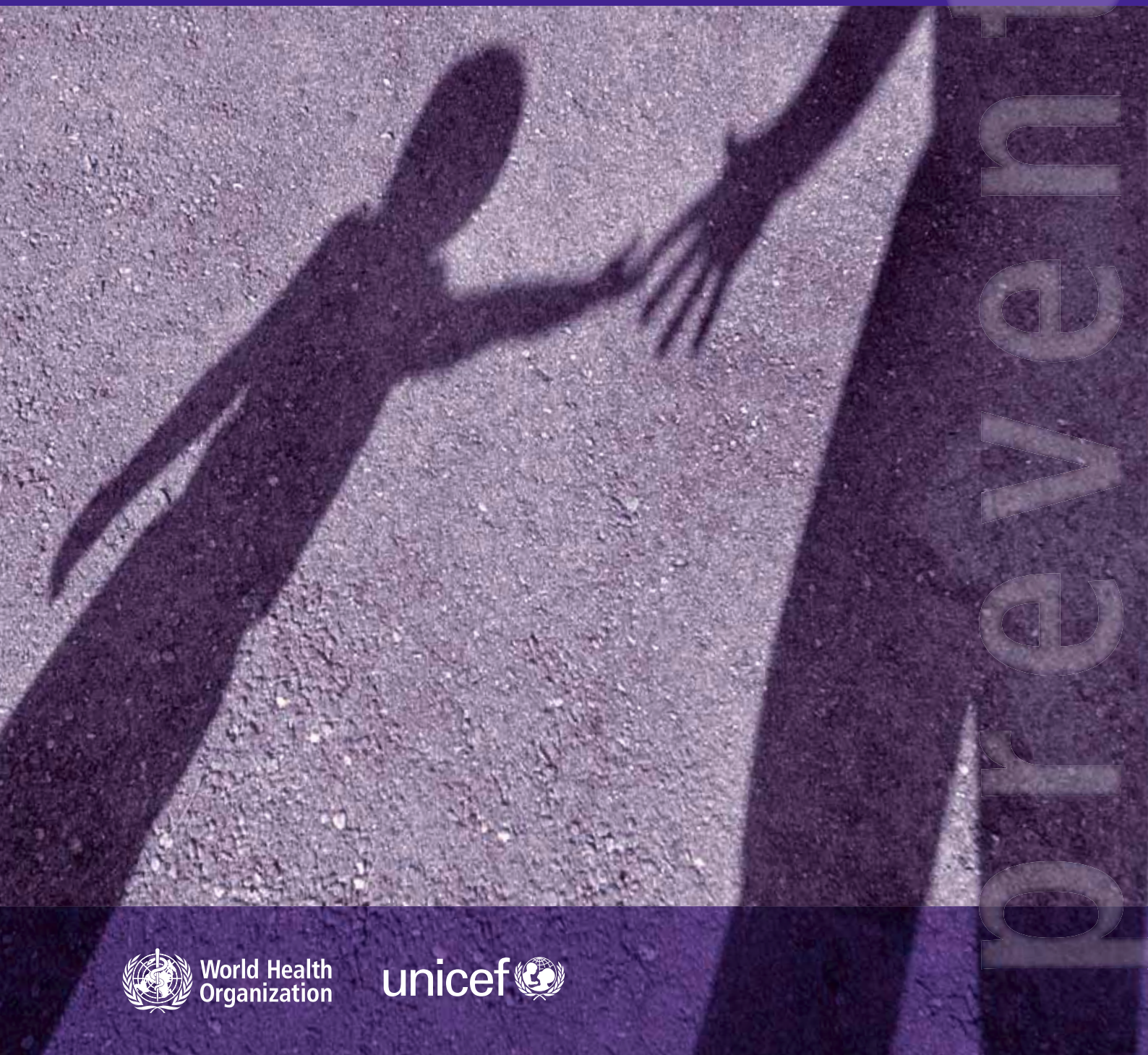
World report on **child injury prevention**



World Health Organization

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World report on child injury prevention

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Foreword

Every day around the world the lives of more than 2000 families are torn apart by the loss of a child to an unintentional injury or so-called "accident" that could have been prevented. The grief that these families suffer – mothers, fathers, siblings, grandparents and friends – is immeasurable and often impacts entire communities. Such tragedy can change lives irrevocably.

Once children reach the age of five years, unintentional injuries are the biggest threat to their survival. Unintentional injuries are also a major cause of disabilities, which can have a long-lasting impact on all facets of children's lives: relationships, learning and play. Among those children who live in poverty, the burden of injury is highest, as these children are less likely to benefit from the protective measures others may receive.

Child injuries have been neglected for many years, and are largely absent from child survival initiatives presently on the global agenda. Through this *World report on child injury prevention*, the World Health Organization, the United Nations Children's Fund and many partners have set out to elevate child injury to a priority for the global public health and development communities. The knowledge and experience of nearly two hundred experts from all continents and various sectors were invaluable in grounding the report in the realities faced in many countries.

Children's maturity and their interests and needs differ from adults. Therefore, simply reproducing injury prevention strategies that are relevant to adults does not adequately protect children. There are proven interventions such as child car seats, cycling helmets, child-resistant packaging for medications, fencing around swimming pools, hot water tap temperature regulation and window guards, to name a few.

Ministries of Health can play a central role in prevention, advocacy and research and in the care and rehabilitation of children with disabilities. Other key sectors include education, transportation, environment and law enforcement.

This *World report on child injury prevention* should be seen as a complement to the *UN Secretary-General's study on violence against children* released in late 2006. That report addressed violence-related or intentional injuries. Both reports suggest that child injury and violence prevention programmes need to be integrated into child survival and other broad strategies focused on improving the lives of children.

Evidence demonstrates the dramatic successes in child injury prevention in countries which have made a concerted effort. These results make a case for increasing investments in human resources and institutional capacities. This would permit the development, implementation and evaluation of programmes to stem the tide of child injury and enhance the health and well-being of children and their families the world over. Implementing proven interventions could save more than a thousand children's lives a day.

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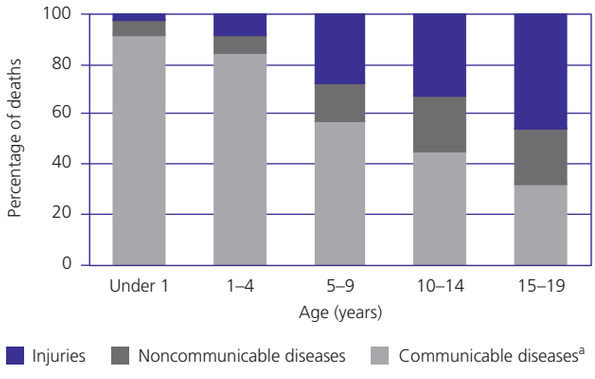
Introduction

Child injuries are a growing global public health problem. They are a significant area of concern from the age of one year, and progressively contribute more to overall rates of death until children reach adulthood. Hundreds of thousands of children die each year from injuries or violence, and millions of others suffer the consequences of non-fatal injuries. For each area of child injury there are proven ways to reduce both the likelihood and severity of injury – yet awareness of the problem and its preventability, as well as political commitment to act to prevent child injury, remain unacceptably low.

Main causes of death among children, World, 2004



[a] Includes communicable, maternal, perinatal and nutritional conditions.

Source: WHO (2008), Global Burden of Disease: 2004 update.

In 2005, WHO and UNICEF issued a call for a greatly expanded global effort to prevent child injury (*1*). This was followed in 2006 by WHO's ten-year plan of action on child injury (*2*). The plan listed objectives, activities and expected outcomes on child injury and covered the fields of data, research, prevention, services, capacity building and advocacy.

This joint WHO/UNICEF *World report on child injury prevention* brings together all that is currently known about the various types of child injuries and how to prevent them. At the same time, it recognizes that there are major gaps in knowledge. The report expands on and strengthens the areas of action set out in the 2005 *Global call to action* and the WHO ten-year plan. It is intended, furthermore, to help transfer knowledge into practice, so that what has proven effective in decreasing the burden of child injuries in some countries can be adapted and implemented in others, with similar results.

The *World report on child injury prevention* is directed at researchers, public health specialists, practitioners and academics. A summary of the report containing the main messages and recommendations and a set of fact sheets are available for policy-makers and development agencies. A version aimed at children – to create awareness and provide children with a sense of ownership of the issues – and a set of posters have also been produced.

Aims

The overall aims of the report are:

- to raise awareness about the magnitude, risk factors and impacts of child injuries globally;
- to draw attention to the preventability of child injuries and present what is known about the effectiveness of intervention strategies;
- to make recommendations that can be implemented by all countries to reduce child injuries effectively.

Definition of childhood

There is no universally agreed age range for what constitutes childhood – a concept that varies considerably across cultures. This report uses the definition of a child specified in the Convention on the Rights of the Child (*3*), and thus focuses on injuries occurring in children "under the age of 18 years". However, it has not always been possible to reflect this age cut-off in analysing data. The reader will notice, for instance, that in some cases WHO data could not be disaggregated to <18 years, and so the category of <20 years is used instead. Some of the published literature uses still other age ranges. For the sake of clarity, age ranges are always indicated in tables and figures in the report.

Scope of the report

The United Nations Secretary-General's *Study on Violence against Children* (*4*) and the accompanying *World report on violence against children* (*5*) provided an in-depth review of intentional injuries to children (see box on the UN Secretary-General's study). In addition, the *World report on violence and health*, published by WHO in 2002, included chapters on child abuse, youth violence and sexual violence (*6*). This report examines the five most common unintentional (or "accidental") child injuries. Determining the intentionality of an injury to a child is, however, not always straightforward. Where, in discussing data for a particular type of child injury, the question of intent may be ambiguous, then intentional injuries are also touched on in that particular chapter.

The UN Secretary-General's Study on Violence against Children: a joint initiative of UNICEF, WHO, OHCHR and ILO

This in-depth study was presented to the United Nations General Assembly in 2006 by an independent expert appointed by the Secretary-General to lead the effort. Supported by UNICEF, WHO, OHCHR, ILO and a wide network of nongovernmental organizations, the study provided a global picture of violence against children, with recommendations to prevent and deal with such violence. The study examined violence against children in different settings: the family, school, community, alternative care institutions, detention facilities and places where children work. Experts from the fields of human rights, public health and child protection all collaborated in this pioneering report.

Despite progress in preventing violence against children, much remains to be done, and several factors limit the impact of preventive measures. These include the lack of consistent data and incomplete knowledge of the root causes of violence against children. Furthermore, efforts to address violence against children are frequently reactive, focusing on symptoms and consequences rather than causes. Strategies tend to be fragmented, as opposed to integrated, and insufficient resources are allocated to address the problems. In addition, international commitments to protect children from violence are often not translated into action at the national level.

The core message of the Secretary-General's study is that no violence against children is justifiable; all violence against children is preventable. While governments have made commitments to protect children from all forms of violence, research and child testimonies show that these commitments are far from being fulfilled. The legal obligations lie with governments. However, all sectors of society share the responsibility to condemn and prevent violence against children and to deal with those children affected.

The consequences of violence against children vary according to its nature and severity. Efforts to prevent and respond to such violence must therefore be multifaceted. They must reflect the type of violence, the setting and the nature of the perpetrator or perpetrators, and they must always take into account the best interests of the child.

The principal recommendations of the study were:

1. to strengthen national and local commitment and action;
2. to prohibit all violence against children (including the death penalty, corporal punishment, harmful traditional practices, sexual violence, torture and other cruel, inhuman or degrading treatment or punishment);
3. to make prevention of violence against children a priority;
4. to promote non-violent values and raise awareness of violence;
5. to enhance the capacity of all who work with and for children;
6. to provide services for recovery and social reintegration;
7. to ensure the participation of children;
8. to create accessible and child-friendly reporting systems and services;
9. to ensure accountability and put an end to violence against children going unpunished;
10. to address the gender dimension of violence against children;
11. to develop and implement systematic national data collection and research;
12. to strengthen international commitment on the issue of violence against children.

Source: The United Nations Secretary General's Study on Violence Against Children (http://www.violencestudy.org/r25, accessed 19 May 2008).

This *World report on child injury prevention* consists of seven main chapters. Chapter 1 places child injuries in the context of other health concerns and related global issues and discusses the fundamentals of child injury prevention. Chapters 2 through 6 examine the five major mechanisms of child injuries: road traffic injuries, drowning, burns, falls and poisonings. Each of these chapters reviews the epidemiology, the risk factors, the interventions and the effectiveness of interventions, and concludes with some important strategies to prevent or manage the particular type of injury. Chapter 7 draws together the common themes of earlier chapters. It also presents a set of broad recommendations that governments and others concerned should seriously consider implementing so as to begin reducing the burden of child injuries.

In deciding which topics to include in this report, the editors were guided by the overall magnitude of each type of injury as presented in WHO's Global Burden of Disease Project for 2004. Consequently, smothering – although a significant problem in infants – has not been included as a full chapter in the report because global data is scant. Similarly, bites and stings have been addressed through boxes within other chapters as these injuries tend to be highly specific to certain regions and global data, again, are not readily available.

This report relies heavily on the certain data sources, including: the WHO Global Burden of Disease project for 2004, the Global School Health Survey, and the UNICEF/ The Alliance for Safe Children community-based studies conducted in Asia. No single database is perfect. However, optimal use is made of the available data, supplemented with information from published literature. The limitations of the data are discussed briefly in each of the chapters. A more detailed overview of the methodologies employed to gather data for the various databases is presented in the Statistical Annex at the end of this report.

Process

The development of this report was led by an Advisory Committee and an Editorial Board and has taken place

over nearly three years. Based on outlines prepared by the Editorial Board, each chapter was written by two or three authors working with a small team of experts from around the world. Nearly 200 professionals from various sectors and all the regions of world provided input to the report.

The examples of good practice provided in each of the topic-specific chapters (Chapters 2 to 6) and the subsequent recommendations made for each chapter were based on rigorous scientific evidence supplemented, where necessary, with "grey literature". Based on the literature reviewed, evidence was graded as: effective, promising, insufficient evidence, ineffective or potentially harmful. Randomized controlled trials and case–control studies were used as the gold standard. Where study methodologies were robust but they were limited to a few high-income countries they were classified as promising. Where there was clear evidence that the intervenion did not work or was harmful, these were classified as ineffective and potentially harmfull, respectively. For many interventions in the area of child injury prevention there is simply insufficient evidence.

