

**Innocenti Working Paper**

**CHILD MORTALITY AND INJURY  
IN ASIA:**

**SURVEY RESULTS AND EVIDENCE**

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## Results and Evidence

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**Summary:** This paper presents a detailed description of the survey results which were introduced in the Overview paper. Results are presented first for proportional mortality in children by age group for a population-weighted composite of the surveys, and then for the individual surveys. Following this, detailed results are presented for fatal injury by national or subnational area, region (urban/rural) and gender for childhood (0–17 years). After this the types of fatal injury that occur at the different stages of childhood are presented.

The second part of the paper presents both fatal and non-fatal injury by type of injury for the composite of the surveys as well as the individual surveys themselves. The results show that the leading causes of non-fatal injury differ from those of fatal injury, and the greatest burden is caused by the more serious categories of non-fatal injury.

Finally, the ratio of the two leading causes of fatal injury in children, drowning and road traffic accidents, are presented for each of the surveys. Drowning is shown to be the leading cause of fatal childhood injury in each survey when compared with road traffic. The paper concludes with a discussion of the major issues illuminated in the results of the surveys.

**Keywords:** children, demographic change, epidemiological transition, child mortality, cause of death, Asia, Bangladesh, China, Philippines, Thailand, Viet Nam, low- and middle-income countries (LMICs), injury, injury mortality, injury morbidity, community survey, mortality estimates, under-five mortality,

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The paper results from the work of a large number of technical contributors who are listed in detail in the annex. The authors acknowledge the enormous contributions made by those listed to this series of papers.

## FOREWORD

There is strong and growing evidence that child injury is a major concern throughout the world, in developing as well as industrialized countries. Research carried out by The Alliance for Safe Children (TASC), UNICEF and local partners in East and South Asia compellingly demonstrates the importance of injury as a cause of child mortality and disability in this region.

The impacts of child injury in developing countries are typically many multiples of those seen in the rich world. For example, for every 100,000 children born in industrialized countries, fewer than 135 die from injuries before the age of 18. In the Asian countries participating in the research presented here, that figure is well over 1,000. The impacts of these rates, due to higher risks, are magnified by the greater numbers of children living in developing countries.

Over the past 50 years, child deaths due to injury have decreased substantially in industrialized countries. The risk of death by injury before the age of 18 to a child born today is less than half the level of 30 years ago. Yet the reduction in the number of deaths in these countries was not merely a natural outcome of economic development. It was the result of a concerted, collective effort that began with recognition of the problem, followed by political commitment and policy change. This long process of research, lobbying, legislation, environmental modifications, public education and improvements in emergency services has saved millions of lives. Fifty years of successfully reducing child injury rates in industrialized countries has taught us that the interaction of a child and a pond, a child and a car, or a child and an animal are as predictable, and as preventable, as the encounter of a child with a virus or bacteria.

We are nearing midway in the effort initiated at the historic Millennium Summit in 2000, where world leaders adopted a set of Millennium Development Goals for the year 2015. One goal calls for reducing the under-five mortality rate by two thirds from its 1990 level. To reach this ambitious goal we will need to work harder to do what we have always done for children's survival – promoting safe motherhood, increasing immunization coverage, ensuring better nutrition, and improving the role and status of women.

To achieve sustainable reduction in child mortality we must also 'work smarter'. Focus must be given to two areas of child deaths that now make up the majority of preventable mortality, and that have not been sufficiently well addressed in the past. One area is the reduction of neonatal deaths, which has become the focus of much recent research and international public and policy attention. Another focus must be on child injury.

Almost three decades ago a child survival revolution was launched, aimed at combating infectious diseases and nutritional deficiencies as the leading killers of infants and children. The targets were a handful of diseases and conditions that were responsible for the vast majority of deaths of infants and children. Based on evidence, interventions were organized through focused, affordable and sustainable actions. Campaigns were launched for breastfeeding and growth monitoring, immunization and oral rehydration therapy. Millions of lives were saved, and the development of many millions more children was advanced.

We now need to take similarly bold steps to prevent drowning, transport injury, poisoning, and other injury-related causes of child death and disability. Experience tells us that accidents and injury are largely preventable with simple and effective interventions. Unless we include injury prevention in our programmes, we stand to lose the impact of the major investments that have been made in immunization, nutrition and maternal and child health care.

In addition, deaths due to injury are but the tip of the iceberg. For every injured child who dies, many more live on with varying degrees and duration of trauma and disability, often denied the right to be productive citizens and to live a life of dignity. Their families are burdened with expensive hospitalization or other costs of caring for them. Likewise, injury to parents may lead to a family losing its breadwinner or its caregiver, contributing to poverty and with a devastating impact on children. Society must invest in preventing injuries, to save lives but also to help ensure the quality of life for children and their families.

Child injury prevention need not compete for the same scarce resources as other actions for children. Initiatives against accidents and injuries must be made complementary to and supportive of our focus on infant and child health, early childhood care, girls' education, HIV/AIDS prevention, and other programmes for young children and adolescents.

This special Innocenti series on Child Injury, developed jointly by UNICEF and TASC, presents recently acquired evidence from surveys in five Asian countries: Bangladesh, China, Philippines, Thailand and Viet Nam. The surveys are large in scale, similar to a census. In total over half a million households and nearly 2.5 million people were surveyed. The scale of the research provides an in-depth view of child mortality from all causes, as well as of morbidity from injury throughout all the years of childhood. The results show in detail the leading contribution made by injury to child death and disability, a fact that has been insufficiently recognized to date.

The findings from this research are important to Asia, one of the most dynamic and rapidly developing regions and home to over half the world's children. However, it is likely that patterns of increasingly significant injury-related child death and disability are occurring just as silently in other regions, difficult to detect by currently available measurement methods.

The work presented here clearly shows that in Asia the efforts for child survival carried out over the past three decades have been enormously successful. In the space of less than two generations the region has been transformed into one where the epidemiology of child and adult deaths is almost comparable to that in the rich world; the rates remain high, but the patterns have evolved. The epidemiological transition is clearly well underway in the region, from infectious diseases to injury and chronic disease as the leading causes of child death and disability. We must now rise to this new challenge.

The surveys and their results are made possible by, and build upon, the development that has occurred in health systems in the region. A strong and capable public health infrastructure now exists in most countries able to provide necessary information about death and illness. This provides policymakers with a firm basis on which to formulate the interventions that will most effectively continue the downward trend in the rates of child death and disability and extend protective benefits to all children.

The realization that almost half of all child deaths after infancy are due to injury gives great pause, but it is also a cause for hope. The revolution in child injury prevention in rich countries over the last 50 years demonstrates that injury is preventable. There is a clear way forward for policymakers in the region to make Asia 'A Region Safe for Children'.

Pete Peterson  
President  
The Alliance for Safe Children

Kul C. Gautam  
Assistant Secretary-General, United Nations  
Deputy Executive Director, UNICEF

## SYNOPSIS OF THE SERIES

The initial papers in this series present a comprehensive overview as well as an in-depth focus on the methodology, the detailed results and the policy and programmatic implications of the surveys that have been carried out on child injury in Asian countries. Papers are also presented on the association of poverty and injury, and on a community laboratory for developing effective injury interventions. A brief summary of these is as follows:

**Child mortality and injury in Asia: An overview.** An introduction to child injury and the issues that underlie the new data with a summary of results. The data show child injury to be far more prevalent than previously understood. Differences in these data and those gathered earlier are explored, and implications are addressed in a non-technical fashion.

**Survey methods.** An explanation of the methodology used for the surveys. It provides a detailed discussion of the methodology for readers with a technical background who desire more in-depth information on the surveys and how they differ from previous work.

**Survey results and evidence.** Detailed presentation of the results from the series of injury surveys, particularly for readers with specific country or category interests. This paper expands upon the description in the overview paper, including the presentation of further statistical analysis.

**Policy and programme implications.** Implications of the new findings are explored for child health programmes within the countries surveyed. The discussion has a practical orientation, to contribute to policy discussions on the measures needed for effective child injury prevention and response.

**The cost of injury and its association with poverty.** Using economic methods introduced for the Jiangxi Survey in China, data are presented on the cost of injury and its association with poverty. These costs and associations have implications for the wider Asian region.

**A community laboratory for child injury prevention in Bangladesh.** An introduction to a new community laboratory in Bangladesh for child injury prevention. Covering over 170,000 rural and urban households, the initiative focuses on measurement of the efficacy of injury interventions and their cost-effectiveness.

Future papers in the series are planned to be devoted to key issues of child injury raised in this initial group, but which call for more detailed discussion. Additional surveys in the field, when completed, will provide coverage of additional settings. These include reports on:

1. Child injury survey findings in Cambodia, as one of the few remaining countries in East Asia with high child mortality.
2. The correlates of survival and death of children and their parents in the Asian tsunami of December 2004, and the lessons for preparation and response in relation to the annually occurring natural disasters involving water in Asia.
3. Drowning, which accounts for the majority of all child deaths from injury. The phenomenon of drowning is unique in many respects, including epidemiology and prevention; the potential exists for elimination of a significant cause of child deaths.

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# **1 INTRODUCTION**

## **Background**

With health histories from nearly 2.5 million residents of over a half million households in five different countries in East and South Asia, the surveys recently carried out (from 2000 to 2005) form a unique evidence base regarding injury in the most populous region of the world. Because the surveys are so large, and cover representative populations in their scope, the measurements are unprecedented in precision and help paint a clearer picture of mortality at all stages of childhood, and morbidity from injury. That picture is more complete than – and markedly different from – that found in previous estimates. The overview paper (IWP-2007-04) went into some detail on the reasons for this, and they are briefly reviewed here for the benefit of readers who have not yet accessed that paper. The differences primarily relate to four factors, three of which are the technical factors of different measurement methodologies, changing epidemiologic patterns, and a more inclusive definition of childhood. The fourth is the result of 30 successful years of the child survival revolution: an alternative method is now possible because of the infrastructure developed in each country over those 30 years.

## **An innovative methodology**

In relation to the first factor, the methodology that has been used for child mortality estimates in the past has principally started from an estimate of the overall number of children under five years of age who die annually in the South and East Asian regions of the world where the surveys summarized here have been done. Then, an estimate of the proportional causes of under-five deaths is applied to that total number. This results in the total numbers of children under five who die from each of those principal causes. Injury is not among the proportional causes estimated currently and it is generally included in an overall category called ‘other’. In contrast, the method used in the studies summarized here is to define a large, representative sample of the country, city or province being surveyed, and then to count the deaths one by one as they have been captured within that sample, assigning a cause of death to each one. The classification used in the surveys counts injury deaths as a specific category, and further breaks overall injury down into its constituent subtypes (drowning, road traffic, falls, etc., etc.) When counted in this fashion, injury is seen to comprise a much larger proportion of under-five deaths than was previously recognized.

## **Changed epidemiologic patterns**

As far as the second factor is concerned, changing epidemiologic patterns, the surveys presented here have all been done since 2000. However, the research on causality of under-five deaths used in the previous child mortality estimations (even those done as recently as 2005) drew on work done in the mid and late 1980s for the bulk of the information. Since that time, overall child mortality rates have fallen over 50 per cent in the countries surveyed, as measured by the under-five mortality rate (U5MR). The experience of the rich countries of Europe today has been that similar rapid decreases in child mortality were accompanied by a change in the pattern of deaths from a predominance of infectious or communicable diseases (CD) to one of non-communicable diseases (NCD) and injury – precisely the pattern that appeared in the surveys summarized here.

### **All children, not just those under five**

Thirdly, previous child mortality estimates have focused almost exclusively on children under five for better resolution of cause when using the proportional mortality methods. The surveys recounted here measure mortality over the full course of childhood, from infancy through 17 years of age, as defined by the Convention on the Rights of the Child. While the single year of infancy is the highest mortality period of all of childhood and the ages one through four years follow next in mortality, about half of all child deaths after infancy occur after age five. These child deaths, excluded from the previous estimates, have been included in the surveys reported here and most of them are caused by injury.

