RESUSCITATION

Developing a community response system with sufficient numbers of providers to ensure rapid CPR delivery to drowning victims requires significant resources and funding. Pilot programmes will need to explore feasibility, provide information on the numbers of CPR-trained persons required in different age groups and community roles, and to develop procedural protocols.

Studies in HICs such as Japan and the United States show that community response networks can provide CPR to drowning children, increasing their chance of survival.⁶⁷ The importance of ensuring

⁶⁴ Cox, R., A. Peden and T. Rubin. 'The Use of Portable Pools to Increase Swim Learning: The SwimSafe Danang experience'. In: Scarr et al (eds), World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p. 206 accessed at www.worldconferenceondrowningprevention2011.org; Rubin, T. et al. 'Portable pools and the SwimSafe Thailand experience'. In: Scarr et al (eds), World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p. 234 accessed at: www.worldconferenceondrowningprevention2011.org.

⁶⁵ Sridharan, R. and B. N. Murthy (May 1999). 'Prevalence and Pattern of Epilepsy in India'. *Epilepsia*, 40(5): 631–636; Schwartz, P. J. et al. (2009). 'Prevalence of the Congenital Long-QT Syndrome'. *Circulation*, 120(18): 1761-1767.

⁶⁶ Besag, F.M.C., (21 April 2001). 'Tonic seizures are a particular risk factor for drowning in people with epilepsy'. *British Medical Journal*, 322(7292), doi: 10.1136/bmj.322.7292.975; Diekema, D.S., L. Quan and V. L. Holt (March 1993). 'Epilepsy as a Risk Factor for Submersion Injury in Children'. *Pediatrics*, 91(3): 612 -616; Albertella L., J. Crawford and J. R. Skinner. (2011). 'Presentation and outcome of water-related events in children with long QT syndrome'. *Archives of Diseases in Childhood*, 96(8): 704-707.

⁶⁷ Kyriacou D. N. et al. (1 August 1994). 'Effect of immediate resuscitation on children with submersion injury'. *Pediatrics*, 94(2):137– 142; Wigginton J., (2002). 'The key role of layperson actions in drowning incidents. In: World Congress on Drowning: Prevention, Rescue and Treatment, 26– 28 June 2002. Amsterdam: Consumer Safety Institute, 2002; Kitamura T. et al. (2010). 'Bystander-initiated rescue breathing for out of hospital cardiac arrests of non-cardiac origin'. *Circulation*, 122:295-299.

immediate resuscitation is discussed in the 2008 WHO/UNICEF *World Report on Child Injury Prevention*. In HIC settings, layperson-delivered CPR is usually followed by a rapid response by emergency medical personnel who can defibrillate the victim at the site of resuscitation, provide advanced life support and quickly transport the person to a hospital for further specialized care. This type of rapid professional response is not feasible in the setting of rural LMICs.

Community response in HICs depends on many factors that are not present or are only minimally available in LMICs. HICs are generally characterized by excellent health, communications and transport infrastructure, and have well educated populations. Large numbers of people – both adolescents and adults – have undertaken formal first-response training, understand the urgency required in resuscitation and can safely carry out rescue of drowning victims. There is often also a community ethos of bystander intervention, often facilitated by ‘good Samaritan’ laws to protect bystanders from liability when helping persons in need.

These factors are mostly lacking in LMICs. It is not clear what factors are critical to an effective community first response system in an LMIC. Any community-based response system will have to be implemented in a very resource poor environment. The lack of professional emergency responders requires a heavy reliance on community volunteers. The lack of infrastructure and a population with low literacy rates present major barriers. These have been shown to be significant barriers to the achievement of other health and development interventions in rural LMICs. Research done in Bangladesh has determined that low literacy, religious beliefs and cultural attitudes are also significant barriers to the completion of CPR training.⁶⁸ For these reasons, and given the uncertainty around successful skills acquisition and the duration of skills retention, CPR has not yet been included in SwimSafe Bangladesh.

CPR is part of the programme in SwimSafe Thailand and SwimSafe Danang. The training takes place in primary schools where literacy and teaching proficiency are not barriers to knowledge acquisition. There are still uncertainties regarding the duration of skills retention, the ability of younger children to successfully intervene as CPR providers, and the cost-effectiveness of the intervention itself.

Research is currently underway in Bangladesh to determine the feasibility, prevention efficacy and cost-effectiveness of creating a village-based network of CPR-qualified first responders.⁶⁹ In Thailand and Viet Nam, research aims to determine the lower age limit for learning resuscitation skills and duration of skills retention, and to evaluate effective use. The research findings should provide important information regarding the feasibility, sustainability and effectiveness of large-scale CPR training in LMIC settings.