The drafts of specific chapters were reviewed and revised following input from four regional consultations organized by the WHO regional offices – involving local experts, practitioners and government officials – as well as input from a set of external peer reviewers.

During the regional consultations, experts had the opportunity to propose overall recommendations on child injury prevention, for inclusion in Chapter 7. Their proposals were then refined by the editors based on evidence of good practice, subjected to external peer review and finally approved by WHO and UNICEF, who advised on the report. It is anticipated that the recommendations in this report will remain valid until 2018. At that time, the Department of Violence and Injury Prevention and Disability at WHO headquarters in Geneva will initiate a review of the document.

Moving forward

This comprehensive global report is an important step in advancing the field of child injury prevention, but it is only one such step. It is the hope of WHO, UNICEF and all involved in the report that its launch will lead to greater awareness around the world and a much increased political will for action at all levels to combat the scourge of child injuries.

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JUAN'S STORY

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Juan lives with his mother, father, four younger brothers and two younger sisters in a small village outside Merida, in Mexico. Aged 14 years, Juan no longer goes to school, as he has to help his father selling fruit at the roadside.

The reason that he left school is related to a terrible accident that the youngest in the family, Martha, suffered 18 months ago.

Martha – six years old at the time – had fallen into the water well in the back yard of the family house, while trying to retrieve a toy that she had dropped into it. Juan was the first onto the scene of the incident and had called for his father who was further up the road selling fruit. The two of them ran to the nearest clinic holding Martha, who was limp and not crying. The doctors managed to resuscitate her but she remained in a critical condition and needed to be transferred to a larger hospital in Merida, where she stayed for many weeks.

Juan went to visit his sister once in hospital, but did not like it there as he said that the hospital had a strange odour. He preferred to stay at home with his grandmother and help with the other children while his mother stayed at the hospital with Martha.

Martha is a beautiful girl, who is now mentally disabled and needs assistance with all her daily needs.

Juan is still very affected by this incident. He feels responsible for Martha's fall into the well, convinced that it would not have happened if he had been there. At the same time, he is proud to show visitors the wooden construction he and his father made to put over the well, to prevent a similar incident occurring.

Chapter 1
Child injuries in context

Background

Every child in the world matters. The landmark Convention on the Rights of the Child, ratified by almost all governments, states that children around the world have a right to a safe environment and to protection from injury and violence. It further states that the institutions, services and facilities responsible for the care or protection of children should conform with established standards, particularly in the areas of safety and health. Safeguarding these rights everywhere is not easy, but it can be achieved by concerted action. Children are exposed to hazards and risks as they go about their daily lives and are vulnerable everywhere to the same types of injury. However, the physical, social, cultural, political and economic environments in which they live differ greatly. Their particular environments are thus very important.

This chapter provides an overview for the report. The first section sets the scene, examining why child injury is important, how the issue relates to other concerns about children, and why there is an urgency to tackle it. The second section examines major features of the problem: the multiple types and causes of injury to children, and the associations between injury and age, gender and a range of socioeconomic factors. The third section seeks to show that child injury is preventable. It describes the principles of injury prevention, the types of approaches that are successful and the problem of adapting proven interventions to different settings. It also discusses the cost and cost-effectiveness of interventions to prevent child injury. The final section summarizes some of the obstacles in this field and the approaches to overcoming them.

What is an injury?

Throughout the report, an injury is defined as "the physical damage that results when a human body is suddenly subjected to energy in amounts that exceed the threshold of physiological tolerance – or else the result of a lack of one or more vital elements, such as oxygen" (*1*). The energy in question can be mechanical, thermal, chemical or radiated.

As discussed in the introductory section, the focus of this report is on *unintentional* injuries: traffic injuries, drowning, poisonings, burns and falls. For more information on *intentional* injury, see the *World report on violence against children* (*2*).

Who is a child?

This report uses the definition of the United Nations Convention on the Rights of the Child, Article 1: "a child means every human being below the age of 18 years" (*3*). Other concepts related to children, though, are more fluid. "Childhood" is a social construction, whose boundaries shift with time and place (*4, 5*) and this has implications for vulnerability to injury. A 10-year-old in one country may be protected from economic and domestic responsibilities, but in another country these tasks may be the norm and considered beneficial for both the child and the family (*6*). Thus, childhood and developmental stages are intertwined with age, sex, family and social background, school, work and culture (*6, 7*). Rather than being rigidly measured, they should be viewed through "context, culture and competences" (*8*).

Why is child injury important?

Childhood injury is a major public health problem that requires urgent attention. Injury and violence is a major killer of children throughout the world, responsible for about 950 000 deaths in children and young people under the age of 18 years each year (WHO Global Burden of Disease: 2004 update). Unintentional injuries account for almost 90% of these cases. They are the leading cause of death for children aged 10–19 years. Table 1.1 shows the contributions that the various types of unintentional injuries make to the leading causes of death among children. Road traffic injuries alone are the leading cause of death among 15–19-year-olds and the second leading cause among 10–14-year-olds.

In addition to the deaths, tens of millions of children require hospital care for non-fatal injuries. Many are left with some form of disability, often with lifelong consequences. Table A.2 in the Statistical Annex shows the leading causes of disability-adjusted life years (DALYs) lost for children aged 0–14 years, with road traffic crashes and falls ranking in the top 15 causes.

The burden of injury on children falls unequally. It is heaviest among the poor with the burden greatest on children in the poorer countries with lower incomes (see Table A.1 and A.2 in the Statistical Annex). Within all countries, the burden is greatest on those from low-income families. Overall, more than 95% of all injury deaths in children occur in low-income and middle-income countries. Although the child injury death rate is much lower among children from developed countries, injuries are still a major cause of death, accounting for about 40% of all child deaths (WHO Global Burden of Disease: 2004 update).

TABLE 1.1

Leading causes of death in children, both sexes, World, 2004

Rank	Under 1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20
1	Perinatal causes	Lower respiratory infections	Lower respiratory infections	Lower respiratory infections	Road traffic injuries	Perinatal causes
2	Diarrhoeal diseases	Diarrhoeal diseases	Road traffic injuries	Road traffic injuries	Self-inflicted injuries	Lower respiratory infections
3	Lower respiratory infections	Measles	Malaria	Drowning	Violence	Diarrhoeal diseases
4	Malaria	Malaria	Diarrhoeal diseases	Malaria	Lower respiratory infections	Malaria
5	Congenital anomalies	HIV/AIDS	Meningitis	Meningitis	Drowning	Measles
6	Pertussis	Congenital anomalies	Drowning	HIV/AIDS	Tuberculosis	Congenital anomalies
7	HIV/AIDS	Protein–energy malnutrition	Protein–energy malnutrition	Tuberculosis	Fire-related burns	HIV/AIDS
8	Tetanus	Drowning	Measles	Diarrhoeal diseases	HIV/AIDS	Road traffic injuries
9	Meningitis	Road traffic injuries	Tuberculosis	Protein–energy malnutrition	Leukaemia	Pertussis
10	Measles	Meningitis	HIV/AIDS	Self-inflicted injuries	Meningitis	Meningitis
11	Protein–energy malnutrition	Fire-related burns	Fire-related burns	Leukaemia	Maternal haemorrhage	Drowning
12	Syphilis	Pertussis	Falls	Fire-related burns	Falls	Protein–energy malnutrition
13	Endocrine disorders	Tuberculosis	Congenital anomalies	War	Poisonings	Tetanus
14	Tuberculosis	Upper respiratory infections	Epilepsy	Violence	Abortion	Tuberculosis
15	Upper respiratory infections	Syphilis	Leukaemia	Trypanosomiasis	Epilepsy	Fire-related burns

Source: WHO (2008), Global Burden of Disease: 2004 update.

Injuries are not inevitable; they can be prevented or controlled. In the Organisation for Economic Co-operation and Development (OECD) countries, for example, the number of injury deaths among children under the age of 15 years fell by half between 1970 and 1995 (*9*). Until recently, little attention had been paid to the issue of injuries in low-income and middle-income countries. The lack of awareness of the problem, compounded by the particular circumstances that these countries face, has meant that proven measures have not been implemented to the same extent as they have in high-income countries.

Countries face many competing priorities and injury interventions need to be properly assessed for their effectiveness. However, a great deal more is known about preventing child injury and death than has been acted upon. Research continues to shed new light on the scale of the problem as well as on the potential that exists for saving lives and preventing injuries. For example, the analyses of the South and East Asian community surveys of injury (see Statistical Annex, Table B.1) show just how significant child injury is. Injury is responsible for 30% of deaths in 1–3-year-olds, with the figure approaching 40% in 4-year-olds and 50% to 60% among those aged 5 to 17 years (*10*).

How does child injury relate to other child health concerns?

As injury is a leading cause of death and disability among children worldwide, preventing child injury is closely connected to other issues related to children's health. Tackling child injury must be a central part of all initiatives to improve the situation of child mortality and morbidity and the general well-being of children (see Box 1.1).

In recent decades, programmes related to child survival targeted infectious diseases and nutritional deficiencies in infants and children. Campaigns were conducted for

BOX 1.1

International contributions towards improving child health

Convention on the Rights of the Child
In November 1989, the United Nations Convention on the Rights of the Child set a new international standard for respecting children and their rights (*3*). The Convention stresses the responsibilities of society to protect children (from birth up to the age of 18 years) and provide them with appropriate support and services. It further states that children have the right to the highest attainable level of health and the right to a safe environment, free from injury and violence.

World Health Assembly resolutions
The World Health Assembly, the annual meeting of the world's health ministers, has strongly promoted, through its resolutions, the recommendations contained in WHO's *World report on violence and health (11)* and *World report on road traffic injury prevention* (*12*). These include Resolution WHA 56.24 on violence and health *(13)* and Resolution WHA 57.10 on road safety and health (*14*). Children are frequently mentioned in these and other resolutions as a special target group for interventions.

Millennium Development Goals
In September 2000, the General Assembly of the United Nations adopted a series of Millennium Development Goals. The fourth goal is to reduce, by two thirds, the mortality rate of children under the age of 5 years, between 1990 and 2015 (*15*). Because of the large number of deaths of children under the age of 1 year from infectious diseases and neonatal causes, injury is responsible for only around 1.5%–2.0% of deaths in this age group. However, for children aged between 1 and 4 years, injuries are a more significant cause of death, accounting for just over 6% of all deaths. United Nations Member States are committed to meeting all eight Millennium Development Goals by 2015. Not all countries will meet the fourth goal if they do not include injury prevention in their programmes.

A World Fit for Children
In May 2002, the United Nations General Assembly held a Special Session on children, from which a document, *A world fit for children,* was produced. This sets out a number of health goals for children. One of these, specific to injuries, calls on all Member States to "reduce child injuries due to accidents or other causes through the development and implementation of appropriate preventive measures" (*16*).

Child survival
Child survival has become an important issue globally, as part of a broader and growing concern for the health and well-being of children and young people. Indeed, child survival has been described as "the most pressing moral dilemma of the new millennium" (*17*). The Bellagio papers provide new estimates of the numbers and causes of child deaths, including injuries, and suggest that two thirds of the nearly 11 million annual deaths among children under the age of 5 years can be prevented by implementing a set of 23 proven and cost-effective interventions (*18*). To be most effective, child injury prevention efforts should be integrated into broader child health initiatives.

breastfeeding, growth monitoring, immunization and oral rehydration therapy. Millions of lives were saved, and the lives of many more children were improved. However, unless injury prevention is included in such programmes, as these children grow up and are subjected to injuries, the impact of the large investments in immunization, nutrition and maternal and child health care may be lost (*19*).

"If we are ultimately going to meet the Millennium Development Goal to reduce child mortality, it is imperative that we take action to address the causes of childhood injury" Anupama Rao Singh, Regional Director of UNICEF East Asia and Pacific.

Child injuries and the changing world

Over fifty years ago, one child injury expert declared that: "it is now generally recognized that accidents constitute a major problem in public health" (*20*). A report of 1960 from the World Health Organization Regional Office for Europe shared this view: in high-income countries, it announced, injury had become the leading cause of death in children older than one year (*21*). However, the acknowledgement that childhood injuries are a significant problem in developing countries has been more recent.

With improvements in other areas of child health and better methods of collecting data, it is now clear that injury is a leading cause of child death and ill-health in low-income and middle-income countries (*22, 23*). The full extent of the problem of injuries in many countries, though, is still not fully understood. Recent large-scale community-based surveys in five countries in South and East Asia (Bangladesh, China, the Philippines, Thailand and Viet Nam) of overall child mortality, have found much higher levels of death from injury – both before and after the age of five years – than had been previously thought (*19*). This approach has complemented hospital-based and clinic-based health information systems, which often miss many injury deaths since, for example, a drowned child is almost never taken to a hospital or local clinic. Drowning, although unrecognized as a major cause of child death in earlier estimates, accounted for around half of all child injury deaths in each of the countries surveyed (*19*).

Tackling the injury problem is possible. Experience and research have both shown that most child injuries, and deaths from injuries, are preventable in all countries (*9, 24, 25*).

Globalization

Globalization involves a set of socioeconomic, cultural, political and environmental processes that intensify the connections between nations, businesses and people (*26–28*). The more rapid dissemination of ideas and knowledge of injury prevention (*29*), and the growth of a global civil society (*26*) involving networks of formal and informal groups, can have a positive influence on injury issues. However, there are also negative effects (see Box 1.2). With greater freedom of movement of capital across national boundaries, the production of goods – often a hazardous process – can more easily shift to regions of cheaper labour (*28*). This, in turn, can lead to increased transport in places where road safety is poorly developed (*30*). Centres of cheap production often have weaker controls on occupational health and child labour.

Whether globalization will increase or decrease the amount of child labour has been the subject of debate (*31*). According to the International Labour Organization, in 2004 there were still 218 million child labourers under the age of 15 years. However, over the past four years, there has been a global fall in the number of children working, particularly of those working in hazardous occupations (*32*). In some places, though – such as Gujarat state in India – economic growth has led to more children working, which is likely to lead to a greater number of injuries (*33, 34*).