### **A collaboration with local institutions**

The surveys summarized here have all been conducted by collaborations between UNICEF country offices, The Alliance for Safe Children (TASC) and counterparts within each country. After three decades of health development, the technical capacity now resident within countries in Asia (and elsewhere as well) is significant and allows for large-scale surveys to be carried out with similar quality outputs as in developed countries. Using a standard methodology, the strong multisectoral relationships between UNICEF country offices and the local capacity available in each country, the surveys have shown that it is now possible to move beyond child death estimates that are limited to the first five years of childhood and do not include all causes of death. The decentralized process that produced these surveys, with the planning, fieldwork, data entry and analysis carried out within each country, has shown it is cheaper and provides more information than other population-based surveys presently being used as supplements to the current child mortality estimates. The surveys have also added a great deal to the evidence base on child injury in Asia that has not been known before – both in terms of numbers and types of events, but as importantly, the surveys provide information on the distortions that current estimation techniques introduce and the need to recognize these in future measurement activities for child injury.

### **Deaths tell only a small part of the overall story**

A fundamental lesson emerging from the surveys is that estimates of child mortality from injury (or any other cause) may tell only a small part of the relevant story: morbidity must also be considered. Deaths of children, whether by age five or up through age 17, are critical but they represent just the tip of the iceberg of impacts to individuals, families and society due to injury. Serious and severe non-fatal injuries can result in permanent disability affecting the child and the family as a whole, and can impose enormous resource burdens. They represent major impediments to child health and development, and so they should be measured alongside fatal events. The surveys have shown some of the technical and methodological problems involved in doing this; however, they show that these measurements are possible, and that the information so gained offers an important contribution to health policymaking and planning.

### **Classification of fatal and non-fatal injury**

Injury is often classified as either fatal or non-fatal, but this implies a dichotomous relationship that is not true in reality. Injury actually occurs as a continuous set of outcomes

of mounting severity which increase as the physical extent of the injury event increases. The most severe outcome on the spectrum of injury is death. Classifying the intermediate outcomes where there are varying effects on health that fall short of death is a very difficult undertaking, as discussed in the paper on the survey methods. The methodology developed to allow comparisons in a standard fashion is based on severity being proportional to the economic and social cost of the injury. Thus an injury so minor that no costs were incurred by the individual or family was ignored in the survey, and only injury that resulted in costs were counted. While it is easy to conceptualize continuously increasing levels of severity ending with death, it is often confusing for them to be presented in this manner. Thus this paper begins in the traditional fashion by presenting the most severe level of injury – fatal injury – first and later presents non-fatal injury with severity classifications. In an attempt to help the reader tie the two together, the composite results of all the surveys are presented with each type of injury showing the entire spectrum of severity from moderate to death.

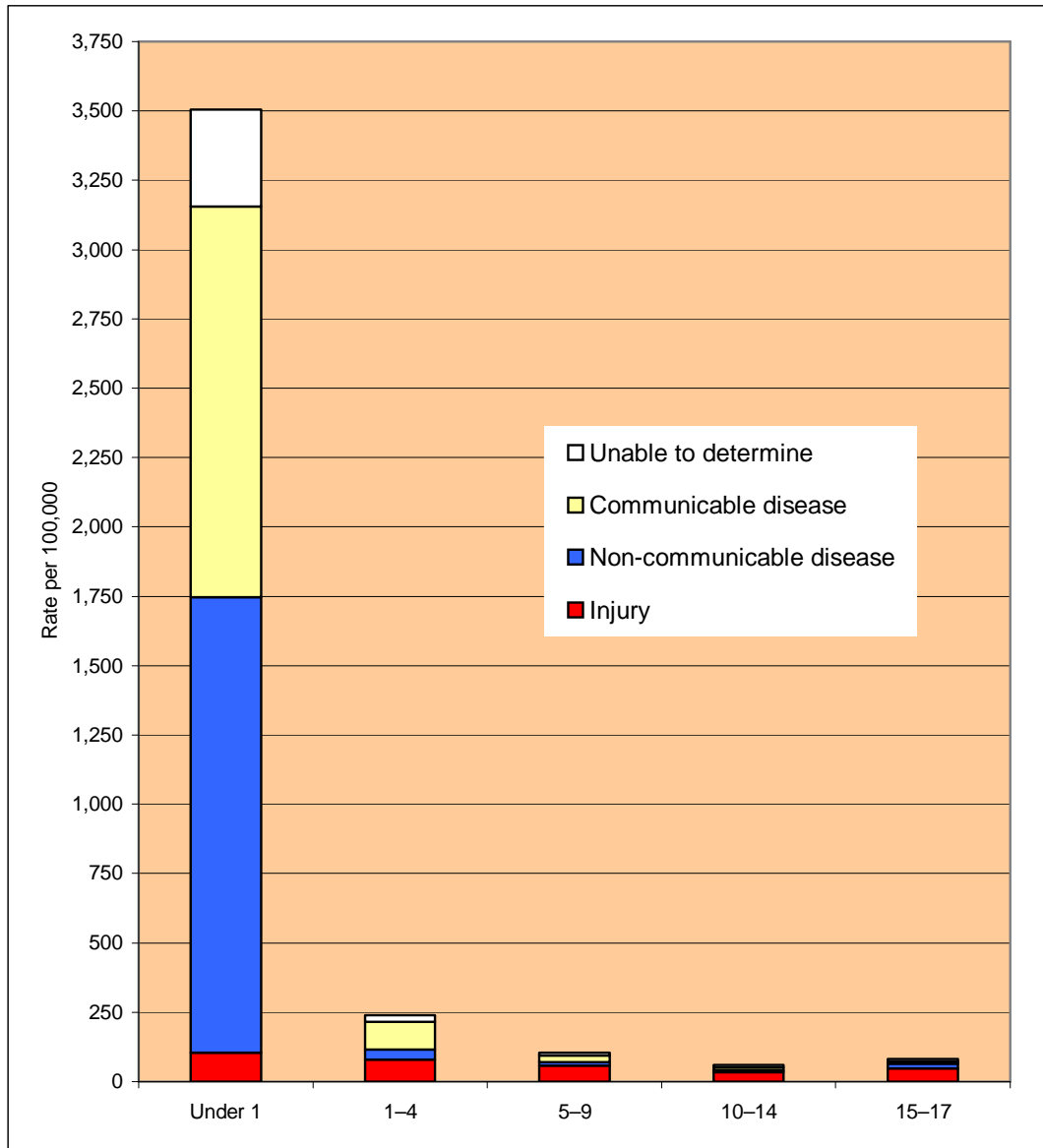
### **Striking a balance between technical precision and clear communication**

There is potential for information overload in the presentation of epidemiological and statistical detail to policy audiences, who form a key component of the intended readership of this Working Paper series. The presentation is accordingly aimed to provide a comprehensive picture so that the reader can ascertain a clear pattern in the findings, with that pattern visible both in the composite of all the surveys taken as a whole and in each of the individual surveys. It should be noted that since the earliest survey, in Viet Nam, had the smallest sample size, the confidence intervals around those estimates are larger than those in subsequent surveys. The survey in Beijing also faced an issue with statistical power due to the very low mortality in the capital city of China. However, as in the case of the WHO child mortality estimates, for the sake of clarity the working group has opted not to encumber the present charts with error estimates or confidence intervals. Readers interested to delve more deeply into the individual and comparative rates and to understand the uncertainties reflected therein are directed to the individual survey reports which contain this level of detail, available from the particular UNICEF Country Office or at <[www.tasc-gcipf.org](http://www.tasc-gcipf.org)>.

## **2 PROPORTIONAL CAUSES OF CHILD MORTALITY BY AGE GROUP**

The general pattern that can be seen in figure 1 is that injury is present as a cause of infant mortality, but is overshadowed by communicable and non-communicable causes. It is clear that the first year of life has the highest mortality of any period of childhood, and that well over half of all child deaths in the age group 0–17 occur in this first year. Most of the deaths in infancy (as many as two thirds) occur in the first month of life, the neonatal period. It is precisely this epidemiologic fact that has made infancy the keystone of child survival. The deaths in the first month are targeted by giving them a label of their own, neonatal deaths. While there are some causes of death unique to this period (mainly related to pregnancy and the process of birth), most of the other causes are the same infectious pneumonias and diarrhoeas that are the main killers in later infancy.

**Figure 1: Proportional mortality by child age group**



Source: Authors' calculations from individual surveys (2000-2005); composite is population-weighted.

It is visually striking how dramatically mortality falls immediately after the infant period, and how different the pattern of causality is after that. While injury causes only about 3 per cent (2.9 per cent) of infant deaths, it causes over a third (36.6 per cent) of deaths of children aged 1-4 years.

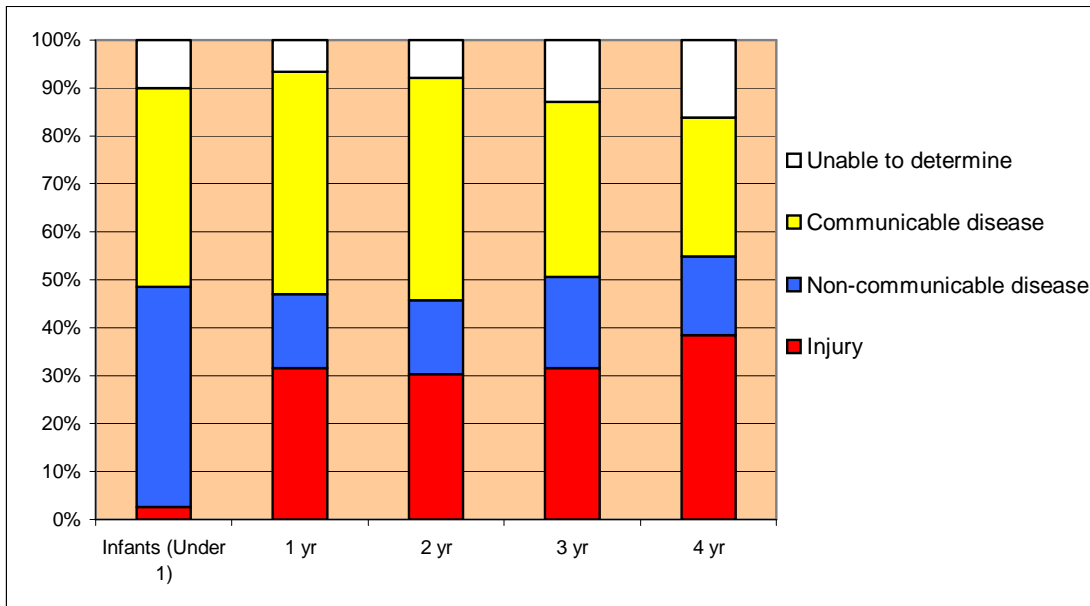
The very high mortality rates in infancy can be seen in comparison to the rest of childhood. After infancy, mortality rates from causes other than injury decline exponentially, while injury mortality declines in an approximately linear manner. It can also be seen that childhood injury is near its peak in infancy.

This epidemiologic shift occurs for two reasons. First, about two thirds of all infant deaths occur in the first month of life, the neonatal period. This is the highest mortality period in

life. Most of these early deaths are due to pregnancy, the birth process or post-partum causes. Once beyond the pregnancy and birth related period, mortality falls dramatically.

Secondly, it occurs as a result of the changing environment of the child. Born totally dependent on its mother for everything, the infant is carried everywhere and protected from hazard by the mother or other caretaker. There is little exposure to hazard, other than falling from surfaces the mother places the infant on, or being accidentally smothered while sleeping next to the mother. However, when the child begins to walk, around age one, the situation changes dramatically. It explores the world around on very unstable legs, often escaping the supervision of the busy mother and ignorant of the hazards entailed. Injury is a leading cause of death in the 1–4 age group, as can be seen in figure 2.