⁶⁸ Mecrow, T. et al. ‘Barriers to CPR Training in a Rural LMIC Setting’. In: Scarr et al (eds), World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p. 67 accessed at: www.worldconferenceondrowningprevention2011.org.

⁶⁹ Nusrat, N. ‘Large-Scale Community Training in CPR as a Basis for a Community Response System in an LMIC’. In: Scarr et al (eds), World Conference on Drowning Prevention, Danang, Vietnam, 2011. International Life Saving Federation, Leuven, p. 72 accessed at: www.worldconferenceondrowningprevention2011.org.

4. THE BASIS FOR INTERVENTION

Drowning is a significant cause of death in infants and a leading killer of children after infancy in the Asian LMICs surveyed. There are a number of considerations that directly result from this, which provide the basis for prompt action by the international community in moving this neglected cause of child mortality onto the child health agenda.

4.1 DROWNING DEATHS IN LMICS ARE PREVENTABLE

The PRECISE effectiveness analysis in rural Bangladesh provides evidence that child drowning deaths in LMICs are preventable in resource-constrained settings in a sustainable manner. The case is strengthened further by the cost-effectiveness analysis, which has shown that preventing these deaths should be given as high priority as other child survival interventions. The number of children who drown each year is large. Addressing a preventable cause of death that is responsible for as many as one out of every four deaths in childhood after infancy is a moral and ethical imperative.

The international community has long recognized the toll on socioeconomic development from childhood diseases such as malaria and diarrhoeal diseases, hence the priority given to reducing mortality and morbidity. The same applies to societal loss from drowning and the same response is needed.

Drowning deaths are responsible for an increasingly large proportion of early child mortality and will present a significant barrier to achievement of MDG4 in those countries struggling to reach the goal. Drowning reduction should be a component of early child mortality reduction in all countries, simply based on numbers, but especially so in those countries struggling to achieve MDG4. Achieving the goal will add momentum to the effort to further reduce child mortality in the period beyond 2015.

4.2 IF DROWNING IS NOT COUNTED, IT DOES NOT COUNT

To become a part of the child survival revolution, child drowning must be counted. The process starts with awareness of the issue itself which is currently lacking. There are significant gaps:

- The UN Inter-agency Group for Child Mortality Estimation Report (2010) does not mention drowning as a cause of death in children.⁷⁰
- There are now 156 different indicators for UNICEF's *The State of the World's Children* report. However, mortality from drowning (or other types of injury) is not included.⁷¹ Similarly, over the past 30 years the report has lacked any mention of drowning as a cause of child death.⁷²
- The Multiple Indicator Cluster Survey (MICS) is used to measure key child health and development parameters and to track progress on a wide variety of child goals.⁷³ MICS-4 (2009-

⁷⁰ United Nations Children's Fund, Levels and Trends in Child Mortality, Report 2010, Estimates Developed by the UN Inter-Agency Group for Child Mortality Estimation. New York: UNICEF.

⁷¹ United Nations Children's Fund (2010), *The State of the World's Children 2011*. New York: UNICEF.

⁷² A word search for the terms 'drowning', 'drownings' and 'drown' on word-searchable PDF copies of SOWC from 1980 through 2012 found only one use of the term 'drowning', in SOWC 2011 and it applied as a metaphor to a nation as a country that was drowning (see quote page 47).

2011) has 107 indicators, but does not include any for drowning (or any other unintentional injury).⁷⁴

Awareness of drowning is a first step, but insufficient without the development of measurement systems that provide accurate numbers for children drowning in early and later childhood and the adoption of programme indicators and monitoring systems for drowning so interventions can be tracked. As Lord Kelvin said, 'if you can't measure it, you can't improve it'.

4.3 LACK OF CAPACITY IN THE INTERNATIONAL CHILD HEALTH AND DEVELOPMENT COMMUNITY

The drowning epidemic has long gone unrecognized, with the lack of technical capacity at both national and regional levels arguably a major determinant. It can also be argued that the lack of information systems capable of counting and accurately reporting the number of drowning incidents is a proximate cause of the lack of current technical capacity.

Within the specialized UN agencies that focus on child mortality reduction, there is an urgent need to build technical capacity around drowning prevention. The WHO regional offices in Asia (Southeast Asia and Western Pacific), the UNICEF regional offices in Asia (East Asia and the Pacific, and South Asia), where drowning is now visible, require staff with training and experience in child drowning prevention programming at country level. At the global level, UN agencies need staff with training and experience in child drowning prevention programming in LMICs.