Urbanization

Urbanization, much of it unplanned and ill-resourced, is accelerating children's exposure to risk (*35*). Over the next two decades, a large part of the world's population growth will be in urban areas. The proportion of the global population in urban areas is predicted to rise from around 50% today to over 60% by 2030 (*36*). Most of this growth will be in Asia and Africa (*37*).

Urbanization can promote positive attributes for health (*38, 39*). Medical care for injuries may be easier to provide in urban than in scattered rural areas and there are economies of scale in providing better housing and services. However, as a result of natural growth and migration, cities may expand beyond the capacity of resources to cope adequately (*40, 41*). Urban slums and squatter camps pose high risks of injury for children across the world (*42, 43*).

Motorization

The increase in motorization is related to trends in globalization and urbanization, yet it is worth examining separately because of its significant impact on child injury.

BOX 1.2

The effects of globalization on child injuries

Valli was devastated. She had left her small daughter alone for a few minutes, to go out to fetch water from the communal tap. On her return, she found the child had drowned in just 10 cm of water. Valli usually carried water from the tap in the traditional *kodam*, but stored it in the new plastic buckets that are now cheaply available in India.

With increasing globalization and a fast-expanding Indian middle class, the country's use of plastic has soared. Plastic is everywhere – in products, packaging and bags for carrying home goods. Unlike many other countries, though, India recycles almost half of all plastic goods, converting them into other cheap plastic products such as water buckets, that are often sold without lids. Local bucket-making factories buy plastic from recycling shops for about 35 rupees (less than one US dollar) a kilogram and make cheap containers of various shapes and sizes from the processed plastic.

Drowning can occur in even just a shallow amount of liquid at the bottom of a bucket. Given the shape, size and stability of these buckets, they may not tip over when a child leans into one and falls inside. The older and safer practice of storing water in a *kodam* – with its narrow opening that kept water cool and dirt-free and prevented drowning – has been discarded in favour of a cheaper plastic solution.

A similar problem of drowning in buckets was observed by the Consumer Product Safety Commission in the United States some 15 years ago. The Commission subsequently recommended a performance standard, a ban on this type of bucket and an information and education campaign.

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Roads have always been dangerous places for children. However, the rapid increase of traffic and the shift of transport systems around the world to roads make the issue especially pressing. Deaths and injuries from road traffic crashes are forecast to rise across the world by 67% between 1990 and 2020 (*12*).

Improved transport and a good road infrastructure are usually considered crucial for overall development (*44, 45*). The OECD Development Co-operation Directorate's Task Team on Infrastructure for Poverty Reduction (*46*) has pointed to benefits for the poor who need better

transport to access markets, job opportunities, education and health facilities. In Morocco, for instance, paved roads have helped increase school attendance substantially (*44*). A major increase in road infrastructure has been proposed for Africa by the Commission for Africa (*47*) as part of the efforts to achieve the Millennium Development Goals. It would be ironic, though, if pursuing the Millennium Development Goals – without strictly considering health and safety issues – led to an increase in death and injury among children from road traffic crashes or as a result of increased pollution.

Environmental change

The scale and impact of environmental risks may well be accelerating, induced by the global effects of climate change. The Intergovernmental Panel on Climate Change has predicted an increase of between 1.5 °C and 6 °C by 2100, depending on future carbon emissions (*48*). The causal pathways by which climate change could affect children's health are not clear; they are often indirect and their consequences may be felt at different times (*49–53*). Children may be exposed to risk of injury through an increase in extreme weather conditions that pose direct hazards – such as flooding, cyclones or mud flows from heavy rains. They may also be exposed through longer-term degradation of environments – such as droughts, desertification or rises in sea level (*54, 55*). Children in low-income countries face the greatest problems. Squatter and other makeshift urban settlements are often highly vulnerable to flooding, and health systems in these places are generally less able to cope (*56*). Both extreme and long-term environmental change can lead to migration, with people ending up living in marginal, unsafe conditions.

The characteristics of child injury

Unintentional injuries are one of the leading causes of death, hospitalization and disability across the world. However, the pattern and aetiology of injuries and their outcome vary substantially within populations and across countries. Epidemiologic analysis has long identified broad factors that, within specific environments, pinpoint the types of injury and the groups of children most at risk (*21, 57*).

In high-income countries, research has identified risk factors and protective factors for individual types of child injury (*58, 59*). Detailed work on child injury in low-income and middle-income countries began more recently and is now indicating priorities for prevention.

The characteristics of children susceptible to injury vary greatly by age, gender, race and socioeconomic status. These factors are dealt with in the following section and in greater detail in the individual chapters in this report.

The child-injury pyramid

Death is the most notable measure of injury but it is neither the only outcome nor the most common. Injury is often graphically represented as a pyramid, with the smallest group, that of death, at the top, hospitalized injury in the middle and the largest group, non-hospitalized injury, at the base. The first study of the sizes of these groups was carried out by the Child Safety Network in the United States in the early 1980s. Their analysis showed that for every one child under 19 years of age who was fatally injured, 45 children required hospitalization and a further 1300 were seen in an emergency department and discharged (*60*).

This pattern has been confirmed by detailed work in other regions and countries, although the exact ratios are affected by the local provision of services and the degree of access to hospital care. UNICEF and the Alliance for Safe Children have examined health histories for two and a quarter million people in five countries of South and East Asia (*10*). The combined data show that, for children under 18 years of age, for each death there are 12 children admitted to hospital or permanently disabled and 34 children who needed medical care or missed school or work because of an injury.

Children are not only affected by injuries to themselves, but also by injury to others. This applies particularly to the loss or disability of parents or caregivers through injury, and indeed of other members of the family, and they are affected by expenses and loss of income within the family as a result of injury (*61, 62*). In Jiangxi Province in China, for instance, for children of primary school age or younger, about half of parental deaths are associated with injury (*63*).

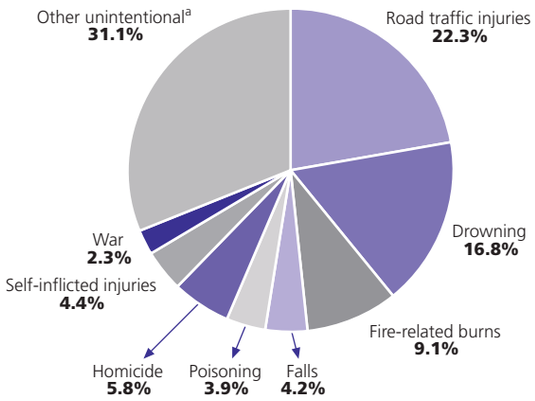
Fatal child injuries

In 2004, approximately 950 000 children under the age of 18 years died of an injury. The majority of these child injuries were the result of road traffic collisions, drowning, burns (fire or scalds), falls or poisoning (see Figure 1.1). These five categories, classified as unintentional injuries, make up 60% of all child injury deaths. A further category, labelled "other unintentional injuries", includes smothering, asphyxiation, choking, animal or snakebites, hypothermia and hyperthermia. This group accounts for 23% of childhood deaths, a significant proportion.

The rate of child injury death is 3.4 times higher in low-income and middle-income countries than in high-income countries, but there are large variations according to the category of injury death. For fire and flame deaths, the rate in low-income countries is close to 11 times higher than in high-income countries, for drowning it is six times higher, for poisons four times and for falls around six times higher (see Table 1.2).

FIGURE 1.1

Distribution of global child injury deaths by cause, 0–17 years, World, 2004



[a] "Other unintentional" includes categories such as smothering, asphyxiation, choking, animal and venomous bites, hypothermia and hyperthermia as well as natural disasters.

Source: WHO (2008), Global Burden of Disease: 2004 update.

TABLE 1.2

Unintentional injury death rates per 100 000 children[a] by cause and country income level, World, 2004

	UNINTENTIONAL INJURIES						TOTAL
	Road traffic	Drowning	Fire burns	Falls	Poisons	Other[b]	
HIC	7.0	1.2	0.4	0.4	0.5	2.6	12.2
LMIC	11.1	7.8	4.3	2.1	2.0	14.4	41.7
World	10.7	7.2	3.9	1.9	1.8	13.3	38.8

[a] These data refer to those under 20 years of age.
[b] "Other" includes categories such as smothering, asphyxiation, choking, animal or snakebites, hypothermia and hyperthermia as well as natural disasters.
HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

The association of age with injury type is found in both rich and poor countries. As can be seen in Table B.1 in the Statistical Annex, the combined results of the South and East Asian community surveys show that, in that part of the world, the main cause of injury death in children under 1 year of age is suffocation. In children under 5 years it is drowning, for those aged between 5 and 9 years drowning is joined by road traffic injuries and animal bites, while among children aged 10–17 years, road traffic deaths are the most significant unintentional injury. However, there are great differences between rich and poor countries. While drowning is the leading cause of injury death among children under 5 years in both the United States and Asia, the rate of death per 100 000 children is 30 times higher in Asia (*19, 62*).

Table 1.3 shows that rates of injury death vary substantially by age in high-income countries with the highest rate, that for 15–19-year-olds, being four times the lowest rate, that for 5–9-year-olds.

TABLE 1.3

Unintentional injury death rates per 100 000 children by age and country income level, World, 2004

	AGE (in years)					
	Under 1	1–4	5–9	10–14	15–19	Under 20
HIC	28.0	8.5	5.6	6.1	23.9	12.2
LMIC	102.9	49.6	37.6	25.8	42.6	41.7
World	96.1	45.8	34.4	23.8	40.6	38.8

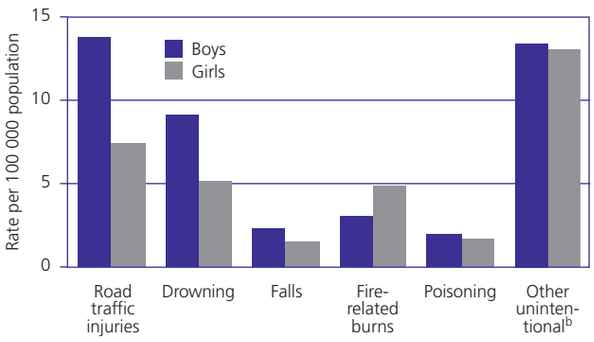
Source: WHO (2008), Global Burden of Disease: 2004 update.

In an analysis of child death rates by sex, the rate of male deaths exceeds that of female deaths in nearly all categories of injury, with the exception of fire-related burns (see Figure 1.2). The female excess in fire-related burns is particularly noticeable in certain parts of the world, such as the WHO South-East Asia Region and the low-income and middle-income countries of the Eastern Mediterranean Region, where deaths of female adolescents can exceed those of males by up to 50% (see Statistical Annex, Table A.1).

In most regions and countries, the gender gap for fatal injuries increases with age. At the global level, injury death rates among children under the age of 1 year, as well as those aged 1–4 years, are about the same for males and females. However, in children aged 5–9 years, male death rates are a third higher than female rates, a discrepancy that increases to 60% among those aged 10–14 years. Adolescents aged 15–17 years show an adult profile, with males in that age group accounting for more than 86% of all injury deaths, particularly in high-income countries.

FIGURE 1.2

Unintentional injury death rates per 100 000 children[a] by cause and sex, World, 2004



[a] These data refer to those under 20 years of age.
[b] "Other unintentional" includes categories such as smothering, asphyxiation, choking, animal and venomous bites as well as natural disasters.

Source: WHO (2008), Global Burden of Disease: 2004 update.

Non-fatal child injuries

The types of injury associated with child death are different from those that cause non-fatal injury and can again be different from those that cause long-term effects. The community surveys conducted in South and East Asia have shown up the relative significance of non-fatal injury and how it differs from fatal injury. Similarly, in Brazil, for children under 15 years of age, the leading causes of unintentional injury death are associated with traffic-related injuries and drowning, while more than half of all non-fatal injuries are the result of a fall (*64*). These findings also come out in the 28-country Global School Health Survey, where in all countries, except one, falls are the leading causes of non-fatal injury but account for only a small proportion of fatal child injuries (see Statistical Annex, Table A.3). Focusing on death data alone, therefore, may result in injury prevention strategies ignoring frequent injuries that are also costly to the health care system.

Injuries and subsequent disability

Head injuries are the single most common – and potentially most severe – type of injury sustained by children. Among minor injuries incurred by children, cuts and bruises are those seen most frequently. However, the most common category of unintentional injuries suffered by children under 15 years and requiring hospital admission are various types of fractures to the arms and legs (see Table 1.4).

In addition to mortality, hospital admissions, emergency department attendances and days lost from school can all be used as markers of injury severity. There are also more specific scoring methods, including notably, the Injury Severity Score, the Revised Trauma Score and the Paediatric Trauma Score. A review of the different types of measures currently used indicates that there is no standard method to determine the severity of an injury in a particular child (*65*). Each type of measure has its drawbacks and may vary according to the cause of injury or access to care. Measures of disability also tend to be non-standard.

TABLE 1.4

Nature of unintentional injuries sustained[a] by children under 15 years, World, 2004

Type of injury sustained	Rate per 100 000 population	Proportion of all unintentional injuries (%)
Intracranial injury[b] – short-term[c]	419.4	16.3
Open wound	316.9	12.3
Poisoning	282.4	10.9
Fractured ulna or radius	209.3	8.1
Burns <20%	152.7	5.9
Fractured clavicle, scapula or humerus	133.8	5.2
Internal injuries	129.3	5.0
Fractured femur – short-term[c]	115.8	4.5
Fractured patella, tibia or fibula	81.1	3.1
Fractured hand bones	70.1	2.7
Fractured face bones	60.1	2.3
Fractured skull – short-term[c]	55.2	2.1
Fractured vertebral column	54.5	2.1
Fractured ankle	34.8	1.4
Injury to eyes – short term	34.3	1.3
Sprains	33.7	1.3
Injured nerves – long-term[d]	26.1	1.0
Other dislocation	24.1	0.9
Fractured foot bones	23.2	0.9
Intracranial injury[b] – long term[d]	21.0	0.8

[a] Requiring admission to a health facility.
[b] Traumatic brain injury.
[c] Short-term = lasts only a matter of weeks.
[d] Long-term = lasts until death, with some complications resulting in reduced life expectancy.