**Figure 2: Proportional mortality of children under five**



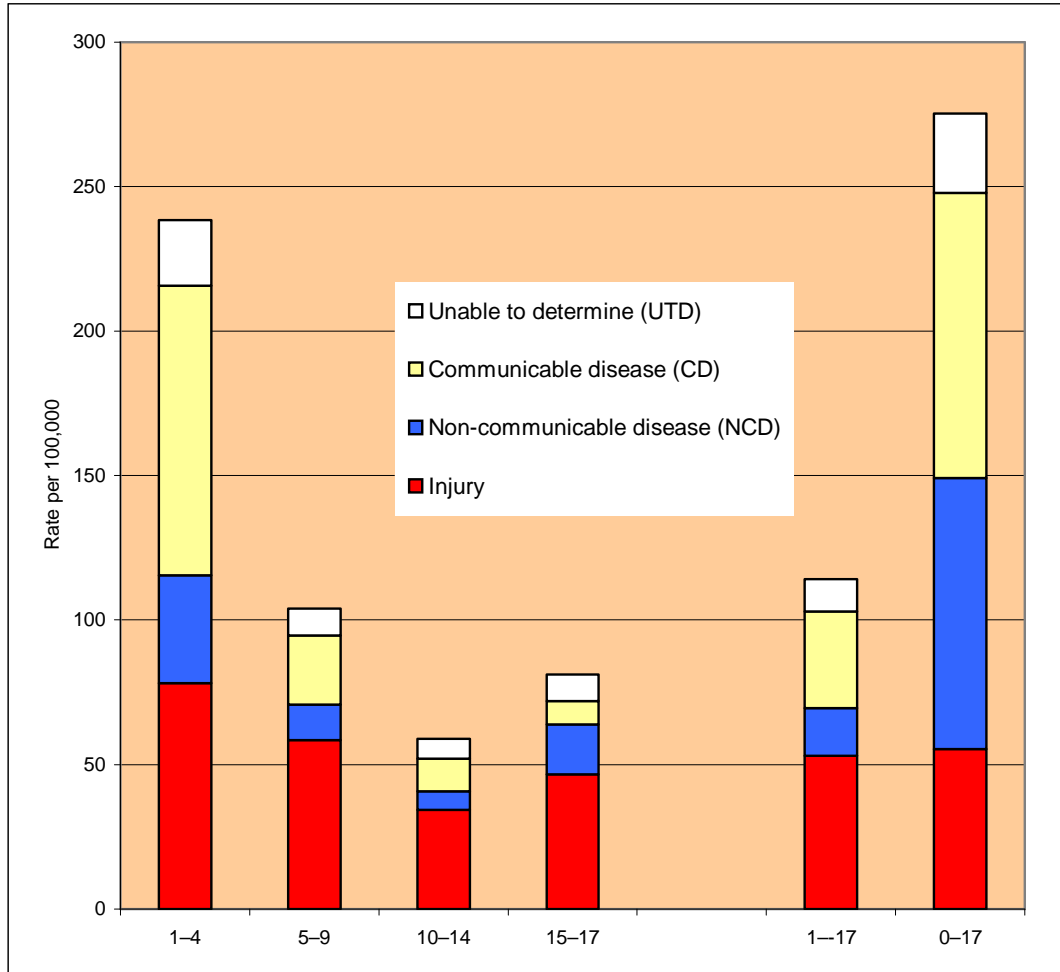
*Source:* Authors' calculations from individual surveys (2000-2005); composite is population-weighted.

The survey sample sizes are sufficiently large for there to be a sufficient number of deaths in each child age group to answer the question of how proportional mortality changes over the first five years of life. It is clear that infancy is a special and separate period of early childhood, with a distinct pattern of mortality which changes entirely after the first birthday.

This has fundamental implications for measurement of mortality in early childhood. Lumping infancy and the 1-4 period together creates a highly distorted picture of early childhood mortality. The mortality rates of infancy are the highest in life, 10 to 15 times more than for those in the next year of life. The largest proportion of those deaths relate to pregnancy, birth or its immediate aftermath, and these do not occur in the later years. Almost 8 out of 10 deaths in the five-year period after birth occur during the first, infant year. Combining these with the dramatically lower rates of the next four years, which have an entirely different pattern, overwhelmingly distorts the epidemiologic picture of the next four years.

Lumping the two different periods together, infancy and early childhood, as ‘children under five’ is convenient. However, it makes it impossible to distinguish which are the leading killers after infancy, and thus develop the most effective interventions for early childhood.

**Figure 3: Mortality rates by child age group (per 100,000 population)**



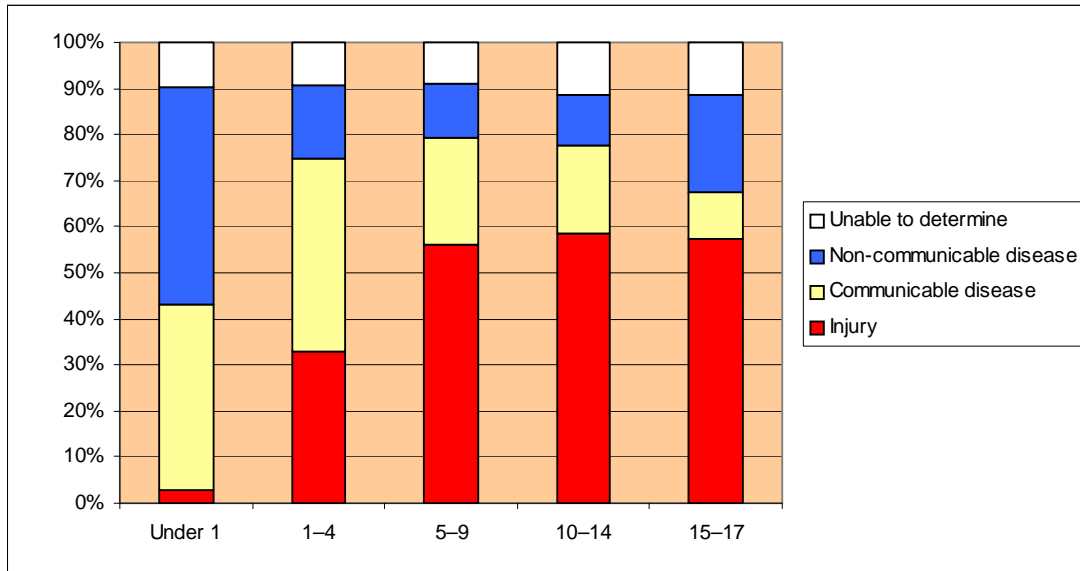
*Source:* Authors’ calculations from individual surveys (2000-2005); composite is population-weighted.

Infancy, defined as the first full year of life, has been excluded in the second bar from the right-hand side of figure 3 in order to clearly show the pattern of proportional mortality in the rest of childhood after infancy. Seen on this scale, injury is a leading killer for the rest of childhood. Injury accounts for about half of all child deaths after infancy (1–17) and for about a fifth of all mortality even when infants are included (0–17).

Injury kills an increasing proportion of children as childhood progresses, even as overall mortality falls, until the late adolescent age group (15–17) when the overall death rate begins to rise again. One reason for this is the increasing rates of intentional injury (suicide and homicide) that become leading causes of child death in the adolescent age group, along with the increase in road traffic accidents (RTA).

The next series of figures show proportional mortality as a percentage rather than a rate in each individual stage of childhood. This emphasizes the relative contributions to all mortality in the age group. It is important to note that injury, while one single cause of death, is made up of a variety of subtypes (drowning, RTA, falls, suffocations, suicides, homicides, etc.). The different patterns of subtypes of injury will be seen in later figures.

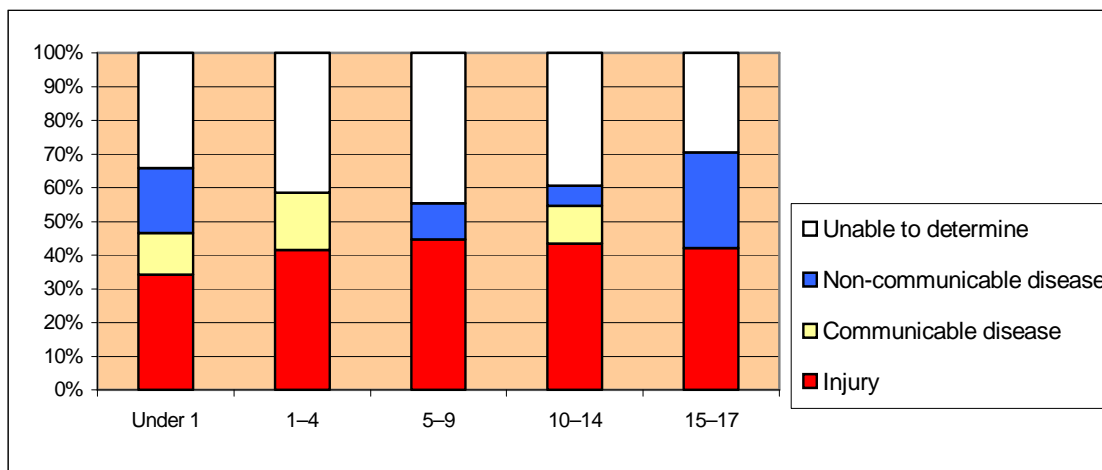
**Figure 4: Proportional mortality by child age group (percentages)**



Source: Authors' calculations from individual surveys (2000-2005); composite is population-weighted.

Figure 4 presents the overall pattern as seen in the composite of the surveys. It is based on 516,818 households from the surveys, with 788,194 children. Figures 5-10 show the respective proportional mortality patterns from each survey.

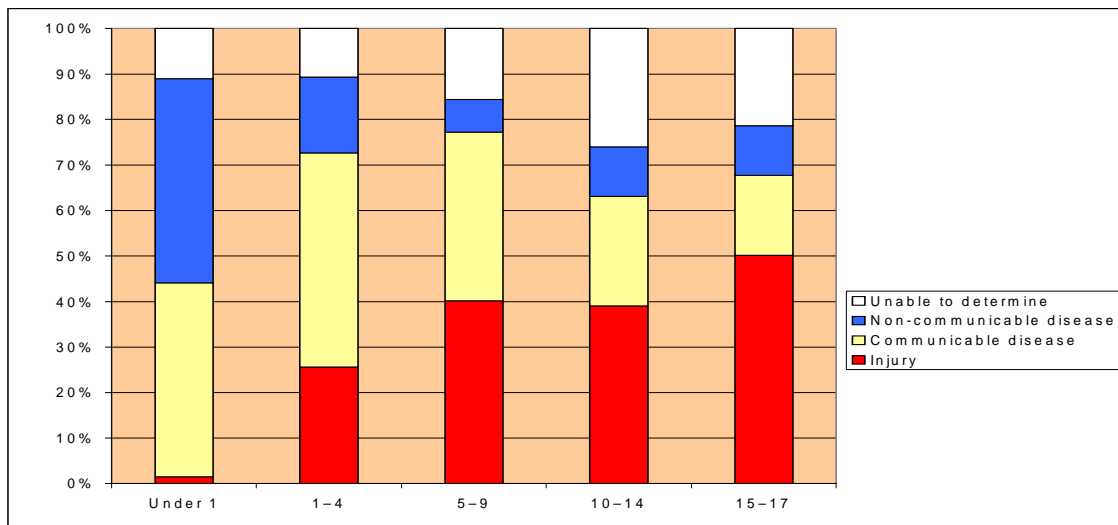
**Figure 5: Proportional mortality by child age group, Viet Nam**



Source: Vietnam Multi-center Injury Survey (2000).

The survey in Viet Nam, the first survey carried out, had a sample size of 26,700 households. This was sufficient to look at mortality over the 0–17 years of childhood. However, it was too small to capture large numbers of deaths in the individual age groups of childhood. This is the reason why figure 5 does not display non-communicable disease deaths in the 1–4 age range or deaths due to communicable disease in the 5–9 age range. These types of deaths certainly occur, but they fall below the resolution power of the survey. Similarly, the high levels of injury seen in infancy are caused by the variability due to a relatively small sample.