There is a need for specially trained and experienced staff in drowning prevention in LMICs in the bilateral health and development community where organizations have yet to create strong technical capacity around drowning.

Global foundations and multinational NGOs similarly need trained and experienced staff in drowning prevention in LMICs.

The Australian Agency for International Development (AusAID) is an exception, having developed an International Drowning Research Centre in Bangladesh, funding drowning prevention programmes in Bangladesh and Viet Nam and sponsoring the 2011 World Conference on Drowning Prevention in Danang, Viet Nam.

⁷³ MICS is a monitoring tool originally developed in response to the 1990 World Summit for Children to measure progress towards mid-decade goals. It has since been used to monitor the Millennium Development Goals as well as other major international commitments, such as the goals of the United Nations General Assembly Special Session on HIV/AIDS and the Abuja targets for malaria. MICS has evolved over three previous cycles. Each of the three previous rounds of MICS has incorporated new issues as they have become recognized as being of sufficient importance. To date, indicators for child injury, including drowning, are not included.

⁷⁴ Information on MICS-4 available at ChildInfo: www.childinfo.org/mics4.html.

5. BUILDING A GLOBAL PLATFORM FOR DROWNING PREVENTION

Drowning is a significant, preventable cause of death among children in LMICs. The challenge is to transform this previously unidentified public health issue from a neglected issue to one addressed by national, regional or global level programmes.

The challenges include:

- Scaling-up a package of effective drowning interventions into national, regional and global programmes.
- Building drowning prevention capacity at all levels of the development continuum.
- Stimulating and sustaining investment in drowning prevention interventions and activities.
- Managing the shift from a scarcity of funds to a programme of well-targeted and coordinated investments.
- Incorporating research into programme design and implementation.

The process must recognize the considerable differences between implementing drowning prevention strategies in LMICs as compared to HICs. In the latter group of countries, lifesaving agencies, drowning prevention councils and governments provide a strong platform for drowning prevention. This capacity is lacking in LMICs and requires that drowning prevention efforts focus for the time being on the community, home, family and individual, while the necessary social, governmental and governance structures are developed.

5.1 SCALING-UP DROWNING INTERVENTIONS INTO NATIONAL, REGIONAL AND GLOBAL PROGRAMMES

Reduction of each major cause of early child mortality required effective interventions delivered on a large, population-based scale in rural LMICs. Earlier interventions such as immunizations, breastfeeding and oral rehydration therapy were developed and shown to be effective at low cost. Sustained use of these interventions then led to the decline in early child mortality in LMICs. A reduction in drowning in LMICs should be no different.

Research from PRECISE demonstrates the efficacy and cost-effectiveness of a number of key drowning interventions. While each intervention has individual promise and application, it is important to note that they were designed and delivered as part of an integrated package of drowning interventions within a community. In terms of cost-effectiveness and the number of child deaths prevented, this package compared favourably to other child survival interventions.

Adopting an integrated approach has helped address many of the challenges for implementing drowning interventions at a community level. When viewed as an integrated package of drowning interventions, several factors should guide future programme expansion. These factors include the role of the community in identifying drowning risk and selecting or initiating interventions, the need to respond to drowning risk across age groups with a range of interventions rather than any single measure, and the need for the types of supporting community-based systems often found in larger scale community development interventions. Such an integrated package is reliant on both the strength of the individual interventions and the degree to which community acceptance and support for implementation has been achieved. Not visible, but equally important, are the supporting mechanisms,

systems and standards, and management and community development approaches that are responsible for the successful implementation of the package.

The PRECISE programme involved a large number of participants in the implementation component of the field study. These participants were grouped into three areas:

- Those responsible for delivering the interventions (i.e. the SwimSafe instructors and Anchal crèche workers);
- Those responsible for management and implementation of the programme (i.e. the managers and field staff); and
- The community level partners (i.e. local government authorities, community health clinics, NGOs, schools and landowners).

Recognition of the role of the latter two groups in the integrated community drowning prevention package helps inform ways of moving forward with national drowning prevention programmes.

The coexistence between the integrated package of drowning interventions and community-level strategies adopted in the child survival revolution (i.e. those strategies used for other child health interventions) is not only feasible but necessary. Both sets of interventions require significant investment in community development infrastructure and a workforce attuned to the needs of the community and experienced in working with parents, children and community leaders. At the national or sub-national level, there is an overlap between the sort of infrastructure, systems and approaches used by existing development sectors, and that required to implement effective and sustainable drowning prevention programmes.