Source: WHO (2008), Global Burden of Disease: 2004 update.

Data from the Global Childhood Unintentional Injury Surveillance conducted in four cities showed that nearly 50% of children under the age of 12 years who had suffered an unintentional injury severe enough to warrant presentation to an emergency deparment were left with some form of disability (Statistical Annex, Table C.1). Among children who had suffered a burn, 8% were left with permanent disabilities, while children injured in traffic crashes were significantly more likely to be left with some form of disability (Table 1.5).

Many young people who survive major trauma are left with ongoing disabilities, with a major impact on their own lives as well as on the lives of their families. These disabilities may be physical, mental or psychological. Some of the problems encountered in the years following injury include an inability to attend school, find suitable work or engage in an active social life. There are also other more basic problems such as having to cope with continued pain. Support for these young people most often falls on their close family and friends (*66*).

Child injury and age

Injury prevention strategies need to take into account child development in different and sometimes changing contexts. Adolescence, for example, has become a more significant developmental stage in many low-income countries, whereas before there had been a more direct transition from childhood to adulthood (*67*). Childhood is also changing at earlier stages in some places. In parts of sub-Saharan Africa, HIV/AIDS is creating parentless households. With young children forced to take on adult responsibilities (*68*) the nature of childhood in these areas has changed radically (*69*).

Exposure to injury risk for children also depends on the particular set of laws that are in place and the degree to which these are enforced. These laws include the legal ages for entering the formal workforce, for driving, and for drinking alcohol. There are often considerable differences between countries.

- Alcohol can be legally consumed at 15 years in Belgium, but not until the age of 20 years in New Zealand.
- A car can be legally driven in New Zealand at the age of 15 years. In Sweden the legal driving age is 18 years (*70*).

What makes children particularly susceptible to injury?

Children are not just small adults. Their physical and cognitive abilities, degrees of dependence, activities and risk behaviours all change substantially as they grow older (*50, 71–75*). As children develop, their curiosity and wish to experiment are not always matched by their capacity to understand or to respond to danger (*76*).

At about 3 months of age children will start to wriggle and roll, at about 6 months they will sit up, and they will start crawling at around 9 months. Objects are reached for, grasped and put in their mouth. At 18 months they are mobile and exploring the world. Child development and behaviour is therefore highly associated with particular injuries. Poisoning, for example, is linked to the grasping and drinking behaviour of children aged 1–3 years, while falls are related to the stage of learning to walk.

Analysis of injury using age ranges in years can be too broad to detect the rapid change in development and injury risk among very young children. By using 3-month age brackets, one study showed that falls were the leading cause of injury in children aged under 3 years, but that the particular items that caused their falls – such as furniture,

TABLE 1.5

Injury severity and estimated long-term effects of unintentional injuries among children[a] presenting to emergency departments in four countries[b]

	TYPE OF UNINTENTIONAL INJURY					
	Road traffic injuries ($n = 350$)	Falls ($n = 913$)	Burns ($n = 210$)	Poisoning ($n = 66$)	Drowning ($n = 20$)	Total
	Injury Severity Score (ISS)					
Lowest score	0	0	0	0	0	0
Highest score	75	75	75	16	75	75
Median ISS	4	4	3	1	4	4
Mean ISS[c]	10	5	5	3	11	7
	Disability					
No significant disability	38%	53%	51%	80%	65%	56%
Short term temporary disability (< 6 weeks)	43%	39%	24%	12%	20%	40%
Long term temporary disability (≥ 6 weeks)	17%	8%	17%	8%	5%	12%
Permanent disability	3%	1%	8%	0%	10%	2%

[a] aged under 12 years.
[b] Bangladesh, Colombia, Egypt, Pakistan.
[c] to nearest whole number.

Source: see Statistical Annex, Table C1.

stairs and playground equipment – were important at different ages. The study also showed that poisoning injury started to rise at the age of 9 months, continuing up to 21 to 23 months, and then declined. Burns from hot liquids were substantially higher among those aged 12 to 18 months (*73*).

The small stature of children increases their risk in a road environment. They are less visible than adults and if hit by a vehicle, they are more likely than an adult to sustain a head or neck injury (*77*). At the same time, small children have difficulty seeing over vehicles, judging the speed of oncoming vehicles and discerning the distance of a vehicle from the sound of its engine (*78*).

Other physical characteristics make children vulnerable to injuries. The skin of infants burns more deeply and quickly and at lower temperatures than the thicker skin of adults (*77*). Smaller airway size increases the danger of aspiration (*24*). In addition, certain physical characteristics of young children may affect injury outcomes. For example, children's larger ratio of body surface area to volume means that not only will the size of a burn – for a given volume of hot liquid – be greater than for an adult, but also that there will be more fluid lost from the burnt area, thus complicating the management of the injury (*79*). Similarly, a given amount of a poisonous substance will more likely be toxic for a child than an adult because of the child's smaller mass. Children's smaller size also creates a risk of entrapment of body parts, most dangerously for the head. Many products and settings do not properly take these risks into account.

Studies of children in road traffic have shown that young children may lack the knowledge, skills and levels of concentration needed to manage the road environment, no matter how benign the road conditions (*80*). Their physical abilities may not be matched by cognitive abilities. For instance young children, in the process of exploring their world, may fall from heights because their climbing ability is not matched by their ability to balance or reason (*77*).

Children's worlds

Young children's behaviour differs from that of adults. A vivid illustration of this is in the home environment. "[They] crawl about the floor, climb onto the window ledge, squeeze through stair balustrades, slide down the stair handrail, swing on the gate, run from room to room and ride bikes inside as well as out, making use of their houses in ways that seem to them reasonable, but have not apparently been foreseen by the designer" (*81*).

Physical and mental stages are important, but children are especially vulnerable to injury because they live in a world in which they have little power or control. The vulnerability of children is exacerbated by their lack of power and status (*6*). They find themselves in urban and rural environments constructed by and for adults (*82*). Their voices are seldom heard and only rarely are places designed in consultation with children (*83*).

Urban planners and policy-makers know little of children's concerns and often assume change will benefit all (*84*). For example, improving water supplies to a neighbourhood may result in young children – often the family water carriers – having to travel an increased distance to a standpipe to fetch water, with possible damage to their head, neck and spine (*85*). New products are often designed without taking into consideration their possible use by children and the consequent harm.

Child injury and gender

Boys tend to have both more frequent and more severe injuries than girls (*1, 76*). Sex differences in injury rates appear within the first year of life for most types of injury (*86*). According to WHO data, in children under 15 years, there are, on average, 24% more injury deaths among boys than there are among girls.

Data from developed countries indicate that, from birth onwards, males have higher rates of injury than females, for all types of injury (*87*). The pattern is less uniform in low-income and middle-income countries, but the overall gender differential is clear, with injury death rates around one third higher for males under 20 years of age than for females.

A number of reasons for these differences in injury have been put forward and investigated. One study found that sex differences were not completely explained by differences in exposure to risk and that differences in injury rates begin to appear at the same age as differences in behaviour (*86*).

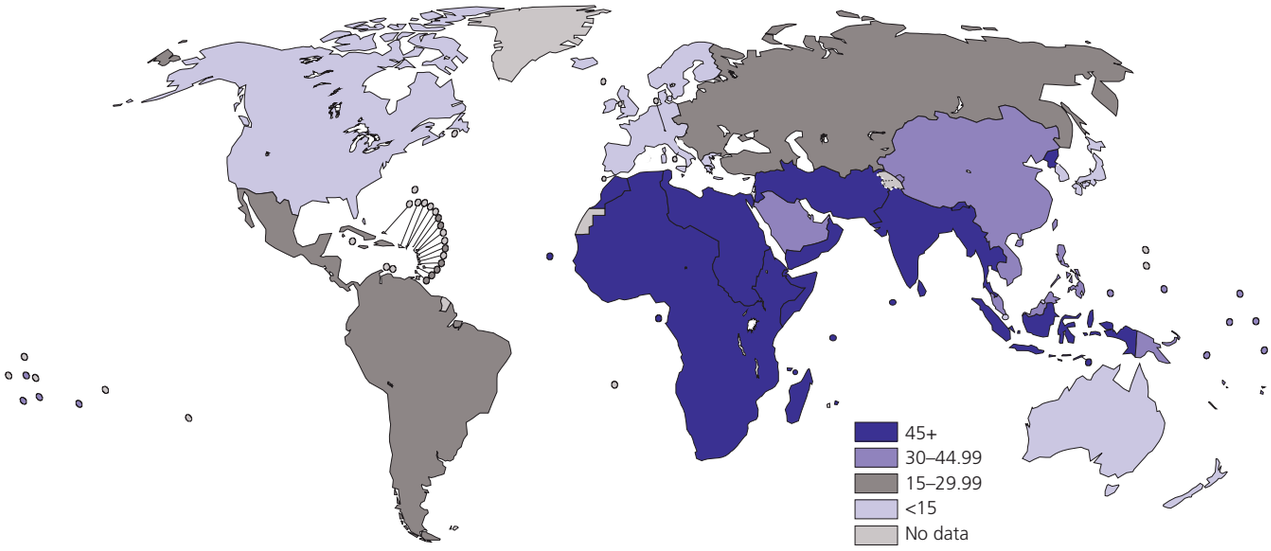
Various theories have been proposed for the difference in injury rates between boys and girls (*88*). These include the idea that boys engage in more risk taking than girls (*89*), that they have higher activity levels (*90*), that they behave more impulsively. Also included are the suggestions that boys are socialized in a different way from girls and are less likely to have their exploration restrained by parents (*91*), that they are more likely to be allowed to roam further (*92*), and that they are more likely to be allowed to play alone (*93*).

Child injury and socioeconomic factors

As can be seen in Figure 1.3, most of the childhood injury burden rests in low-income and middle-income countries, and within these countries, poor children are disproportionately affected (*94*). Some of the most vulnerable groups are those who live in chronic poverty (*95*). They are a heterogeneous group, often living in remote rural areas or conflict zones or else displaced. In the Islamic Republic of Iran, for example, a community-based survey has shown that the majority of fatal unintentional injuries to children under the age of 15 years occur in remote or rural areas (*96*). The chronic poor have few buffers against shocks – such as income and social networks (*97*). The first target of the Millennium Development Goals is to halve, between 1990 and 2015,

FIGURE 1.3

Rate of unintentional injuries per 100 000 children[a], by WHO region and country income level, World, 2004



Africa	Americas		South-East Asia	Europe		Eastern Mediterranean		Western Pacific	
LMIC	HIC	LMIC	LMIC	HIC	LMIC	HIC	LMIC	HIC	LMIC
53.1	14.4	21.8	49.0	7.9	25.4	41.6	45.7	7.8	33.8

[a] These data refer to those under the age of 20 years.
HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

the proportion of people living on less than one US dollar a day.

Definitions of poverty

There are two broad categories of poverty: "absolute poverty" and "relative poverty". The former relates to the minimum requirements needed for physical survival or subsistence, the latter to the prevailing living standards of a society. It has been suggested that poverty goes beyond mere subsistence, involving also what in a particular society are considered the minimum conditions of well-being (*98*).

The injury field abounds with different operational definitions of poverty and related socioeconomic factors. These variations have made it difficult to consistently collect comparable data on important demographic factors such as the socioeconomic status of parents, family income and education, as well as on the characteristics of particular areas, schools, medical centres and childcare centres. There is a great need for standardization of definitions and methods to improve the quality and usefulness of information.

Socioeconomic factors and risk for injury

A broad range of socioeconomic factors associated with injury risk has been identified (*74*). These factors include:

- *economic* factors – such as family income;
- *social* factors – such as maternal education;
- factors related to *family structure* – including single parenting, maternal age, numbers occupying the household, and number of children;
- factors related to *accommodation* – such as type of tenancy, type of housing, level of overcrowding and various factors describing the neighbourhood.

Socioeconomic factors affect injury risk in a number of ways (*74*).

- In poor households, parents may not be able to:
  - properly care for and supervise their children, who may need to be left alone or in the care of siblings (see Box 1.3);
  - afford safety equipment, such as smoke alarms or safety helmets.
- Children living in poverty may be exposed to hazardous environments, including:
  - a high volume of fast-moving traffic;
  - lack of space and facilities for safe play;
  - cramped living conditions, with no proper kitchen and open cooking fires;
  - unprotected windows and house roofs, and stairs without handrails.

Access, or the lack of it, to good-quality medical services is an important explanatory factor for variations in mortality rates. In a Nigerian study, 27% of 84 children admitted to hospital for a burn injury died as a result of their injury (*79*), in contrast with a similar study from Kuwait, where 1% of a sample of 388 children died (*99*). This discrepancy, though, may also be related to differences in the severity of burns seen.

BOX 1.3

Child supervision

Supervision is widely recognized as vital to protecting children from harm. Some estimates suggest that 90% of injuries to young children occur in or around their home when they are supposedly being supervised by a caregiver. Despite the beliefs that childhood injury is often related to a lack of supervision, evidence to support this premise is limited.

There have been few attempts formally to define the term "supervision" in the context of injury prevention. A reasonable definition, consistent with existing evidence, is that supervision refers to behaviours that are related to *attention* (watching and listening) and to *proximity* (touching, or being within reach). Furthermore, these behaviours are judged by how *continuous* they are (whether constant, intermittent or not at all).

What some researchers are finding, though, is that caregivers exhibit a spectrum of patterns of supervision – ranging from almost total neglect to extreme vigilance. While there are many parallels between good parenting skills and good supervision practices, there does not seem to be any agreed-upon supervisory style that is uniformly protective. In addition, the effectiveness of supervision will be affected by whether the caregiver becomes distracted, and by the caregiver's mental health status, use of alcohol or drugs, complacency or overconfidence.

Models of supervision have focused on:

- the need for supervision based on a child's age, developmental status and exposure to possible hazards;
- the supervisor's judgement, skills and ability to influence the child;
- the physical proximity of the supervisor to the child, taking into account the setting and the characteristics of the child;
- the degree of verbal and physical interventions with the child;
- how much of the time the supervisor is actively supervising.

Tools are needed to measure these various constructs more accurately.