**Figure 6: Proportional mortality by child age group, Bangladesh**

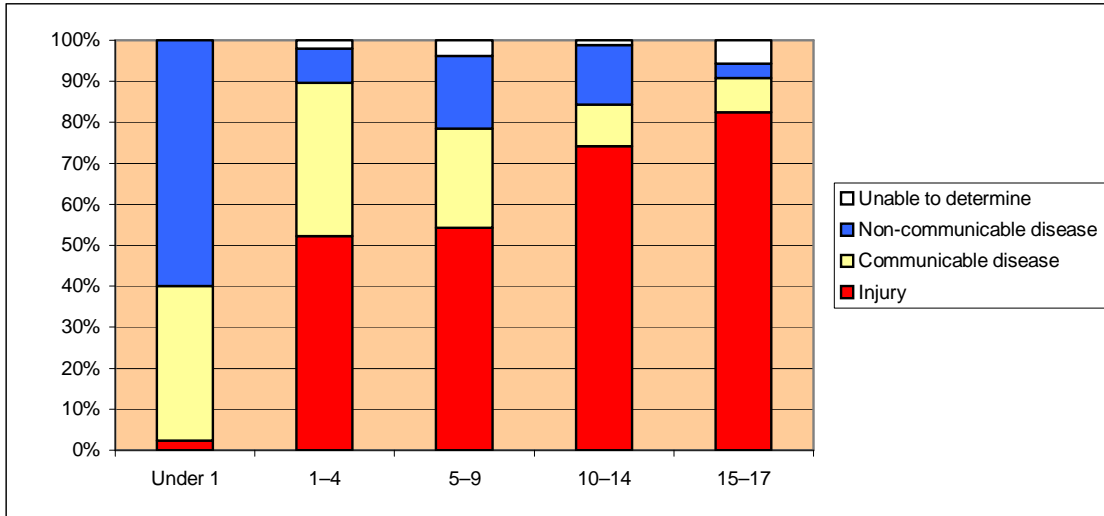


Source: Bangladesh Health and Injury Survey (2003).

The Bangladesh survey had the largest sample size (171,000 households), the largest number of children (351,651), and thus the highest power of the surveys. Bangladesh also had the highest under-five mortality rate among the countries surveyed (71.6/ per ,000 live births), showing that even at this high level of under-five mortality, injury is a leading killer in children aged one to four, and the predominant killer in children aged five and over.



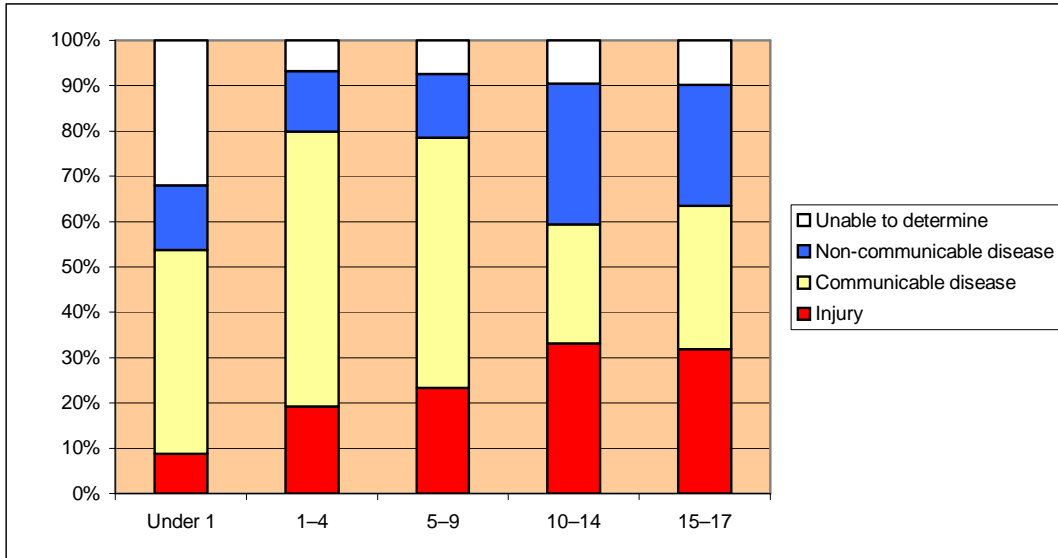
**Figure 7: Proportional mortality by child age group, Thailand**



Source: Thailand Injury Survey (2003).

The sample size in Thailand was 100,179 households, with 98,904 children. It had sufficient power to show the common pattern of a small proportion of fatal injury in infancy, dramatically rising in the 1-4 age group, and continuing to increase in proportion as childhood progresses.

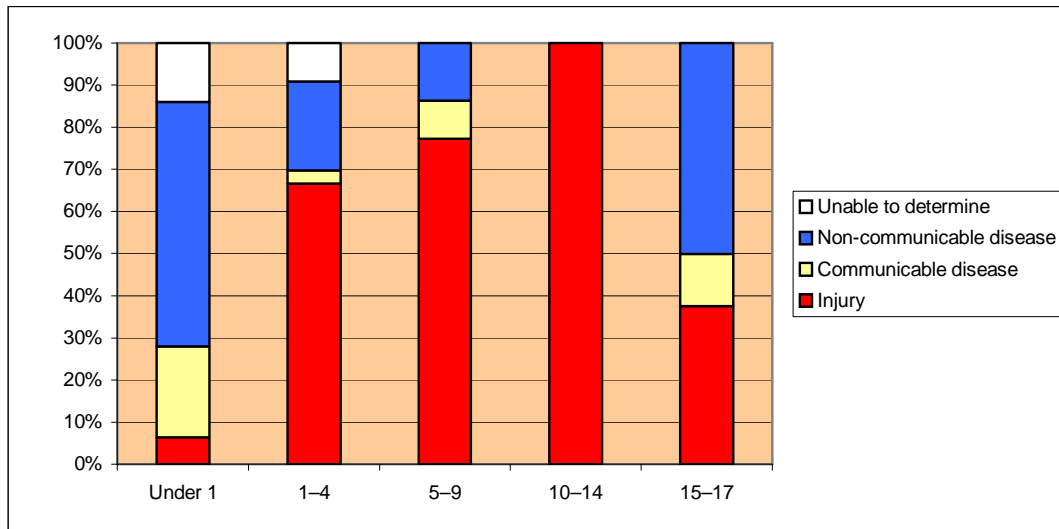
**Figure 8: Proportional mortality by child age group, Philippines**



Source: Philippines National Injury Survey (2003).

The sample size in the Philippines was 90,446 households, with 178,938 children. It shows the same common pattern at somewhat lower levels for injury.

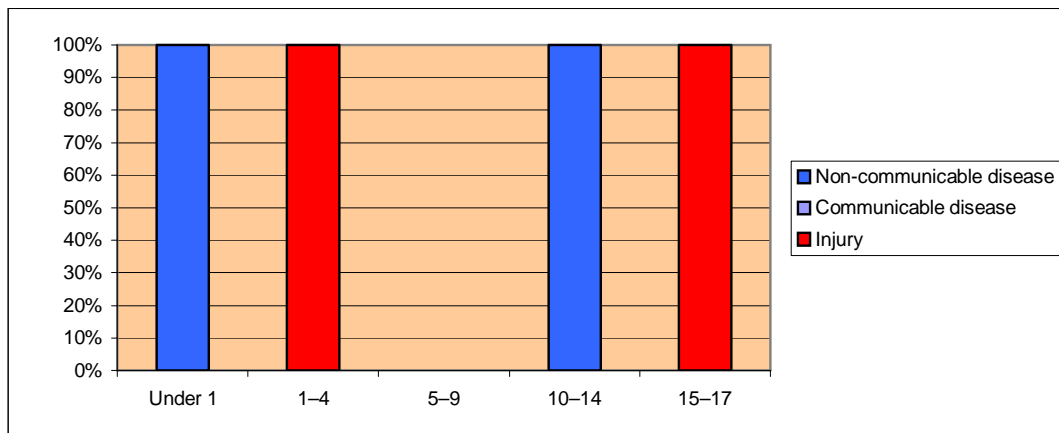
**Figure 9: Proportional mortality by child age group, Jiangxi Province, China**



Source: Jiangxi Injury Survey (2005).

Jiangxi Province had a sample size of 100,010 households. Consistent with the one-child policy, it covered only 98,335 children. This smaller number of children decreased the relative power of the survey in those age groups so that deaths from non-communicable diseases were below the level of resolution in the 10–14 age range. NCD and infection deaths happen in this group, but at levels too low to be detected by the survey.

**Figure 10: Proportional mortality by child age group, Beijing, China**



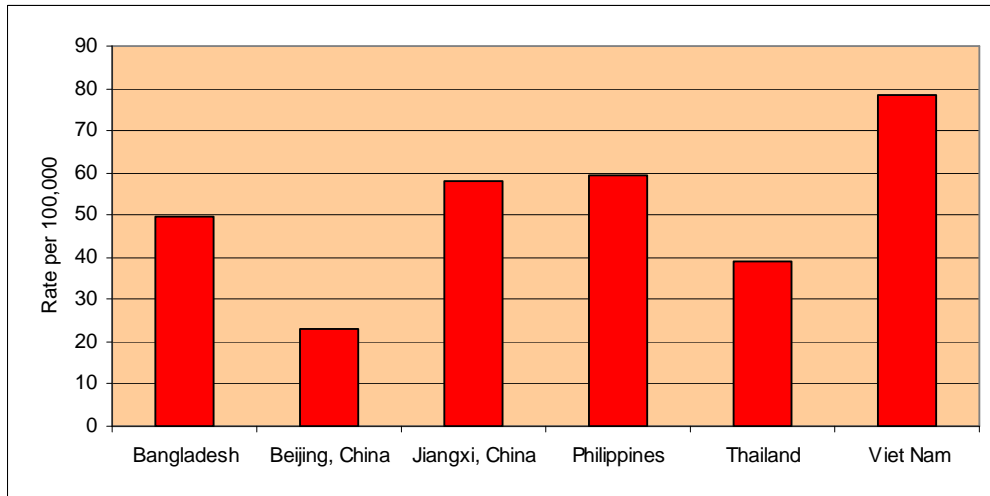
Source: Beijing Injury Survey (2004).

Child mortality from any cause was very low in Beijing; the graph is included for consistency. Despite the large sample size for this one city (28,084 households), as a result of the one-child policy and other demographic factors only 13,508 children were included. The survey lacked sufficient power to find any deaths from communicable disease. There were 7 total child deaths (0-17 years). Three of the seven were injury deaths, the other four were NCD deaths. No deaths of any cause were found in children 5-9 years old.

### 3 PATTERNS OF FATAL CHILD INJURY

Substantial differences in fatal injury rates in childhood can be seen in the individual surveys, with the lowest rates in Beijing (BIS) substantially lower than the highest rates surveyed, found in Viet Nam (VMIS) (see figure 11). However, these rates are not age-standardized, and China is unique in its one-child policy. Age standardization would markedly decrease the differences. It suggests that fatal injury rates in children in the countries surveyed show considerable similarity as a group and are considerably higher than in developed countries.

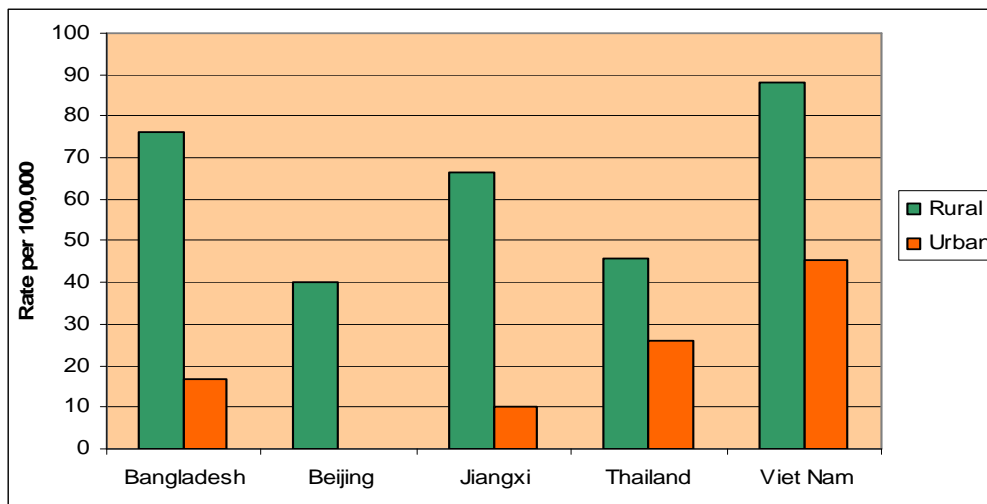
**Figure 11: Fatal injury in children 0–17 years by survey location**



Source: Authors' calculations from individual surveys (2000-2005).