Incorporation of the integrated package of drowning interventions with other development programmes provides benefits for national expansion, including:

- Reducing intervention costs and increasing efficiencies by using existing infrastructure (implementation, management and surveillance) at community, sub-national and national levels.
- Increasing the rapid scale-up of programmes through use of existing community partnerships.

Strengthening other interventions by providing a vehicle for delivery of a range of health interventions is both effective and sustainable, as shown by the evidence on the village crèche model. The health sector is just one development sector where investments in drowning prevention may coexist. Opportunities in other sectors, including disaster risk reduction, water and sanitation and rural development, warrant further exploration. Anecdotally, there is some recognition of the severity and importance of addressing drowning by programme experts in these sectors. For example, some disaster risk reduction programmes, particularly those focused on community-based disaster risk reduction, have implemented survival swimming, rescue and resuscitation programmes. Rural development programmes in the Mekong Region of Viet Nam, for example, have supported local swimming education for children. The challenge for drowning prevention is to provide a platform where such approaches are strengthened, monitored for safety and linked to national drowning prevention programmes.

5.2 BUILDING DROWNING PREVENTION CAPACITY AT ALL LEVELS

To produce a significant reduction in the burden of drowning in LMICs substantial investment is needed in building capacity at all levels of the development continuum. At national level there needs to be recognition that drowning prevention requires multisectoral collaboration. Fundamental to this is ensuring that the limited resources and focus of key groups and government agencies are aligned to boost the overall capacity of the system to reduce drowning. This pressure is accentuated in LMICs given the emerging nature of the drowning issue on the public health agenda. It may raise dissent or disinterest among many already engaged in child mortality reduction as ‘mission creep’, and may be seen as another set of interventions for which staff and funding is unavailable. The newly available evidence on the significance of the drowning epidemic among children in Asian LMICs may help overcome some of these objections.

National responses to drowning prevention are impeded by a lack of technical and operational capacity, such as limitations in the skills required to teach survival swimming or to manage large-scale survival swimming programmes. The PRECISE project in Bangladesh and the SwimSafe Danang programme in Viet Nam have aimed to build community and government capacity to implement and monitor drowning prevention programmes in the respective areas. In Bangladesh, the number of survival swimming instructors has grown exponentially since the programme was first developed. This has been achieved through the standardization of instructional resources, recruitment of community-based instructors and supervision models that delivered on-the-job mentoring and professional development. External supervision and certification was crucial to the project’s success. In Viet Nam, schoolteachers across the province were trained and had regular supervision and professional development conducted by master trainers under external supervision. The resulting cadre of survival swimming instructors is now in demand by the Vietnamese Ministry of Education and Training and other programme managers, who recognize the advantages of having Vietnamese master trainers.

Building the capacity to implement, manage and monitor drowning prevention programmes is essential, but focus must also be given to the issue of elevating drowning prevention into national government priorities, increasing the availability of funds and devising systems and plans to prevent and reduce drowning nationally. Success in this area is premised on an acceptance that drowning prevention requires multisectoral collaboration. Lifesaving agencies and drowning prevention specialists in HICs have come to this recognition, after having worked with limited and fragmented resources for many years, frequently compromising the effectiveness of their efforts. For example, much of the drowning prevention efforts in Australia have been driven at community level through volunteer lifesaving models, and academics often lament the lack of funds available to support or strengthen the evidence base for prevention. Multisectoral collaboration builds on the strength of each sector, and can result in additional fundraising and strengthened advocacy for prevention of child drowning. In recent years, LMICs too have recognized the need for a multisectoral approach. In Viet Nam, with assistance from UNICEF and WHO, the Government formed an Inter-Ministerial Panel for Child Drowning Prevention in 2009 to coordinate the work of a range of government agencies on drowning prevention. Other models exist and an example is the Philippine Life Saving Society. PLSS has initiated the Philippine Drowning Prevention Council as a strategy to formulate plans, engage all sectors and increase government involvement in drowning prevention.

In both cases large community surveys that mapped the scale and patterns of drowning were conducted. While it has taken some time, this research and others like it has contributed to the elevation of drowning among key government and NGO sectors, stimulating drowning prevention interventions and prompting recognition of the need for multisectoral approaches and the development of drowning prevention capacity.