There is considerable *indirect* evidence that associates supervision with a child's risk of injury. This risk increases substantially when the child lives with a single caregiver, in a home with multiple siblings, or with a substance-abusing caregiver – all of which can compromise the ability of a caregiver to attend closely to the child. In large families, supervision of younger children by older children may be common, but is usually inadequate.

Good child supervision is likely to be an important intervention to protect children from injury. However, the role of supervision and guidelines for its age-appropriate application in various settings of injury risk need further investigation. Research to improve the effectiveness of supervision as an injury prevention strategy should include efforts to define and measure different types of supervision. Models of good supervision should be developed, and cultural influences on the ways supervision is conducted should be examined. Interventions to influence the behaviour of caregivers also need to be considered. A final critical step is to evaluate different supervision strategies and measure their impact on reducing injuries.

A few studies in developed countries have attempted to look at the association between childhood injuries and socioeconomic status.

- In England and Wales, a study examined injury mortality data by occupational group of the parents for children aged 1–15 years over two time periods – 1979–1983 and 1989–1992 (*100*). All childhood injury deaths had declined between the two periods of study, but the associations of injury deaths with socioeconomic factors had become stronger. Social gradients were particularly steep for certain types of injury such as homicide, fire burns and pedestrian injuries.
- A recent study in New South Wales confirmed that the association between relative socioeconomic disadvantage and non-fatal injury risk among children in this Australian state was strongest for transport-related injuries, burns and poisoning (*101*).

There are even fewer studies from developing countries that have examined childhood injuries according to socioeconomic group.

- A study in South Africa explored the incidence and causes of injury across socioeconomic and environmental settings in six neighbourhoods in a poor area of Johannesburg – two informal settlements, two neighbourhoods of council houses and two of council-built apartment buildings (*102*). The informal settlements reported higher rates of injury than the other types of neighbourhood.
- A survey on the economic impacts of injury in rural Viet Nam showed that poverty was a significant risk factor for injury, and also that children in poor households had higher rates of injury sustained in the home than better-off children (*103*).

Injuries as a cause of poverty

Poor populations are particularly vulnerable to a range of calamities, which can trigger a further decline in family resources. Crises brought about by ill-health, a road traffic crash or an episode of flooding may push people into poverty (*104*).

- A study in Bangalore, India and in Bangladesh found that the burden from road crashes had pushed many households into poverty. In Bangalore, 71% of households in urban areas and 53% in rural areas were not poor before the crash; in Bangladesh the comparable figures were 33% in urban areas and 49% in rural areas (*105*).
- In Viet Nam, the cost of injury to poor households was estimated as equivalent on average to 11 months' income. The risk of a poor household falling below the poverty line was 21% higher among those that had had an injury than among those that had not (*106*). Health-

care costs and the loss of income were the main factors contributing to this effect.

Children are a particularly vulnerable group, either directly through being injured themselves or indirectly through the loss of their parents.

- In a Bangladesh slum, 40% of malnourished children came from households where the breadwinner had been incapacitated by illness or injury (*107*).
- In Ghana, a study of the economic consequences of injury within the family found that in rural households, 28% of families reported a decline in food consumption following an injury (*108*).
- A study in Bangladesh found that injury was the leading cause of children losing a parent, with about 7900 fathers and 4300 mothers dying each year (*61*).

Certain groups of children have higher than average rates of injury. These rates may be associated with the specific circumstances and environment of the children – for instance, being refugees or being homeless. The groups that stand out most clearly with respect to their higher injury rates are indigenous populations, who also tend to experience greater relative poverty than their compatriots (*109*).

- Injury is a major cause of death and morbidity among the Maori population in New Zealand (*110*).
- In the United States and Australia, injury death rates in indigenous people are two to three times the rates for non-indigenous people (*111*).
- The death rate from road traffic injuries among indigenous Australians under 15 years of age, is two and a half times that for non-indigenous young Australians (16.7 per 100 000, compared to 6.6 per 100 000) (*112*).

The preventability of child injury

The principles of injury prevention

Injuries can be prevented or controlled. Because of their many causes and the close interrelationship between them, a wide range of prevention approaches is called for. Various prevention models have been proposed, but for the purpose of this report the classic model is used, including:

- primary prevention: preventing new injuries;
- secondary prevention: reducing the severity of injuries;
- tertiary prevention: decreasing the frequency and severity of disability after an injury (see Box 1.4).

The contribution of Haddon

William Haddon Jr developed a scheme (known as the "Haddon Matrix") in the 1960s to apply the principles of public health to the problem of road traffic safety (*117, 118*). It has since been used as a means of developing ideas to prevent injury of all types. The matrix consists of 12 cells. These are arranged in a table of four columns relating to the host, agent/vehicle, physical environment and social environment, and of three rows relating to the periods before, during and after the injury (corresponding to primary, secondary and tertiary prevention).

The resulting matrix provides a means to identify, cell by cell:

- strategies and priorities for injury prevention, in terms of their costs and effects;
- existing research and research that needs to be undertaken;
- the allocation of resources in the past and the future, and the effectiveness of such allocation.

Haddon went on to describe 10 strategies to accompany the matrix, which describe the ways in which the harmful transfer of energy can be prevented or controlled in some way (*119*) (see Table 1.6, where Haddon's 10 strategies have been applied to child injuries).

The significance of the Haddon Matrix and Haddon's 10 injury prevention countermeasures is that they highlight the fact that not only can society intervene to reduce injury, but that such interventions can occur at different stages (*120*).

Public health approaches

As has occurred with several other health issues, the emphasis has shifted over recent years from the individual to the environmental context in which an injury occurs. Along with this shift of emphasis, there has also been a realization that single-cause explanations of injury are incomplete and that models using a range of causes are needed instead. The public health model is therefore useful as it approaches the issue in a systematic and coordinated way, following four logical steps (Figure 1.4) – all of which call for good evidence on which to base activities. It is a model that can reveal important emerging issues in child injury prevention (see Box 1.5).

FIGURE 1.4

The public health approach to injury prevention

A public health perspective also allows for a holistic approach to the issue of child injury. Such an approach can bring together, as partners, the diverse range of national and local agencies and organizations involved in injury prevention, and coordinate actions under a single umbrella (*120*).

BOX 1.4

Access to care

Much can be done to lower the burden of death and disability from injury by strengthening trauma care services across the spectrum from pre-hospital care through hospital care to rehabilitation. The chain of survival starts at the scene of the incident. Prompt, quality pre-hospital care can save many lives after an injury. Where formal emergency medical services (usually with ambulances) exist, their performance can be improved by standardizing equipment, training, infrastructure and operations. Where they do not exist, starting new formal emergency medical services can be a reasonable option, especially along busy roads with high rates of crashes. However, these services can be costly. In any circumstance, and especially where there are no formal emergency medical services, pre-hospital care can be improved by building upon existing, informal systems of pre-hospital care and transport. In many cases this involves drawing upon resources in the community to train and possibly equip those whose job it is to be the first on the scene of an emergency. These may be members of the lay public, members of organizations such as the Red Cross and Red Crescent societies, or members of national emergency services, such as the police and fire services.

A good example of the effectiveness of such an approach is a project, creating a two-tier system, that operated in northern Iraq and Cambodia. Several thousand villagers, forming the first tier, were trained in basic first aid. When needed, a second tier of more highly trained paramedics was called upon. This system sharply decreased mortality rates among victims of mine explosion and of other trauma, and is a good example of how pre-hospital care can be improved at low cost without developing ambulance systems (*113*). Similar examples can be found in WHO's *Prehospital trauma care systems* (*114*).

The treatment that an injured child receives on reaching the hospital is another point in the chain of survival where lives can be saved. Improving the organization and planning of trauma care services is an affordable and sustainable way to raise the quality and outcome of care. This includes defining a set of essential trauma care services, which every injured child should receive, as well as the required resources, both human and physical, to assure such services. Continuing education courses on trauma care should be introduced, along with quality improvement programmes, and the system for referrals between different parts of the health care system should be strengthened through inter-hospital transfer agreements.

The essential elements of trauma care need not be expensive. However, the cost of care can be a barrier to access, especially where users are asked to pay in advance of receiving emergency services. It is therefore essential to ensure that the essential trauma care services can be delivered to all who need them irrespective of the ability to pay, with cost recovery coming only after the treatment is given. More detailed recommendations on strengthening trauma care at hospitals and clinics can be found in WHO's *Guidelines for essential trauma care* (*115*).

A visit to the emergency department after an injury is often the first encounter that children have with a hospital. The experience can add to their physical distress if there is a lack of understanding or information or if they feel lonely or frightened. When treating children who have been injured, health-care personnel should provide information, communicated in a manner appropriate to the child's age, and seek to make the hospital environment less intimidating and inhospitable (*116*). In short, both hospitals and their health-care staff should do their utmost to be child-friendly.

Finally, many injured survivors lead lives of disability. Much of this disability could be avoided with improved rehabilitation services. This would involve improving services in health care facilities and as well as access to community-based rehabilitation. Assessments have shown that such rehabilitation services are poorly developed globally and are in fact among the least developed within the spectrum of trauma care services. Strengthening such rehabilitation services will reduce the extent of disability following an injury and help those with persistent disabilities to achieve their maximum potential and lead meaningful lives.

TABLE 1.6

Ten countermeasures and examples of child injury prevention

	Strategy	Example related to child injury prevention
1	Prevent the creation of the hazard in the first place	Banning the manufacture and sale of inherently unsafe products
2	Reduce the amount of energy contained in the hazard	Speed reduction
3	Prevent the release of the hazard	Child-resistant medicine containers
4	Modify the rate or spatial distribution of the hazard from its source	Use of seat-belts and child restraints
5	Separate people in time or space from the hazard and its release	Bicycle and pedestrian pathways
6	Separate people from the hazard by interposing a material barrier	Window bars, pools fencing, covering wells
7	Modify the relevant basic qualities of the hazard	Softer playground surfaces
8	Make the person more resistant to damage	Good nutrition for children
9	Counter the damage already done by the hazard	First aid treatment for scalds – "cool the burn"
10	Stabilize, repair and rehabilitate the injured person	Burn grafting, reconstructive surgery and physical therapy

BOX 1.5

Dog bites: injury data reveal significant public health problem

Dog-bite injury has been the subject of very few scientific publications. It was only after the introduction of external cause coding of hospitalized injury cases and the setting up of emergency department injury surveillance systems that population-based rates of dog bites could be estimated. With greater injury surveillance and more country-wide or province-wide household surveys of injuries, the real burden of dog-bite injury is now becoming apparent. Death registration and injury surveillance data in high-income countries show that dog bites are a potentially serious injury and a frequent cause of hospitalization, but that they are only rarely fatal.

Children are particularly vulnerable to dog attacks as a result of their size and the fact that their face is usually close to that of the dog. Bites to the head and neck are common in small children and decrease with age (*121*).

The table below summarizes the most common circumstances resulting in a dog bite.

External circumstances of dog bites

Circumstance	*%*
Playing with or near the dog	28
Passing the dog (walking)	14
Cuddling the dog	10
Feeding the dog	8
Passing the dog (cycling)	4
Disturbing the dog while eating	4
Surprising the dog	2
Pulling the dog's tail	2
Interfering during a dog fight	2
Unknown	26

Source: reference *122*

In high-income countries, examples of reported fatality rates from dog bites include:
- Australia: 0.04 per 100 000 population;
- Canada and the United States: 0.07 per 100 000 population.

In these countries, children are over-represented. They account for 36% of dog-bite fatalities in Australia and between 70% and 80% in the United States (*123*). Similarly, published rates for hospitalization or emergency department visits in these high-income countries, as well as in some other places, highlight the over-representation of children, with those aged 0–4 years, followed by those aged 5–9 years, the most vulnerable (*121, 124*).

There are fewer reports specifically on dog-bite injury from low-income and middle-income countries. Recently, UNICEF and The Alliance for Safe Children (TASC) collaborated with partner institutions in five Asian countries on community injury surveys. Such surveys supplement injury surveillance, and record more minor cases of bites and as well as those that are treated outside the hospital system by local practitioners, traditional healers or family members. These community surveys have revealed the previously unrecognized burden of animal-related injury, especially of dog bites, among children in low-income and middle-income countries. From these surveys, TASC has also estimated the number of days lost from school or work, following an injury, for children aged between 0 and 17 years. Data for this age group from surveys in five countries estimate the animal-related injury rate at 380 per 100 000 population, second only to falls as a leading cause of time lost from school or work (*19*).

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The 2001 community survey in Viet Nam showed that around 360 000 Vietnamese children suffer animal bites each year, with dog bites accounting for almost 80% of these. Every day, some 30 children in Beijing suffer animal bites, 81% of them caused by pet dogs. While two decades ago dog ownership was not allowed in China, it is now common. The cost of treatment of such bites in Beijing has been estimated at US$ 4.2 million annually (*19*).

Dog bites in poor countries come with the added risk of rabies. In countries where rabies is endemic – including India, China and many parts of Africa – a dog bite that may not otherwise be serious can lead to death. Rabies is the tenth most common cause of death from infection worldwide. More than 99% of the 55 000 annual worldwide deaths from rabies occur in Asia and Africa (*125*). There is evidence that between 30% and 60% of the victims of dog bites in endemic areas of canine rabies are children under 15 years of age (*126*).

- A study in New Delhi estimated the rate of rabies from animal bites at 80 per 100 000 population, and significantly higher for 5–14-years-olds, with bites from stray dogs accounting for 90% of cases (*127*).
- A study of 2622 Thai children with rabies exposure found that 86.3% of the cases were related to dog bites (*128*).
- A Ugandan study found that the majority of dog bites were to children under the age of 15 years and that these children were at greater risk of developing rabies, in the absence of treatment, due to the location of the bites they had suffered (*129*).
- A study from the United Republic of Tanzania showed that significantly more children aged 5–15 years are bitten by a suspected rabid dog than are adults (*130*).

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Most children who die from rabies were either not treated or else received inadequate post-exposure treatment. Many bite victims do not receive rabies immunoglobulin because of a perennial global shortage. Its high price makes it frequently unaffordable in countries where canine rabies is endemic (*126*). In addition to human vaccination, an estimated 50 million dogs are vaccinated against rabies worldwide, either privately or through government-organized campaigns (*125*). In some countries – including China, the Islamic Republic of Iran, Thailand, South Africa and much of Latin America – a sustainable reduction in dog rabies has been achieved by programmes of improved post-exposure treatment of humans and of control measures against dog rabies. In others, including Morocco, Sri Lanka and Tunisia, such activities have at least led to rabies being contained. However, in some African and Asian countries, vaccination coverage has reached only 30%–50% of the dog population, a level insufficient to break the disease transmission cycle.