Fatal child injury occurred at higher rates in rural areas as compared to urban areas in all the surveys (see figure 12). In the case of China, while Beijing is a capital city, it has large rural areas within the administrative boundaries which had higher rates of fatal injury than the urban portions as well. The rate for urban Beijing is so low that it does not register on the graph.

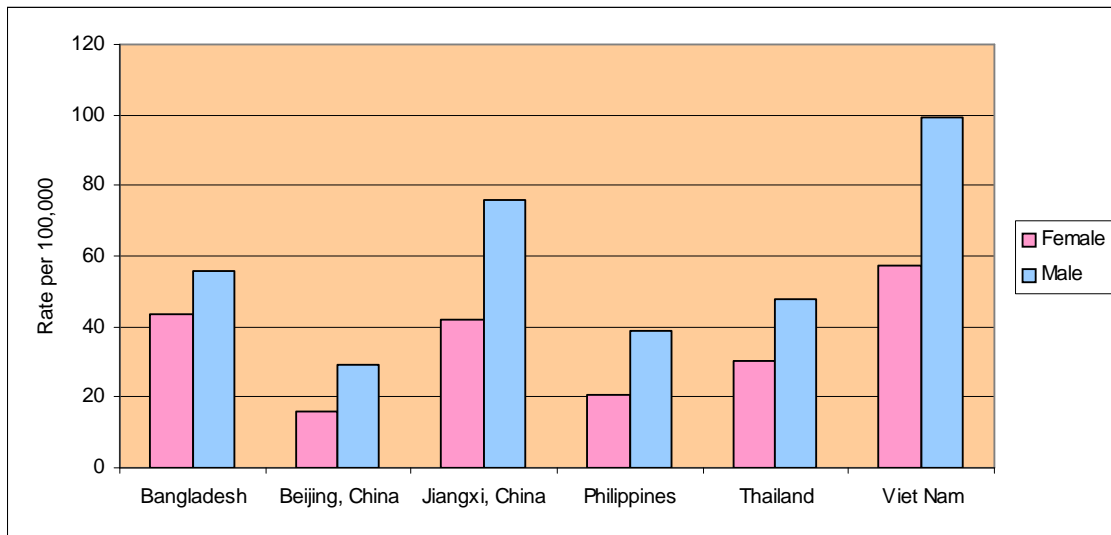
**Figure 12: Fatal injury in children 0–17 years, by urban/rural area**



Source: Authors' calculations from individual surveys (2000-2005)

There were gender differences, with males having higher rates of fatal injury in childhood compared to females in all the surveys (see figure 13).

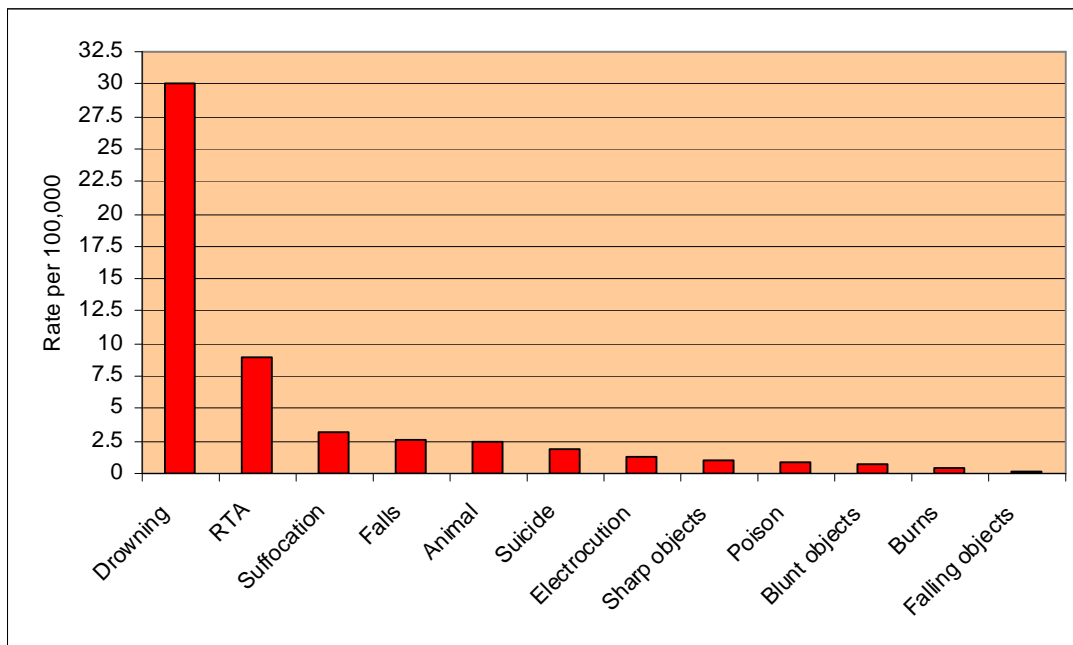
**Figure 13: Fatal injury in children 0–17 years, by gender**



Source: Authors' calculations from individual surveys (2000-2005).

Drowning was the overwhelming leading injury cause of death in childhood, accounting for over three times as many deaths as RTA,<sup>1</sup> which was the second leading cause (see figure 14). Overall, drowning caused about half of all injury deaths in childhood.

**Figure 14: Fatal injury in children 0–17 years, by type**

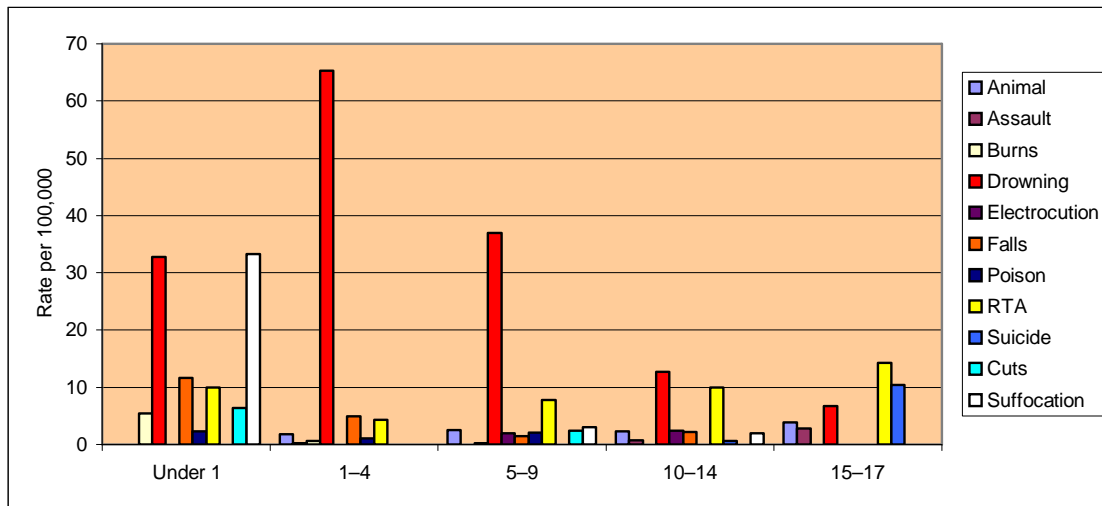


Source: Authors' calculations from individual surveys (2000-2005); composite is population-weighted.

<sup>1</sup> RTA is the preferred term to refer to road transport injuries in the countries. (The alternative abbreviation 'RTI' is used for respiratory tract infections and reproductive tract infections.) For the purposes of this definition 'accident' means lack of intent.

Figure 15 shows how these causes appear in the different age groups. Drowning was highest in early and middle childhood, and RTA was highest in adolescence. Suffocation mainly occurred in infants, and falls in all age groups. Fatal injury caused by animals was due to rabid dogs and poisonous snakes in younger children. Suicides occurred during adolescence.

**Figure 15: Fatal injury in children by type and age group**



Source: Authors' calculations from individual surveys (2000-2005); composite is population-weighted.

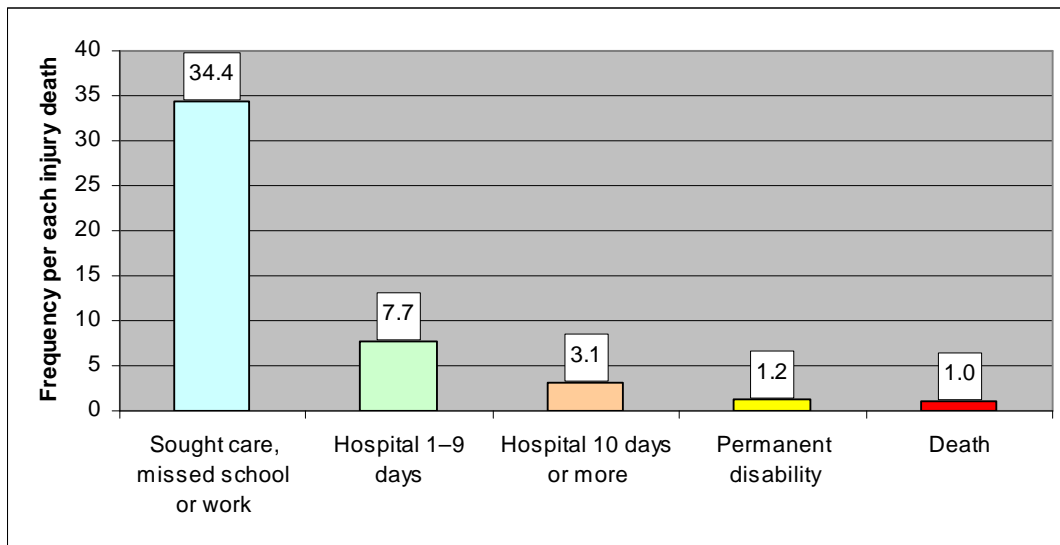
#### 4 ASSESSING FATAL AND NON-FATAL INJURY TOGETHER

Injury (like other causes of adverse health outcomes in children) is usually presented according to two separate outcomes: fatal and non-fatal. This implies that there is such a stark division between the two that they should be treated separately. In reality, three reasons may be identified for why they are presented this way. One is that many surveillance systems only count fatal injury. The second is that there is no standard way of categorizing severity levels for non-fatal injury. The third is as a convenience of graphing them – the rates of non-fatal injury are so much higher than those of fatal injury that it is awkward to place them together on the same chart.

Outcomes following injury proceed in a continuous path, from no or some minimal level of severity through increasingly severe levels that require increasing levels of medical and rehabilitative care, to the most severe outcome, which is death. The present surveys apply a standard set of definitions enabling the levels of severity of injury events to be classified in a consistent manner.

The least severe level counted is injury requiring medical care and missing work or school. Injuries without this result, and which do not incur economic or social costs, are not counted. The next two levels of severity count hospitalization without major surgery, and then hospitalization with major surgery. These levels have very high economic costs associated with them. The most severe non-fatal category is permanent physical disability, with major ongoing, lifelong social and economic consequences. Finally, the most severe outcome is identified as death. Figure 16 shows the relationships between these categories across the set of surveys.