5.3 STIMULATING AND SUSTAINING INVESTMENT IN DROWNING PREVENTION

While the newly available evidence on drowning has spurred prevention activities in each of the countries surveyed, it is clear that LMICs cannot effectively address the issue on their own. Just as global health partnerships have informed the child health and development communities in areas such as malaria, immunizations and tuberculosis, drowning prevention advocates can and should utilize global health partnership models to initiate action at regional or global levels to support efforts being undertaken in LMICs with high drowning rates.

As an example, global efforts to eradicate malaria have taken many forms in the last four decades. A review of limitations of the first attempts resulted in a more recent approach, Roll Back Malaria, which is based on progressive scale-up of a package of interventions, global partnerships and national action plans. Drowning prevention advocates may take lessons from the GAVI Alliance approach to public-private sector partnerships, governance and attracting investment from governments and philanthropists, or from the focus of the Global Fund to Fight AIDS, Tuberculosis and Malaria, on raising funds, coordinating donors and monitoring results.

Partnership models in other sectors including disaster risk reduction, water and sanitation and rural development also reinforce the need for coordinated planning by drowning prevention advocates. The collaborative plans in these sectors may be particularly relevant to drowning prevention given the overlapping constituents in LMIC's. For example, many of the communities with high rates of drowning in Bangladesh rely heavily on rural agriculture and are vulnerable to disasters such as severe flooding and coastal inundation.

While starting from a low base of support, drowning prevention is not without global or regional advocates. The International Life Saving Federation (ILSF) is made up of national lifesaving and drowning prevention bodies and collaborative partners across all regions. Its mission is to act as the world authority on drowning prevention, lifesaving and lifesaving sport, and among many initiatives convenes a bi-annual global conference on drowning prevention.

Influenced heavily by the findings of the first UNICEF-TASC special series of working papers on child injury published in 2007, the World Conference on Drowning Prevention was held in May 2011 in Danang, Viet Nam. At this event, a diverse cross-section of stakeholders, including representatives from UN agencies, international and national lifesaving federations, regional governments and the research sector convened to address the issue of drowning prevention at global, regional and national levels. A key outcome of the event was the initiation a global platform to reduce drowning.

5.4 MANAGING THE SHIFT FROM SCARCE FUNDS TO WELL-TARGETED, COORDINATED INVESTMENTS

The Global Platform to Reduce Drowning seeks to establish a dialogue among high-level stakeholders with an interest in elevating drowning as a public health issue worldwide. With growing awareness, consensus and concern about the need to act to prevent drowning, the stakeholders represented at the ILS World Conference on Drowning Prevention 2011 called for well-targeted and coordinated investments, and the need to capitalize on momentum being generated for drowning prevention efforts in Asia. The results of their efforts, the Global Platform to Reduce Drowning, aims to provide a vehicle for lifesaving organizations, multilaterals, national governments and partners across the drowning prevention and development sectors to explore multisectoral collaboration. The principles outlined in the Platform are as follows:

- Take actions to raise the profile of drowning prevention.
- Establish drowning as an issue in national and international health and development agendas.
- Establish drowning prevention focused partnerships and multisectoral collaboration.
- Increase and mobilize funds and other resources.
- Stimulate research for drowning and further design and test interventions.
- Increase the scale and scope of intervention programmes.
- Build drowning prevention focused capacity across sectors.
- Establish and strengthen standards specific to the varying aspects of drowning prevention in different development settings.

There was recognition of the need to focus on the most vulnerable groups in all regions, countries and communities of the world. For many HICs this may mean a focus on very young children, indigenous, migrant and aging populations, and on men undertaking high-risk recreational activities. In the case of LMICs the starting focus was clearly on children in early and middle childhood.

Participants recognized the need to collaborate with other development sectors. There was recognition that agencies already working in communities in other development aid sectors may provide existing community infrastructure and mechanisms that support the implementation of drowning prevention programmes. The main strategies to be included in the Global Platform to Reduce Drowning are:

- Prioritize drowning prevention and risk reduction strategies.
- Foster multisectoral collaboration.
- Ensure evidence supports responsive, adaptive and effective interventions.
- Create drowning safe homes, communities and environments.
- Promote universal survival swimming and drowning prevention education.
- Promote community drowning prevention resilience.
- Build policy, legislation and standards that reduce drowning.

5.5 THE TIME TO ACT IS NOW

It has been said that the child survival revolution began with the Alma Ata Declaration in 1978. For much of the development community in the three and a half decades since the beginning of the child survival revolution, water safety has meant water that did not transmit diarrhoeal diseases and other infections. More recently it has taken on an additional association, with the recognition that water must be free of arsenic and other chemical contaminants. It is now time to embrace a definition of water safety that also encompasses prevention and protection from drowning.