In addition to training school-aged children, it is advisable to teach dog owners and parents to be alert when children are close to dogs. The blame for a dog attack should not be placed on the children. The table below summarizes some of the behaviours older children can be taught in order to minimize attacks by dogs.

Code of behaviour to prevent dog bites

Characteristics of dogs	Instructions to children
Dogs sniff as a means of communication.	Before petting a dog, let it sniff you.
Dogs like to chase moving objects.	Do not run past dogs.
Dogs run faster than humans.	Do not try to outrun a dog.
Screaming may incite predatory behaviour.	Remain calm if a dog approaches.
Dogs may regard infants, especially new members of the family into which the dog already feels integrated, as intruders or as subordinate.	For infants and small children, do not hug or kiss a dog.
Direct eye contact may be interpreted as aggression.	Avoid direct eye contact.
Dogs tend to attack extremities, face and neck.	If attacked, stand still (with feet together) and protect neck and face with arms and hands.
Lying on the ground provokes attacks.	Stand up. If attacked while lying, keep face down and cover the ears with the hands. Do not move.
Fighting dogs bite at anything that is near.	Do not try to stop two fighting dogs.

Source: reference *122*

In conclusion, dog-bite injury is a widespread and hitherto poorly-documented global problem, disproportionately affecting children and adolescents. Good data collection systems are vital for identifying the characteristics of injuries such as dog bites. Only when good data become available can the extent and nature of such injuries be appreciated and proper prevention measures set up.

Learning from places with good safety records

Experience from countries with the best safety records shows that positive leadership, together with widespread, multisectoral efforts to provide safer physical and social environments can produce sustained reductions in injury mortality and morbidity (*131*). In addition, those countries which have a designated government focal point with overall responsibility for addressing injury have made significant advances (*132*).

Sweden was the first country to recognize the importance of injuries as a threat to child health and to tackle the problem in a coordinated manner (*133*). In the 1950s, Sweden had death rates from child injury higher than those in the United States. Since the late 1980s, it has had the lowest child injury death rates of any country in the world. Factors contributing to its success have included (*134*):

- good surveillance data;
- a commitment to research;
- regulations and legislation for safer environments;
- broad-based safety education campaigns involving partnerships of different agencies;
- committed leadership on safety issues.

In addition, Sweden was one of the few countries that followed WHO's recommendations to set up policies for safety, to organize a national multisectoral safety promotion programme and to allow academic institutes to participate in public health policy-making (*135*). A sense of corporate responsibility in Sweden has greatly helped in allowing the protection of children to become a major goal of society.

There have been relatively few systematic attempts to examine factors that might explain differences between countries in child injury rates. One example is the OECD study of road safety policy and practice. This used mortality data, demographic and socioeconomic indicators, exposure surveys and surveys based on questionnaires addressed to the leading informants in transportation departments in OECD countries. The study identified the pivotal role of good data. The best-performing countries in the study – those with the lowest injury rates – had a comprehensive, coordinated policy on road traffic injuries and had adopted a holistic approach (*136*). The importance of international networks of researchers has also been identified to encourage the rapid dissemination of ideas between countries (*137*).

Which approaches work?

Interventions to prevent unintentional injuries have traditionally been considered in terms of the "three E's": education, enforcement and engineering – and within the framework of the Haddon matrix discussed before. While randomized controlled trials are considered the gold standard for assessing the effectiveness of injury interventions, such trials are still relatively rare in relation to child injuries. Many trials would be impractical or unethical to implement because their benefits are obvious. A recent publication on disease control priorities in developing countries included a chapter on the prevention of unintentional injuries in low-income and middle-income countries (*138*). Although the interventions suggested as promising or proven are for all ages, many are applicable to the prevention of child injuries.

> *"Evidence is the foundation for setting priorities, crafting policies, and measuring results. Evidence can have great persuasive power at the policy level"* Dr Margaret Chan, WHO Director-General.

The sections below summarize the approaches that have been adopted in a number of countries. Examples are given for each approach, along with evidence, where available, from systematic reviews, using the Cochrane database of systematic reviews and other reviews.

Legislation and enforcement

Legislation is a powerful tool in the prevention of injury. It can be regarded as a "test of commitment to the cause of child safety" (*9*). There is evidence that legislation has increased the uptake of preventive measures and reduced childhood injuries in a number of areas. These areas include:

- In the road environment:
  - child passenger restraints (*139*);
  - seat-belts (*140*);
  - bicycle helmets (*141*);
  - motorcycle helmets.
- In the home environment:
  - smoke alarms (*142*);
  - hot water temperature legislation (*143*);
  - child-resistant containers (*144*).
- In the leisure environment:
  - isolation fencing of swimming pools (*145*).

There is some evidence of the beneficial effect of legislation on the use of booster seats (restraints in cars for children who have outgrown child seats), though this was mainly from uncontrolled before-and-after studies (*146*). A systematic review (*147*) found legislation on bicycle helmets to be effective in increasing helmet use, particularly in the younger age group and in areas with previous low rates of use (*148*), and in reducing head injuries (*141*).

As well as the introduction of new laws, how consistently they are applied and how rigorously enforced are important. The UNICEF league table report compared the legislative record for seven areas of injury legislation in 26 OECD countries. Only three countries

had legislated in at least six of the seven areas assessed: Australia, Canada and the United States (*9*).

Many countries have specific standards or regulations – some mandatory – for a wide range of goods and services, including:

- toys and nursery furniture;
- playground equipment;
- items designed for childcare – such as nail clippers and hair brushes;
- safety equipment such as helmets;
- furniture and furnishings – such as the provision of baby gates at the top of stairs.

There are also usually regulations and standards related to construction work on buildings, as well as to health and safety generally in the workplace. All these standards and regulations have an important bearing on the extent to which child injury can be prevented.

Since, for many products, standards often do not exist, and the introduction of standards for individual products can be a slow process, a useful approach is to identify the particular hazards for a product and the measures and mechanisms that reduce risk. So-called "vertical standards" based on hazards compile this information so that manufacturers and regulators can identify known hazards in products and reduce them to acceptable levels. This approach is the one adopted, for instance, in *ISO/IEC Guide 50: Safety aspects: guidelines for child safety* (*149*). Risk reduction here is meant to cover the way people actually use the products and it should be for the life of the product. In 2007, for example, there was a worldwide recall of toys that had been found to contain hazardous levels of lead paint.

In developed countries, the way in which legislation is enforced varies considerably. Because of a frequent lack of structures and resources, enforcement in developing countries is even more difficult. In Karachi, a study of bus safety showed that legislation was not likely to produce much effect, but that instead increases in bus drivers' wages and small changes to the vehicles were potentially more effective (*150*).

Product modification

Changing the design and manufacture of products can:

- *reduce the risk* of an injury – for instance, by manufacturing staircase railings with the gap between the upright banisters sufficiently narrow to prevent small children putting their heads through;
- *reduce access* to a hazard – an example being the use of child-resistant closures for medicines;
- *reduce the severity* of an injury – for instance, by modifying the design of the caps on pens to reduce the risk of fatal choking in the case of a cap being inhaled.

Product modification has contributed to preventing childhood injuries. However, often a series of small changes is made in products and it is difficult to attribute a reduction in injuries to any one specific change. There is considerable evidence that the introduction of child-resistant closures has been effective in reducing the number of childhood deaths from poisoning (*151*). An evaluation of an intervention in South Africa involved the distribution of child-resistant containers for the storage of paraffin. This strategy proved an effective means of reducing paraffin ingestion and provided evidence that families will use such free devices when they are provided (*152*).

Modification of basic cooking and heating products may also offer considerable possibilities. About half the world's population still relies on solid fuels – including wood, animal dung, crop residues and coal for every day energy needs – and a high proportion of households burn the fuel in open fires (*153*). In rural Guatemala, an improved wood-burning stove, the *plancha* (an enclosed combustion chamber and cooking surface out of reach of young children), has been introduced. The stove has the potential to reduce not only acute lower respiratory tract infections in children, but also burns and scalds. Preliminary results have been promising for young children (*153*). Reducing the number of open fires would have a beneficial impact in places such as sub-Saharan Africa, where 80% to 90% of rural homes use open fires.

> *"Adapting the environment to the characteristics of children and integrating safety into the design of products are among the most successful child injury prevention strategies"* Wim Rogmans, Director, Consumer Safety Institute.

Environmental modification

Modifying the environment to make it more user-friendly has become an important approach in injury prevention, benefiting people of all ages, not just children, in the passive protection that it affords. Area-wide engineering solutions can lower the rate of injuries in pedestrians, cyclists and car occupants. One review examined whether traffic-calming schemes reduced rates of crash-related deaths and injuries, for all age groups (*154*). It concluded that traffic calming in towns did indeed have the potential to reduce the rate of injuries. As regards modification of the home environment, there is at present insufficient evidence from trials to show that such changes reduce the number of injuries (*155*).

In high-income countries, there has been considerable progress in making the transport infrastructure safer, including around schools and kindergartens. But in low-income countries, such expensive options may not be possible. In most low-income countries, pedestrians, cyclists, cars, animals and buses share the same road space. The conflicting requirements of non-motorized vehicles need to be addressed using various models of

traffic safety, including the separation of different types of road user (*156*).

Supportive home visits

Home visiting by paediatric nurses to families at high risk of injury has been used for a wide range of purposes. These include: to improve the home environment, to prevent problems of child behaviour or supply and explain safety equipment. A review of the effects of home visits in early childhood has shown substantial positive effects for the prevention of child maltreatment (*157*). The greatest impacts were for programmes using professional visitors and for programmes of a longer duration. Home-visiting programmes have been shown to be associated with an improvement in the quality of the home environment as a means to reduce unintentional injuries (*158*).

Safety devices

The promotion of safety devices can lead to a fall in injuries and increased compliance in using the device. A variety of approaches has been used, including professional counselling, to encourage the use of safety devices, supported by a range of media. Some programmes have included rewards or coercion, such as fines, to encourage compliance. The positive effects from such programmes diminish one or two months after the intervention and more intensive programmes produce more positive results (*159*).

- Wearing a bicycle helmet dramatically reduces the risk of severe and fatal head injuries and facial injuries for bicyclists involved in a crash involving a motor vehicle (*148*). Community-based projects that provided free helmets along with an educational component led to an increase in the observed wearing of helmets (*160*). A study in Canada has shown that, despite less wearing of helmets in low-income areas, population-based bicycle helmet campaigns can still have an impact in these areas in cutting the risk of injury (*161*). The WHO helmet manual (*162*) provides a number of examples of good practice, such as the *Helmets for Kids* safety campaign in Viet Nam.
- Motorcyclists are also at high risk in traffic crashes, particularly for head injury. A review of studies concluded that helmets reduce the risk of head injury by around 69% and death by around 42% (*163*).
- Fires detected with smoke alarms are associated with lower death rates. However, one review found that programmes to promote smoke alarms only, without legislation, function modestly, if at all, and have not yet demonstrated a reduction in fires or fire-related injuries (*142*).

Education, skills and behaviour change

The value of educational programmes as a form of injury prevention has been subject to debate in the field of child injury. Clearly, education underpins many other strategies – such as legislation, the promotion of safety devices and home visiting. Education on pedestrian safety can result in an improvement in children's knowledge and can change observed behaviour of crossing roads. Whether, though, this reduces the risk of injury or of a pedestrian suffering a collision with a motor vehicle is unknown (*164*). The focus of education should extend beyond the immediate caregivers of children, to include health professionals, policy-makers, the media and the business community (*120, 165*). Novel ways of introducing safety messages into television programmes should be explored. These might include a person testing the water temperature before bathing a child, portrayals of swimming pools surrounded by fencing, and characters in dramas putting on their seat-belts in a car (*166*).

The PRECEDE-PROCEED model (a planning model for health education and health promotion programmes) provides a comprehensive structure to assess people's health and quality-of-life needs. It also helps in the design, implementation and evaluation of health promotion programmes and other public health programmes to meet those needs (*167*). These principles have been further elaborated in a guideline on generic behaviour change. This guideline recommends collaboration between individuals, communities and organizations to plan interventions and programmes (*168*).

Community-based studies

Injury prevention, with its broad range of injury types and possible countermeasures, lends itself to community-based approaches. It is important to have long-term strategies, effective and focused leadership, collaboration between a range of agencies, appropriate targeting and sufficient time to develop local networks and programmes (*169*). The use of multiple interventions, repeated in different forms and contexts, can lead to a culture of safety being developed within a community.

There is some evidence that the WHO Safe Communities model is effective in reducing injuries in whole populations (*170*). However, the countries that have evaluated their Safe Communities with a sufficiently rigorous study design are among the wealthier countries and have lower injury rates than most other countries. No evaluations are available yet from other parts of the world.

Universal and targeted interventions

There have been a considerable number of systematic reviews of child injury prevention. However, "the evidence on its own does not provide a complete recipe for success, or an imperative for action" (*171*). The findings of research need to be translated into practice, so that they are tailored to local contexts and circumstances (*172*). Proven interventions in developed countries may not be readily transferable across all social groups or to other

contexts within developed countries. They may also not be transferable to developing countries. Caution is needed here, because of the very different environments in some low-income countries (*173*). In these places, childhood drowning, for instance, does not generally take place in swimming pools and bathtubs as in developed countries, but in natural bodies of water such as ponds, lakes and rivers, as well as cisterns, wells, irrigation ditches and paddy fields.

Closing the childhood injury gap

As stated previously, within all countries, the burden of child injury falls most heavily on those from the most disadvantaged groups. The gap in injury rates between the most affluent and the most disadvantaged provides "some measure of preventability and shows that there is considerable scope for improvement and intervention and a yardstick of what is achievable" (*74*).