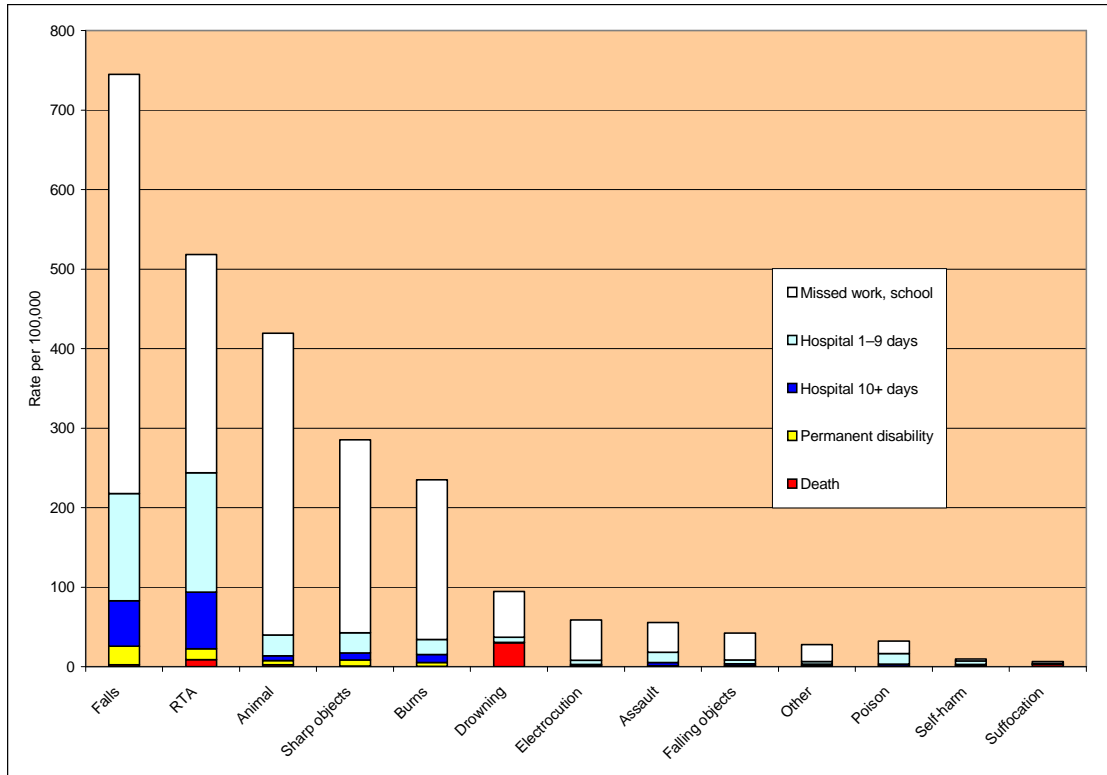
**Figure 16: Ratio of non-fatal injuries to death by severity level**



*Source:* Authors' calculations from individual surveys (2000-2005); composite is population-weighted.

The ratios of non-fatal injury by severity level compared to one death, as seen in figure 16, demonstrate the complexity of the public health issue of the total burden of ill-health or disease, beyond that incurred by deaths alone. Large economic costs and lifetime social burden result from the high levels of severity for non-fatal injury. While infectious and non-communicable diseases also generate disability and large costs (examples are HIV/AIDS and diabetes), injury has a great impact on children because it is so frequent.

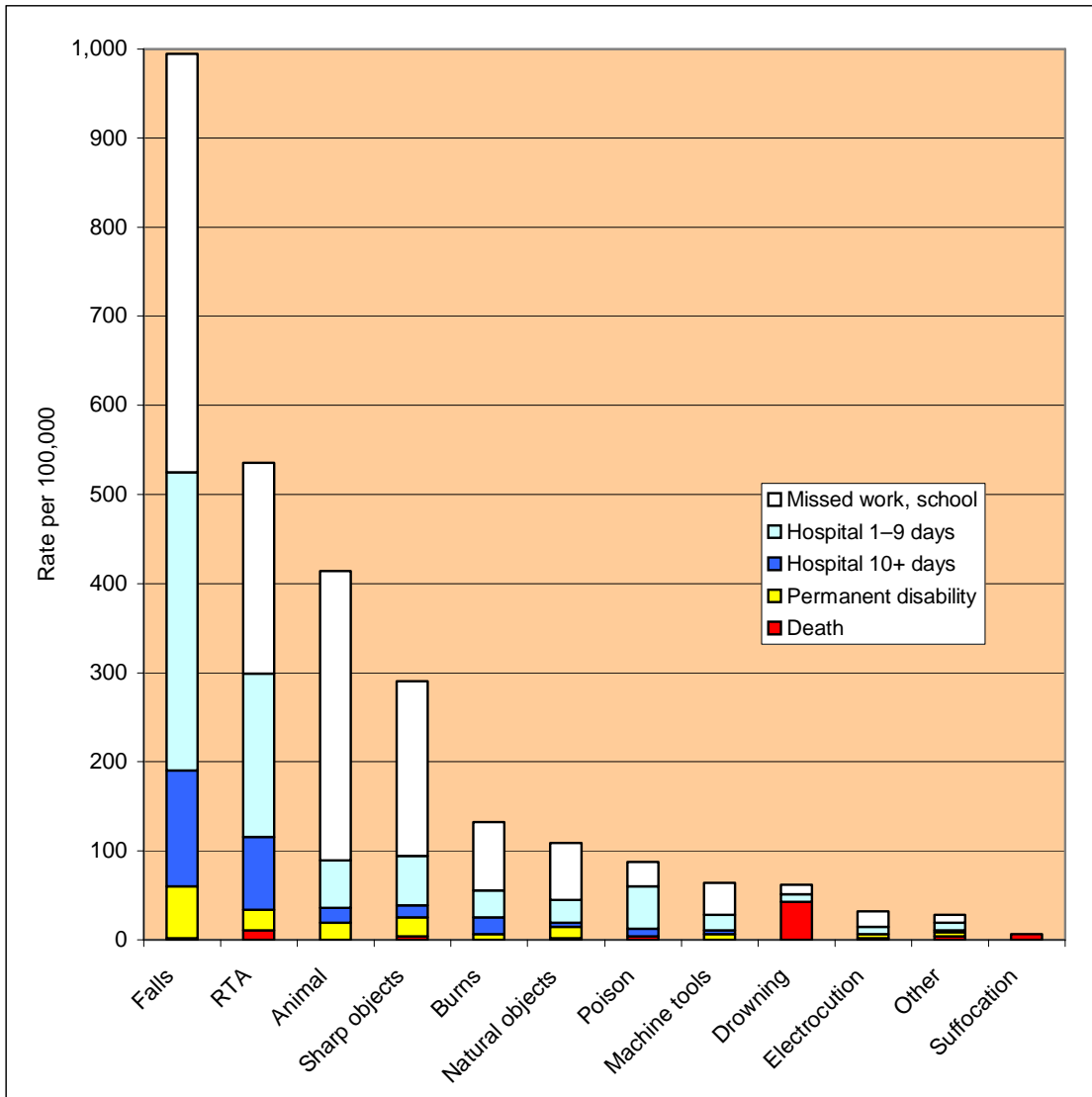
**Figure 17: Types of injury and severity level in children 0–17 years**



Source: Authors' calculations from individual surveys (2000-2005); composite is population-weighted.

The leading causes of non-fatal injury differ from those of fatal injury, as presented in the figures above. While this may suggest two distinct injury dynamics, in reality what is reflected is different degrees of injury outcome, with fatal injury the most severe. Figure 17 shows that non-fatal injury imposes the larger health burden, an understanding that is missed when only child mortality estimates are relied upon. This figure also shows the extremely high case fatality rates for drowning, illustrating why it is the leading cause of death from injury. However, when viewed against the full spectrum of child injury at all severity levels, it is the sixth leading cause of injury overall.

**Figure 18: Types of injury and severity level, children 0–17 years, Viet Nam**

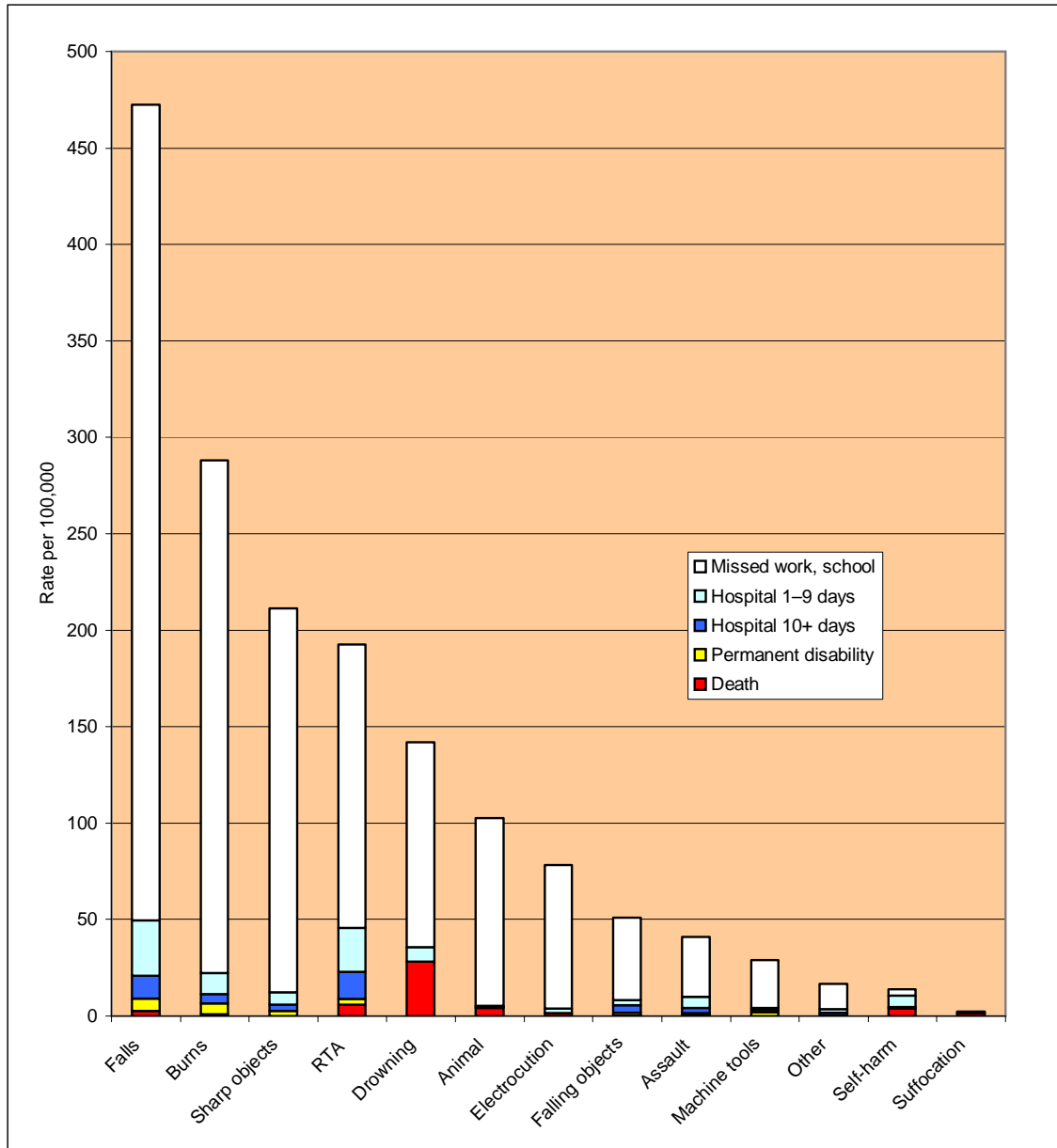


Source: Vietnam Multi-center Injury Survey (2000).

Figure 18 shows the pattern of non-fatal injury in Viet Nam by severity level and type. Falls are the leading cause of permanent disability from injury in childhood, largely as a result of brain and spinal cord injury associated with falls.