Along with the entire class of injury mortality, drowning is usually listed by researchers in child mortality estimations in the category labeled 'other'. However, there is no intervention that has shown to be

effective against 'other diseases and conditions'. Experience gained from decades of interventions against primary causes of childhood mortality and morbidity show that targeted interventions – either in isolation or as part of a package of interventions – are most successful. But until drowning is recognized as a key driver of mortality in children of all ages, particularly after infancy, it cannot be effectively addressed.

The recent evidence that shows that drowning prevention interventions are effective and cost-effective in resource-constrained settings makes the case for it to be counted with specificity. Looking back at the data from the Matlab DSS, in the years 1978-1984 drowning accounted for about the same number of deaths as measles. The child health community prioritized measles because it was recognized as a leading killer of children. A great deal of time and money was spent to develop vaccines and technologies to keep vaccines at correct temperature in storage and to transport them as well as to train the necessary logisticians, trainers and vaccinators. This resulted in very high universal coverage rates (more than 90 per cent) among children. The global health community undertook this effort because a vaccinated child had lifelong measles immunity and protected others through providing herd immunity, which was key to making the intervention cost-effective. As a result, in the 1980s, measles was essentially eliminated as a significant cause of child death.

The development community is now at the same place with drowning. In the region of the world that holds two thirds of the world's children, we know that drowning is a leading cause of mortality. We also know that there are cost-effective interventions against this leading killer – we know that children placed in crèches and other early child development programmes are safe from drowning; that older children who are taught survival swimming skills are protected and when taught safe rescue skills, they use them to protect their peers.

There is much to be done to address the pressing needs for more evidence, expertise, recognition and intervention; but the evidence now in front of us is more than enough to act upon. Simply put, child drowning is a leading cause of death in children in LMICs in Asia. This region contains the majority of the world's children, thus making it a problem of global proportions. Now that we know drowning is as preventable as other leading causes of child death in these countries, it is time to act.

It really is that simple.

ACRONYMS

AusAID	Australian Agency for International Development
BHIS	Bangladesh Health and Injury Survey
BIS	Beijing Injury Survey
BMI	body mass index
CAIS	Cambodia Accident and Injury Survey
CD	communicable disease
CDD	control of diarrhoeal diseases
CIPRB	Centre for Injury Prevention and Research, Bangladesh
CODMOD	cause of death model (GBD estimation methodology)
CPR	cardiopulmonary resuscitation
DALY	disability-adjusted life year
DSP	Disease Surveillance Points (system in China)
DSS	Demographic Surveillance System
EPI	Expanded Programme on Immunization
GBD	Global Burden of Disease (World Health Organization)
HIC	high-income country
ICD	International Classification of Diseases
ICDDRB	International Centre for Diarrhoeal Disease Research, Bangladesh
ILSF	International Life Saving Federation
IMCI	Integrated Management of Childhood Illness (IMCI) initiative
IMR	infant mortality rate
IRC	Innocenti Research Centre (UNICEF)
LIC	low-income country
JIS	Jiangxi Injury Survey
LMIC	low- and middle-income country
MCH	maternal and child health (programmes)
MDGs	Millennium Development Goals
MDS	Million Death Study (India)
MIC	middle-income country
NCD	non-communicable disease
LMIC	low- and middle-income countries
ORS	oral rehydration salts (or solution)
PLSS	Philippine Drowning Prevention Council
PRECISE	Prevention of Child Injuries through Social Intervention and Education
RLSSA	Royal Life Saving Society-Australia
RTA	Road traffic accident
SIDS	sudden infant death syndrome
TASC	The Alliance for Safe Children
TNIS	Thai National Injury Survey
U5MR	under-five mortality rate
UTD	undetermined (cause of death)
VMIS	Vietnam Multicenter Injury Survey
WHO	World Health Organization
WHO CHOICE	CHOosing Interventions that are Cost Effective (methodology)

ANNEX: LIST OF CONTRIBUTORS

This paper incorporates the professional contributions of many people. It is a continuation of the UNICEF *Innocenti Working Paper Series* on 'Child Mortality and Injury in Asia' published in 2007. It pulls together the body of work related to child drowning from the series as well as an additional national survey done in Cambodia and research on drowning interventions done in Bangladesh, China, Thailand and Viet Nam.

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