There is a range of interventions known to be effective in preventing and reducing injuries (see Chapter 7). What is less well known, though, is how such approaches can be applied to close the socioeconomic gap with regard to childhood injuries. It is partly in response to this problem, where active strategies have not yet been successful, that passive solutions – that is, design solutions – may be most successful. In the broader field of health promotion, four broad approaches to tackling socioeconomic inequalities in health have been suggested (*174*):

- strengthening individuals;
- strengthening communities;
- improving access to services;
- encouraging macroeconomic and cultural change.

Approaches for strengthening individuals can include targeting children and their carers.

- Prevention initiatives for parents on drowning can be integrated into existing child survival and development programmes – particularly for the period, from nine months of age onwards, when children are entering into the 'window' of drowning risk (*61*).
- A study conducted in a deprived community of Scotland, a high-income country, that reviewed a training programme in practical road-safety skills, found improved skills in 5–7-year-old children in crossing the road (*175*).

Strengthening communities is an approach adopted by many organizations working on safety issues, and is the leading strategy employed in the Safe Communities network.

- The Waitakere Community Injury Prevention Project in New Zealand included a range of programmes targeting different indigenous and ethnic groups (*176*). For one of these programmes, the coordinator employed was a Maori, with experience of the culture and perspectives of the target group, and injury prevention was incorporated into a holistic view of health.
- The Safe Block project, based in a poor African-American inner-city community in Philadelphia, PA, USA, used a network of community volunteers. The project involved making simple modifications to homes to prevent injuries, inspecting homes and providing information on home hazards, and educating people – with the use of cascade training – on specific injury prevention practices (*177*).
- A partnership with residents from townships in South Africa worked effectively to lobby the local government to provide a pedestrian bridge over a highway (*102*).

There are various ways in which *improving access to services* can help prevent child injuries.

- New roads can contribute to improving access to a range of community services, including to health care, education and leisure facilities.
- Electrification can reduce exposure to more hazardous fuels such as kerosene.
- Removing dangerous debris and improving waste collection can directly reduce injuries to children.
- Providing sanitation can help children avoid having to walk in darkness to toilet facilities.

Encouraging macroeconomic and cultural change includes:

- broad land-use policies, such as locating schools away from busy roads;
- transport policies that take into full account the needs of pedestrians;
- the promotion of walking as a healthy activity;
- the design of communities, to include safe outdoor play facilities.

Financial problems and poor living conditions have been found to preoccupy adults, with the result that they spend less time supervising children (*24, 76*). Policies targeting poverty reduction could reduce childhood injuries in the long term, but need to be accompanied by more short-term and medium-term measures.

Most researchers believe that packages of policies and intervention, rather than single policies and interventions, are needed to substantially reduce socioeconomic inequalities in health.

Transfer of knowledge

One study in low-income countries looked at successful interventions to prevent transport and home injuries (*25*). It also evaluated injury interventions developed in industrialized countries that might be usable in low-income countries. The conclusion was that several interventions could be imported by low-income countries and should be considered, including:

- vehicle seat-belts, bicycle helmets and motorcycle helmets;

– speed limits;
– pedestrian crossing signs;
– adequate road lighting;
– the separation of pedestrians from vehicles;
– measures to enhance conspicuity, such as the use of reflective products;
– simple safety equipment;
– packaging of items to prevent poisoning.

The importance of transferring knowledge in a sensitive and context-specific manner has been repeatedly stressed. The Commission for Global Road Safety (*44*), for instance, has stated: "Public acceptance and support, based on information and knowledge and evidence of effectiveness, will be achieved only if road safety messages are seen to be appropriate and targeted at local needs".

Interventions that appear most effective are those encompassing a variety of strategies, including legislation, environmental modification and education (*178, 179*). There is a general need for more interventions to be evaluated and for research experiences to be shared worldwide. Many of the principles of injury prevention can be transferred, but interventions need to be tailored to the social and physical environments of those localities. Interventions should reach across different sectors, build on existing networks and involve communities.

Cost and cost-effectiveness

The costs of injuries are enormous. In developing countries, road traffic injuries alone account for 1%–2% of gross domestic product (about US$ 100 billion) each year, or twice the total development aid received worldwide by developing countries (*180*). There are no global data on the cost of unintentional child injuries, but a recent evaluation in the United States has shown that the medical costs and losses in productivity as a result of all injuries to 0–14-year-olds are in the range of US$ 50 billion (*181*). There is thus a great need for cost-effective and well-targeted responses.

Costs of safety

Not much research has been carried out on the availability, price and affordability of child-safety or family-safety devices, and this is especially the case in low-income and middle-income countries. Data from 18 economically diverse countries have been compared for four effective devices: child safety seats, booster seats, child bicycle helmets and smoke alarms (*182*). The prices of these devices varied widely and in many countries they were very expensive. A factory worker in a low-income country had to work 11 times as long as a counterpart in a high-income country to buy a bicycle helmet, while for a child safety seat 16 times as many hours' work were required. Low-income countries manufacturing devices for export did not generally use spare plant capacity to produce devices for local consumption.

Cost-effectiveness of interventions

There are very few analyses in low-income and middle-income countries of the cost-effectiveness of injury prevention measures (*183*). There is also scarce data on injury epidemiology and the efficacy of interventions in these countries. One study attempted to model the costs and effectiveness of five interventions for which there were data on effectiveness in a low-income or middle-income country (*184*). Four out of the five interventions related to the road environment: vehicle speed control, treatment of dangerous junctions, bicycle helmet legislation and motorcycle helmet legislation. The fifth was on the home environment, and involved child-resistant containers to reduce poisoning from paraffin.

In the United States, a survey conducted in the late 1990s on the costs of childhood unintentional injuries and the cost-effectiveness of interventions to prevent them showed that approximately 15% of medical spending resulted from an injury (*185*). The same study found that seven child injury safety measures – child safety seats, bicycle helmets, zero tolerance of alcohol for young drivers, provisional licensing, smoke detectors, childproof cigarette lighters and poison control centres – had similar cost-effectiveness ratios to other well-accepted strategies to prevent childhood illness. The implementation of these strategies, though, is not yet widespread (*185*). As can be seen from Table 1.7, many cost-effective strategies for unintentional injury can save not only lives but costs to society as well.

TABLE 1.7
Financial savings from selected injury prevention interventions

Expenditure of US$ 1 each on:	Savings (US$)
Smoke alarms	65
Child restraints	29
Bicycle helmets	29
Prevention counselling by paediatricians	10
Poison control services	7
Road safety improvements	3

Source: reference *186*.

Cost and cost-effectiveness analysis of interventions to reduce or mitigate child injuries is urgently called for. Such evidence can have a strong impact on policy-makers and persuade them to invest in the appropriate primary prevention interventions.

Overcoming the obstacles

Although considerable progress has been made during recent decades to reduce the rates of child death and injury in developed countries, more needs to be done. In

developing countries such efforts are just beginning. This section examines some of the fallacies, limitations and other obstacles that efforts to prevent child injury face.

"Injuries are due to fate"

If injury is considered to be the result of random, uncontrolled factors and that chance and bad luck or fate are the main factors, then there is little that can be done to prevent injury.

However, injuries *are* preventable. The public health approach to injury prevention involves data collection, risk factor analysis, intervention, evaluation and the widespread implementation of proven prevention methods. Scientific research and evidence underpin this approach.

The wide range of injury types

The nature of injury presents problems. Injuries fall into a wide range of categories that occur in many different environments. They can therefore be the responsibility of a number of separate agencies or government departments, each of which may favour a different approach.

Injuries need to be viewed collectively as a single "disease", with broadly similar approaches being used to prevent them. Collaboration between a range of agencies is necessary, with some form of principal agency to coordinate activities.

Limitations of data

Data on the scope and patterns of injury are essential for identifying priority issues, understanding the causes of injury and identifying groups at high risk of injury. With limited data it is difficult to convince policy-makers and others that there is an injury problem. It is also impossible to decide how to prioritize and develop effective programmes.

It is estimated that, of the 193 WHO Member States, only 109 currently provide usable vital registration data to WHO in coded form, using the International Classification of Disease taxonomy. Unfortunately, the quality of the data tends to be weakest where the problems are greatest. In developing countries, data coverage is particularly poor in relation to child drowning, burns, poisoning, road traffic injuries and bites and stings. Data on the evaluation of interventions and the cost of injuries are also largely absent or – at best – are weak in these places. High-quality data relating to hospital usage are similarly skewed. They are available in some high-income countries, but rare in countries with the highest injury rates.

The general lack of data on health care, in particular on high-cost hospital admissions and trauma care, results in the burden of injury being underestimated in many countries. It also prevents a proper analysis being made of the groups receiving such expensive and scarce health care and of the nature of their injuries. A high proportion of trauma deaths occur outside hospital in developing countries, so that many deaths – and other injuries – are not counted in data collection systems in these countries.

An important goal in injury prevention is thus to establish reliable estimates of the level and pattern of child injury and death, especially in low-income and middle-income countries. To this end, the volume, quality and availability of national and regional data needs to be increased. This should be done through a combination of better data collection systems, improved hospital surveillance, more community-based surveys and other appropriate research.

Lack of political commitment and understanding

The significance of child injury in absolute and relative terms is not always widely appreciated and the possibilities of prevention are often underestimated. This lack of understanding inhibits the allocation of resources to prevention efforts and also the political and organizational will that are necessary for change.

Injury must become an issue for concern and debate at all levels, not just at the global level, but at national and local levels as well. One example of high-level political commitment that led to immediate and observable reductions in injury was in France, where in 2002 the president declared road safety a national priority. This led to the formation of an interministerial committee and a national action plan (*131*). Between 2002 and 2004, a 34% reduction in road traffic deaths was reported, as a result of the coordinated implementation of a range of preventive measures, including: speed reduction, traffic calming, control of drinking and driving, and increased seat-belt use (*187*).

Effective and inexpensive interventions must be developed (*188*). The aim should be to develop measures that give as much return on money invested as immunizing children against measles, polio or tetanus.

Limited capacity

All countries face limitations in their capacity to prevent injury, to provide emergency and continuing care following an injury, and to provide appropriate rehabilitation services. This is particularly the case in countries where the burden of child injury is greatest. The training of more injury prevention practitioners and researchers across the world is urgently needed, and particularly in low-income and middle-income countries. For low-income countries, incentives may be necessary to encourage professionals to remain in their country of origin and not emigrate to high-income countries.

The content of training courses also needs to be carefully planned. Such syllabuses generally include principles and concepts that further knowledge and understanding. Competencies, though, also need to be taught, including skills in group work, community development, collaboration across sectors and lobbying.

Difficulties of implementation

As already stated, the main aim in child injury prevention is the adaptation of proven prevention measures to local circumstances. In areas of the world where substantial progress has already been made, efforts are required to apply effective interventions more widely. A recent analysis conducted in the United States showed that child injury deaths could be reduced by one third if practices that had proved effective in certain states were adopted in other similar states (*189*).

Lack of funding

Funding levels need to reflect the importance of injury as a major cause of death and ill-health in children. "Those who control the purse strings must be persuaded that most injuries are truly preventable and that the cost of failing to do so greatly outweighs the relatively small costs of prevention" (*190*).

Conclusion

Despite the many and complex obstacles, injury prevention nevertheless offers opportunities. The public health significance of road traffic injury and of violence has increasingly been recognized in recent years. There has been much experience and understanding developed on all aspects of injury prevention. These developments can create a strong basis to bring about significant and sustainable reductions in child mortality and ill-health throughout the world.

All countries need to urgently investigate the full extent of the problem of child injuries. Their results should be used in developing an action plan, coordinating the activities of different sectors – including nongovernmental organizations, academic institutions and industry. Measures that are known to work should be implemented everywhere, with adaptations where necessary to suit local circumstances.

Resources devoted to child injury prevention must be appropriate for the size of the problem. More investment is needed for such activities as data collection, community-based injury surveys, capacity building, programmes aimed at local communities, and evaluations of the costs of injuries and of the cost-effectiveness of prevention measures.

Child survival initiatives have been highly successful. At the beginning of the "child survival revolution", more than 75% of the world's children lived in countries where child mortality was high – while now, only 30 years later, less than 20% of children do so. Further improvements in child health, though, will require broad programmes for injury reduction and control for children up to the age of 18 years.

Now is the right time to address this avoidable harm to children and to society. While there is much research that still needs to be carried out, there is already considerable information available. This information is quite sufficient to make a substantial impact in bringing down the incidence of child injury death and morbidity.

Every child lost to injury or severely disabled will cost the future economy of that country. Putting into practice what is known about reducing child injury will help meet the Millennium Development Goals. It will reduce costs in the health care system, improve the capacity to make further reductions in injury rates, and will most importantly protect children.

Chapters 2 to 6 of this report will discuss the five leading causes of unintentional injury. These will focus on the magnitude of the problem, the risk and protective factors for each type of injury, as well as interventions and recommendations for primary, secondary and tertiary prevention.

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DEANA'S STORY

Deana is my daughter. She was 17 years old when her life was cut short. Deana was with four friends going to a birthday party. They had just got out of a taxi and were trying to cross the Nile Corniche in Maadi. The traffic is heavy, chaotic. There are no traffic lights, no crosswalks, just a constant stream of speeding, weaving cars, trucks and buses. You have to dart across several lanes of traffic to get to the other side. Deana was hit and killed by a speeding bus as she tried to cross the road. The bus driver didn't even slow down.