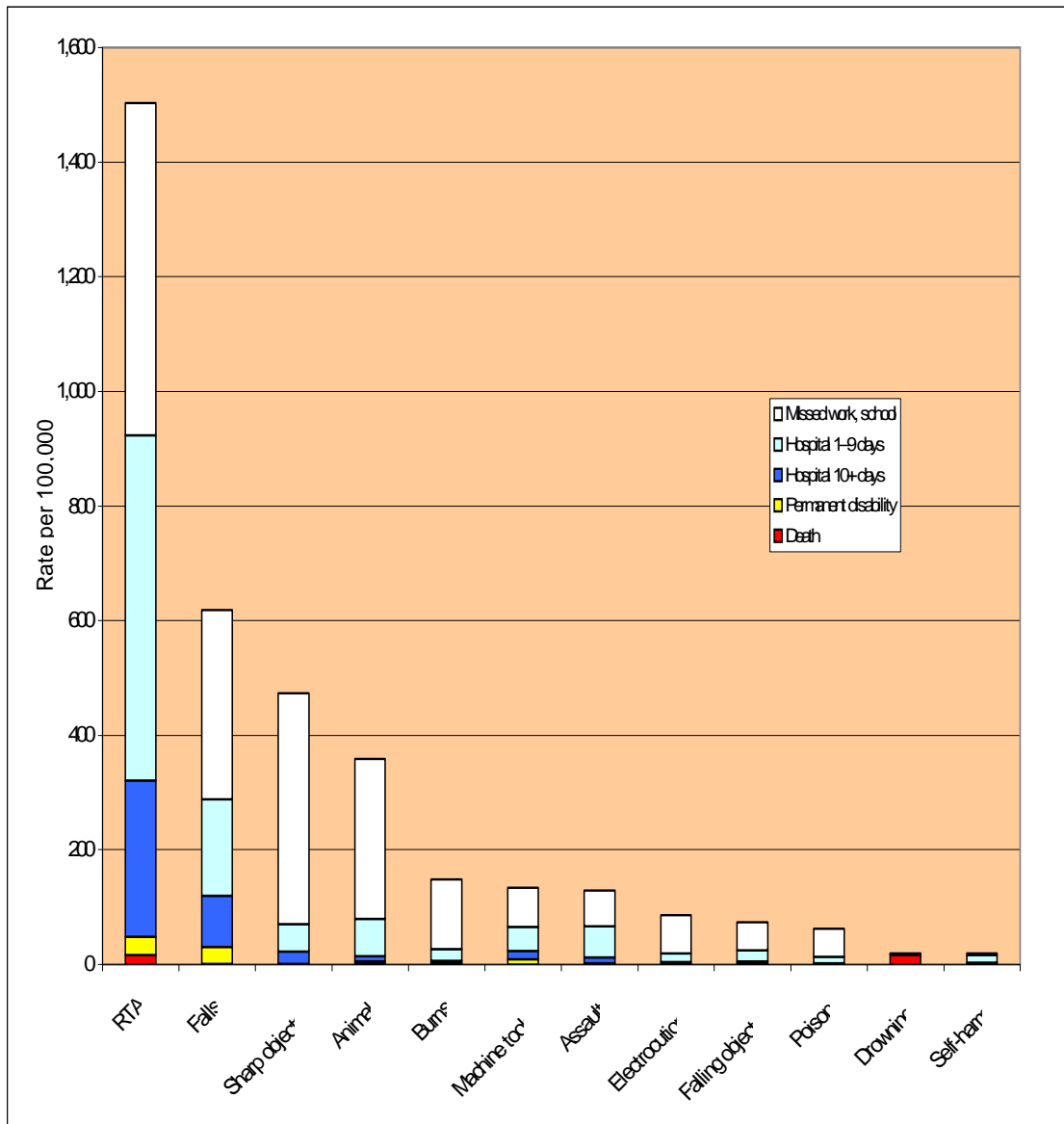
**Figure 19: Types of injury and severity level, children 0–17 years, Bangladesh**



Source: Bangladesh Health and Injury Survey (2003).

The same basic pattern is seen in figure 19 for Bangladesh, with falls being the leading cause of permanent disability, and traumatic injury (falls, burns, cuts, RTA) being the leading causes overall. The unique nature of drowning, with its very high case fatality rate, is clearly seen.

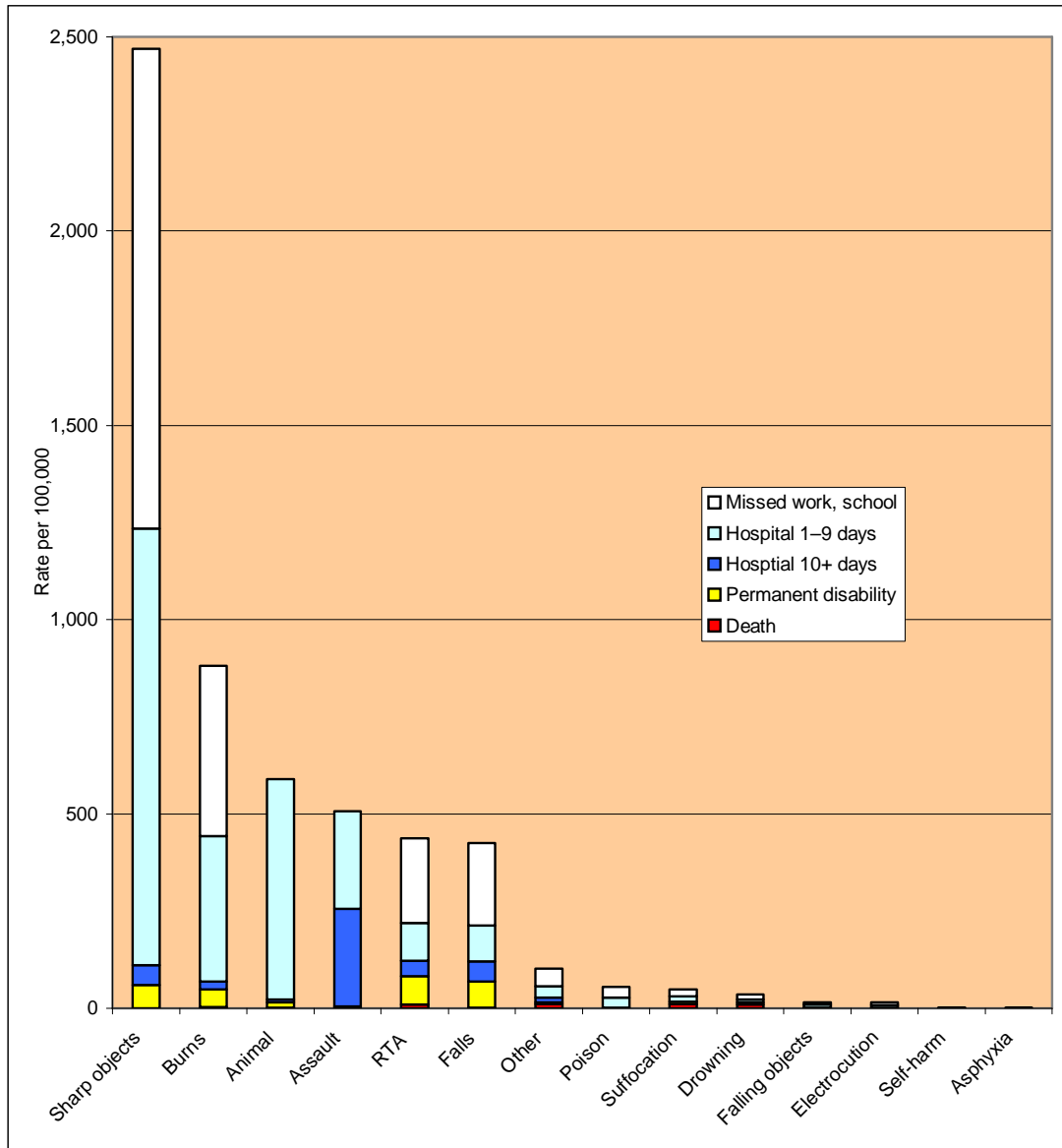
**Figure 20: Types of injury and severity level, children 0–17 years, Thailand**



Source: Thailand Injury Survey (2003).

Thailand follows the preceding basic pattern (figure 20), with traumatic types of injury being the leading causes of non-fatal injury in children. RTA was the leading cause of non-fatal injury, falls the leading cause of permanent disability, and the high case fatality rate of drowning is easily visible.

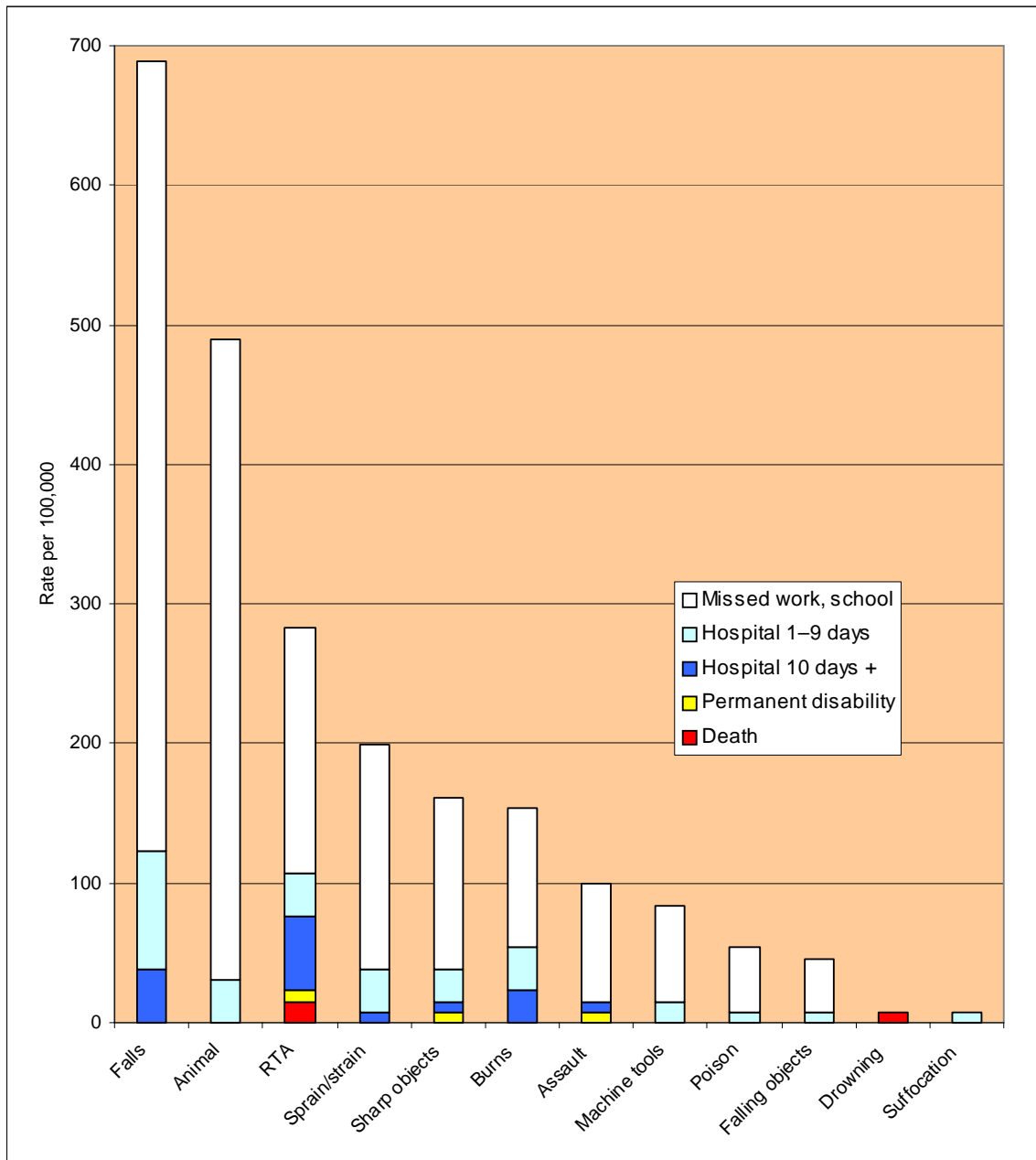
**Figure 21: Types of injury and severity level, children 0–17 years, Philippines**



Source: Philippines National Injury Survey (2003).

The Philippines followed the same basic pattern (figure 21), with traumatic injury (cuts, burns, animal bites) leading causes of non-fatal injury.

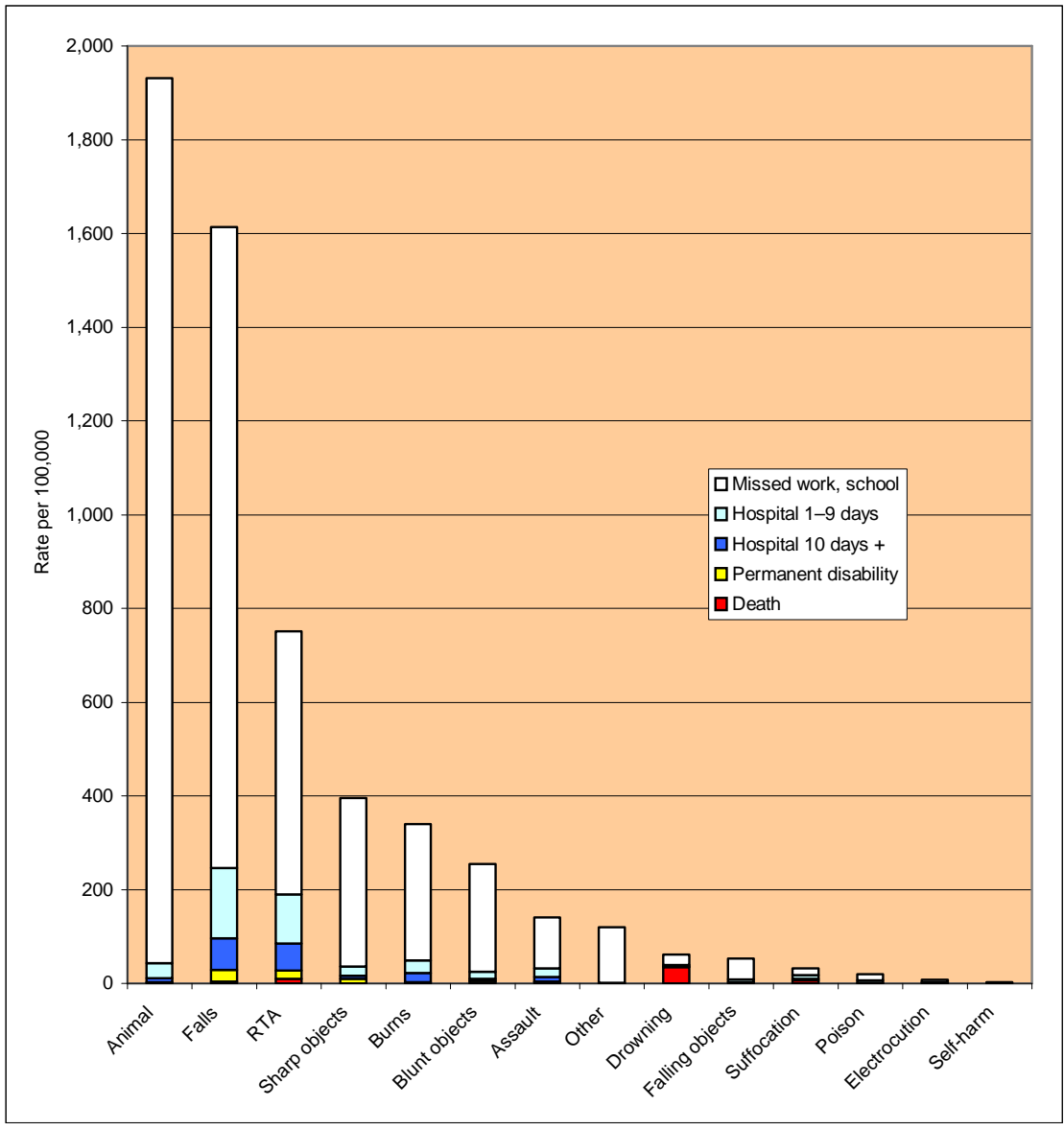
**Figure 22: Types of injury and severity level, children 0–17 years, Beijing, China**



Source: Authors' calculations from Beijing Injury Survey (2003).

Beijing also shows the same pattern (figure 22), with traumatic injury accounting for the leading causes. Almost all the animal injury in the Beijing survey was from dog bites. Drownings were entirely fatal in the survey.

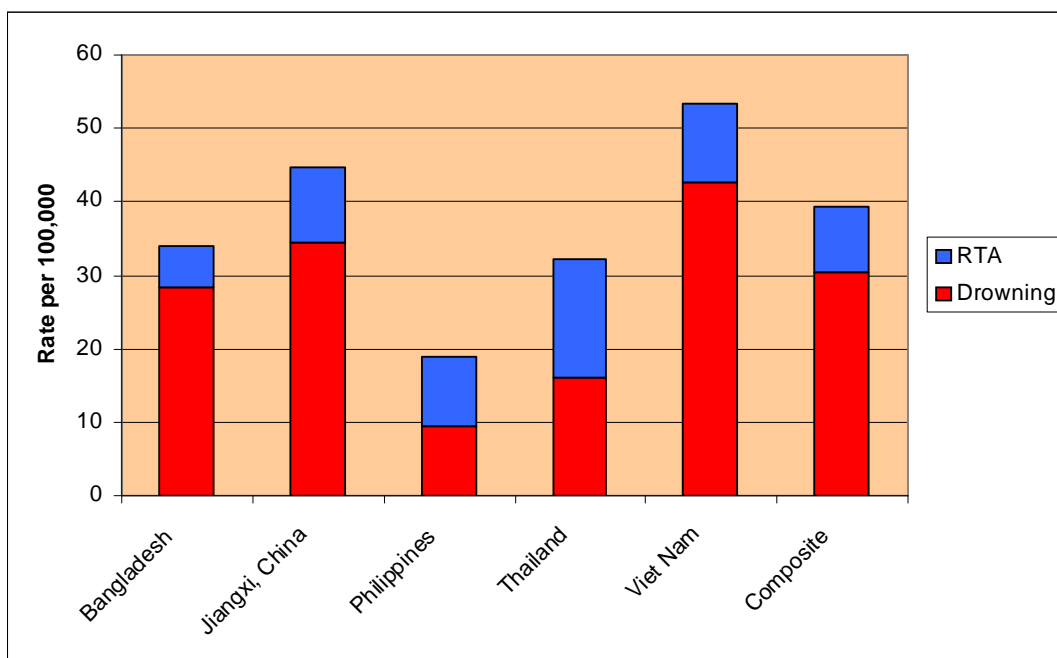
**Figure 23: Types of injury and severity level, children 0–17 years, Jiangxi Province, China**



Source: Jiangxi Injury Survey (2005).

Jiangxi Province, China, also exemplifies the pattern of traumatic injury constituting the leading causes (figure 23). Animal injury was particularly high, with the majority caused by dog bites. Drowning was the leading cause of injury death for children, but only the ninth leading cause of injury when non-fatal injury is included.

**Figure 24: Fatal injury rates from drowning and RTA by survey location**



Source: Authors' calculations from individual surveys (2000-2005).

Figure 24 shows the relative contributions of drowning and RTA to fatal injury in the locations surveyed. These two were the leading causes among all causes of fatal injury. In each survey, drowning was the leading cause and often by a significant margin (Bangladesh, Jiangxi Province and Viet Nam). However, at the national, regional and global levels, drowning has largely been invisible because the surveillance methods depend on hospital and facilities for reporting. Drownings are very rapidly fatal, and most children who die from drowning are simply buried or cremated, depending on the country, and are never seen at a hospital. Surveillance for drownings requires data gathered at the community level.

## 5 DISCUSSION

It is easy to become overwhelmed by the 'figure-after-figure' presentation. Many more detailed and important figures were omitted in an attempt to foster communication of the key points. Readers desiring greater detail with more extensive statistical information are referred to the individual survey reports. The following are the key points to be conveyed in this paper.

### **Injury is a significant cause of child death in all age groups in each survey location.**

The weight of the evidence is considerable. Epidemiologists and statisticians can (and no doubt will) have arguments about power, confidence intervals and the arcana of complex sampling. However, policymakers simply need to understand one clear finding: Injury is a major killer of children in Asia. Whether it is *the* leading killer after infancy or *a* leading killer after infancy can be argued in technical terms. However, from the policymakers'

perspective it does not matter which of these is correct; it is clear that injury is responsible for a very large proportion of child deaths, and these deaths are largely preventable.

**While fatal injury is high in all the countries surveyed, the economic impact and social burdens imposed by serious non-fatal injury appear to exceed those for fatal injury.**

Previous analyses of the impacts of child injury have not systematically incorporated non-fatal (morbidity) estimates because of the limitations of available data. The surveys presented in this series of papers do so, and provide a strong basis to argue that non-fatal injury imposes high economic and social costs when compared to fatal injury. These factors should be incorporated into decision-making regarding child health programmes. Injury is a leading cause of permanent disability in each of the countries surveyed and a leading cause of hospitalizations. Due to the traumatic nature of most injury, the higher severity levels create major burdens for scarce clinical health resources. Injury is a leading cause of major surgery in childhood – requiring blood banks, anaesthesiologists, surgeons and ancillary trained health staff to support them, as well as recovery rooms and intensive care units. The economic costs of injury are very high, and they can be predicted to rise dramatically in the near term as development and motorization rates increase.

**Injury is a leading cause of death, permanent disability and serious morbidity in children in the countries and their neighbours in Asia; however, there are no intervention programmes in place to address it.**

Injury is the only leading cause of child death, disability and serious morbidity not currently being monitored and addressed through programmes and policies. An important goal of this series of Working Papers is to note this gap and to support the process of redressing it. Efforts to prevent injury and to mitigate its impacts need to be included within the set of interventions aimed at decreasing child mortality.

**Drowning is unique among causes of death of children from injury, sharing many attributes with vaccine-preventable infectious diseases.**

Similarly to the case for vaccine-preventable diseases, lifelong protection may be provided against drowning by teaching a child to swim. Once mastered, the protective skill is always there. Work carried out in Bangladesh shows that it is possible to safely train children aged four years and over to swim within their natural village environments in the same cost-effective manner that immunizations are delivered in those same village environments.<sup>2</sup>

A second similar attribute is herd immunity, which protects the vulnerable by surrounding them with protected peers. Just as having large numbers of immunized children serves to isolate and shelter those not yet immunized against an infectious disease, children who have learned to swim can use these skills to rescue their peers and save their lives when they are at risk of drowning.

The third similar attribute is the large proportion of mortality addressed by preventing drowning. Just as vaccine-preventable diseases were responsible for more than half of all

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<sup>2</sup> See 'Midterm Review of PRECISE (Prevention of Child Injuries through Social-intervention and Education) Project', July 2007, conducted jointly by TASC, the Center for Injury Prevention and Research, Bangladesh, and UNICEF Bangladesh Country Office.

deaths of children under five, drowning caused about half of all child injury deaths in the surveys.

Despite solid evidence showing it to have been a leading killer over the last 25 years,<sup>3</sup> drowning has not registered on the global child health radar. The surveys summarized here show the centrality of drowning prevention for the 1–4 years age group, where drowning is responsible for between 75 and 90 per cent of all injury deaths.

A final lesson of the surveys is that the failure to recognize the importance of drowning results from the current system of facility-based surveillance (mainly hospitals and clinics). The surveys show that child drownings are largely invisible to this system. This issue is addressed in detail in the Survey Methods paper in this series (IWP-2007-05). The conclusion is that surveillance for child deaths and serious injuries is most effectively conducted where the deaths and injuries occur, namely at the community level. This is a key lesson of the surveys for child health in developing countries.

In summary, there is clear and convincing evidence from the surveys that injury represents a leading cause of child mortality in Asia. As importantly, it is also a leading cause of serious morbidity and permanent disability for children in Asia. There is the opportunity to act on this knowledge and to intervene with the same focus and vigour that has been so effective in diminishing the other leading killers of children.

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<sup>3</sup> Based on annual Matlab surveillance data, 1982 through 2006.



## **ANNEX: Contributors to the Series**

This series of papers grew out of a meeting of the Technical Advisory Group (TAG) for The Alliance for Safe Children (TASC), held in Bangkok, Thailand in August 2005. At the meeting, the group considered the results of the six national and subnational surveys that form the basis of these papers. These were done in Bangladesh, China, Philippines, Thailand and Viet Nam, with an additional sentinel survey on drowning carried out in Indonesia in 2004. This resulted in the formation of the Bangkok Working Group on Child Mortality Estimates (BWG-CME).

During 2005-2007 Dr. Michael Linnan, the Technical Director for TASC, worked with BWG-CME members, the Principal Investigators for the surveys and UNICEF regional and country staff to jointly author the first seven papers in the series. The individual contributors are listed in each paper. Others who contributed to the series as authors, editors or reviewers, including members of the TAG and the Bangkok Working Group, survey Principal Investigators and UNICEF staff, are listed below along with their institutional affiliations.

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