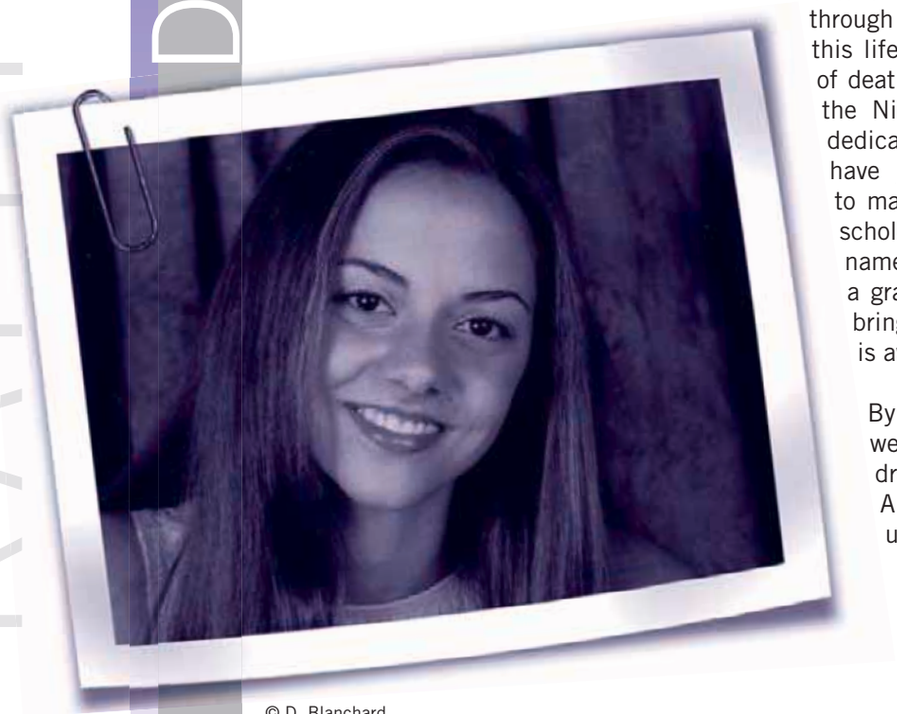
I was in Damascus at the time, travelling for my work. My brother-in-law called me to tell me the terrible news that my baby girl had been hit. You can imagine my guilt. I should have been in Cairo. I could have driven her to the party.

Deana loved so many things, she loved life. She had an infectious smile. She always had time for other people more than for herself. She wanted to be a paediatric dentist – she loved kids. She had a special love of angels. She always had pictures or figurines of angels in her room. For us, she has become the "Angel of the Nile".

Everyone was deeply affected by Deana's death, her family her friends, the entire community. I think of ripples of pain, an ever-widening circle of those who were affected. My wife, son and I had to leave Cairo after Deana's death. It was too painful, too many memories. We came back to Cairo just a few months ago.

I guess that early on I made a decision. I could roll up into a ball in a foetal position and never wake up. It would be very easy to do this and give up. But I felt that I had tried to make sense out of the senseless, the unbelievable. I decided to do something tangible, something that would save other people's lives.

An NGO, the Safe Road Society, started because our daughter lost her life. It is dedicated to making the roads in Egypt safer for its citizens. Our first project is the building of a pedestrian tunnel under the Maadi Corniche El Nile. Governmental permits have been obtained and request for construction bids sent. Our next step is to ensure sufficient funds are raised through voluntary donations to complete this life saving project. This busy road of death runs alongside the serenity of the Nile River. Many concerned and dedicated Egyptians and foreigners have joined together with the goal to make the tunnel a reality. Also, a scholarship was started in Deana's name at her school and every year a graduating senior who smiles and brings light to another student's day is awarded a helping hand.



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By building a pedestrian tunnel we hope to save lives and, in my dreams, to see my Deana, my Angel of the Nile, looking down upon us and smiling in approval.

Chapter 2
Road traffic injuries

Introduction

In many places the road network is constructed without considering children. Children, though, use the roads as pedestrians, bicyclists, motorcyclists and occupants of vehicles. They may live close to a road, play on a road, or even work on the roads. All these interactions with roads, together with a range of other risk factors associated with childhood, increase the susceptibility of children to road traffic injury.

This chapter examines the extent and characteristics of road traffic injuries for different types of road users among children aged 0–17 years, as well as their risk factors. Proven and promising interventions, for the different types of road user, are discussed, along with their effectiveness and cost-effectiveness. The chapter concludes with some recommendations for preventing the growing toll of road traffic injury.

For the purpose of this report, a road traffic crash is defined as "a collision or incident that may or may not lead to injury, occurring on a public road and involving at least one moving vehicle". Road traffic injuries are defined as "fatal or non-fatal injuries incurred as a result of a road traffic crash" (*1*). Although other definitions exist, a road traffic fatality is considered to be a death occurring within 30 days of a road traffic crash (*2*).

This chapter focuses on children aged 0–17 years. Comprehensive data, however, are not always available across the whole age range. In particular, information is often limited for children aged between 15 and 17 years. There are also problems of under-reporting of road traffic deaths and injuries, particularly in low-income and middle-income countries, limitations that need to be taken into account when interpreting the data.

The road is a dangerous place for children and young people. However, road traffic injuries do not have to be the price children and their families pay for the increasing mobility and independence of children as they grow up. There are proven and effective measures that can be put into place to reduce their risks to a minimum.

Epidemiology of road traffic injuries

According to the WHO Global Burden of Disease project, in 2004 nearly 1.3 million people of all ages were killed in road traffic crashes around the world and up to 50 million more were injured or disabled. The South-East Asia and the Western Pacific Regions of WHO together accounted for two thirds of all road traffic deaths. However, the highest rates of road traffic death were in the African and Eastern Mediterranean Regions. Globally, 21% of road traffic deaths were among children.

There have been downward trends in the numbers of road traffic deaths and injuries over the last couple of decades in several developed countries. Globally, though, the outlook is disturbing. By the year 2030, road traffic injuries are predicted to be the fifth leading cause of death worldwide (*3*) and the seventh leading cause of disability-adjusted life years lost (*4*). The South-East Asia, African and Western Pacific regions are expected to see the most significant increases in road traffic injuries. Of particular concern is the fact that in India and China – each with more than a sixth of the world's population – the number of road traffic deaths is predicted to increase, by 2020, by approximately 147% and 97%, respectively (*5*).

Mortality

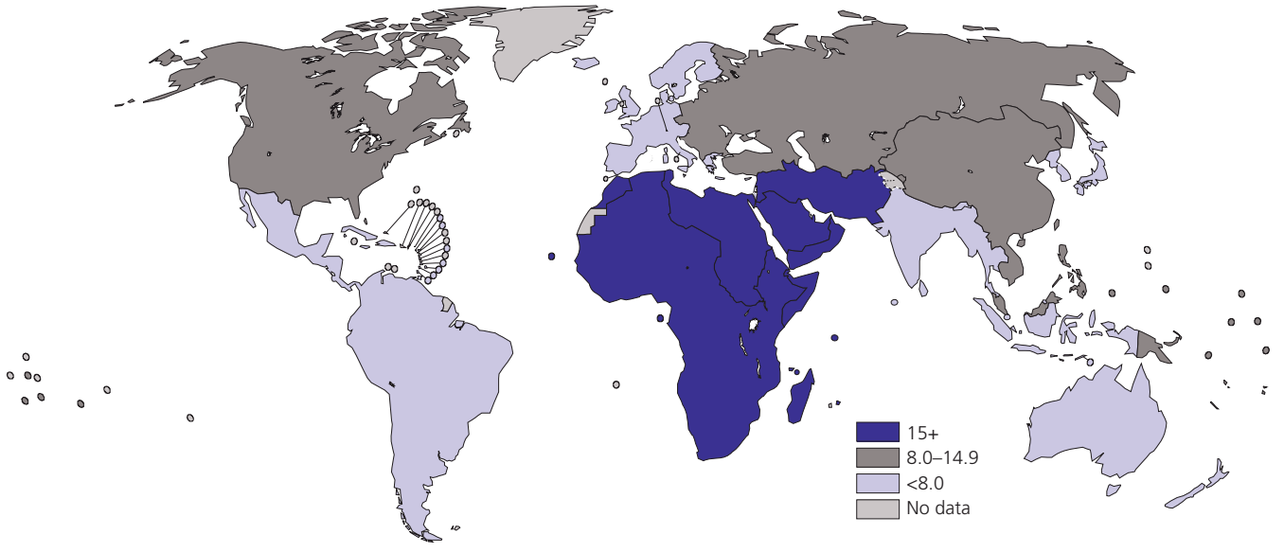
In 2004, road traffic injuries accounted for approximately 262 000 child deaths among children and youth aged 0–19 years – almost 30% of all injury deaths among children (see Statistical Annex, Table A.1). Road traffic injuries are the leading cause of death among young people aged 15 to 19 years (see Table 1.1). Globally, these deaths on the roads account for nearly 2% of all deaths among children. There are significant geographic variations, however. In the South-East Asia Region, the proportion of childhood deaths due to road traffic injuries is 1.3%, while in the Americas it is as high as 4.7%. Some 93% of child road deaths occur in low-income and middle-income countries (see Statistical Annex, Table A.1). In 2004, the South-East Asia and African Regions and the low-income and middle-income countries of the Western Pacific Region accounted for two thirds of all road traffic deaths among children.

Data shows that globally, the road traffic death rate among children is 10.7 per 100 000 population (see Figure 2.1). In South-East Asia, however, the rate is 7.4 per 100 000 population, while in the African Region it is 19.9 per 100 000 population. Although the mortality rate is not as high in Europe, road traffic injuries still account for around a fifth of all childhood *injury* deaths across the European Union (*6*).

In addition to regional differences, there are also variations according to the type of road user. In 70 countries – mainly middle-income and high-income countries – that provide sufficiently detailed mortality data to WHO, about 33% of all child deaths around the world are pedestrians, while 65% are car occupants or bicycle or motorcycle riders (*7*).

FIGURE 2.1

Road-traffic injury mortality rates per 100 000 children[a] by WHO region and country income level, 2004



Africa	Americas		South-East Asia	Europe		Eastern Mediterranean		Western Pacific	
LMIC	HIC	LMIC	LMIC	HIC	LMIC	HIC	LMIC	HIC	LMIC
19.9	8.7	7.7	7.4	5.2	8.3	18.3	17.4	4.2	8.6

[a] These data refer to those under 20 years of age.

HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

Age

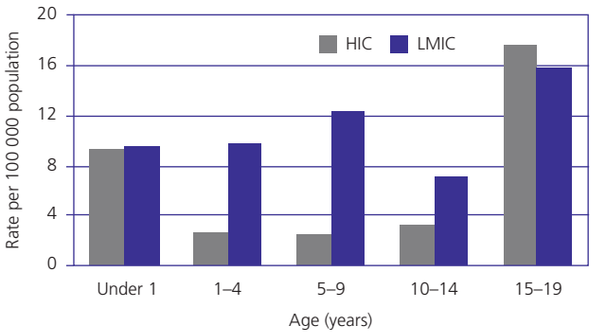
Globally, road traffic injuries are the leading cause of death among 15–19-year-olds and the second leading cause among 5–14-year-olds (see Table 1.1). Global road traffic fatality rates increase with age (see Figure 2.2), reflecting the way children of different ages use the road. Children up to the age of nine years are more likely to be accompanied by parents when they travel, either in vehicles or as pedestrians, while older children tend to travel more independently, initially as pedestrians and later as bicyclists, motorcyclists and finally drivers. The higher rates of injury among children aged 10 years and over is a result of this increased mobility as well as of their increased tendency to exhibit risk-taking behaviours.

For all age groups, except for the 15–19-year age group, road traffic fatality rates are greater in low-income and middle-income countries than they are in high-income countries.

Surveys in five Asian countries showed that road traffic injuries are the second leading cause of child mortality (see Statistical Annex, Table B.1). In Bangladesh, for instance, road traffic injuries were the second most common cause of injury deaths in children aged 1–9 years, whereas in children aged 10–14 years they were the leading cause, accounting for 38% of all child deaths. In those aged 15–17 years, road traffic injuries accounted for 14% of injury deaths (*8*). In Thailand, 40% of injury deaths in 10–14-year-olds were from road traffic injuries (*9*).

FIGURE 2.2

Fatal road-traffic injury rates per 100 000 children by age and country income level, World, 2004



HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

Gender

From a young age, boys are more likely to be involved in road traffic crashes than girls. The difference in incidence rates between boys and girls increases with age until children reach 18 or 19 years of age, when the gender gap

is similar to that seen in adulthood (see Table 2.1). Overall, the death rate for boys is 13.8 per 100 000 population, compared to a rate for girls of 7.5 per 100 000 population. In the high-income countries of the Eastern Mediterranean Region the gender gap is greatest among young children while in the regions of Europe, the Western Pacific and the Americas the gap is more pronounced among older children (see Statistical Annex, Table A.1).

TABLE 2.1

Fatal road-traffic injury rates per 100 000 children by age and sex, World, 2004

	Age ranges (in years)					
	Under 1	1–4	5–9	10–14	15–19	Under 20
Boys	11.5	9.7	13.3	8.7	23.4	13.8
Girls	7.4	8.3	9.3	4.5	7.9	7.5

Source: WHO (2008), Global Burden of Disease: 2004 update.

Morbidity

The number of children injured or disabled each year as a result of road traffic crashes is not precisely known, but has been estimated at around 10 million. This figure is based on data from health-care institutions that suggest that children make up between a fifth and a quarter of those involved in a road traffic crash and admitted to a hospital (*10–12*). However, community-based surveys from Asia suggest that the figure could be much higher. The surveys found that, for every child who died as a result of a traffic injury, 254 presented to a hospital facility with injuries, four of whom where left with permanent disabilities (*13*).

In children under the age of 15 years, road traffic injures rank as the eleventh cause of death and the tenth cause of burden of disease among children (see Statistical Annex, Table A.2). Globally, road traffic injuries among this age group account for 9482 disability-adjusted life years lost – 1.7% of the total disability-adjusted life years lost.

In general, there is a lack of data on morbidity, particularly from low-income and middle-income countries. This is partly because not all children injured in road traffic incidents are taken to hospital and partly as a result of poor data collection systems.

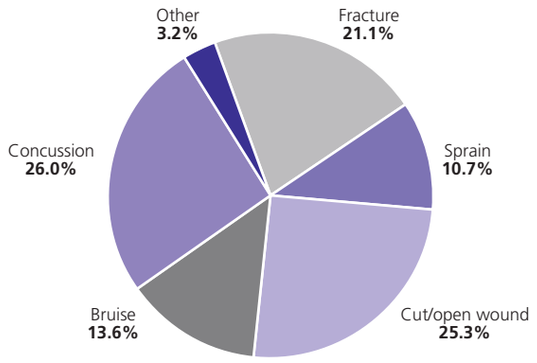
Nature and severity of road traffic injuries

The head and limbs are the most common parts of the body injured in children involved in road traffic crashes. The severity of injuries will vary, depending on the age of the child, the type of road user and whether protective devices were used. A recent school-based survey conducted by WHO looked at 13–15-year-olds in 26 countries. Of those children reporting an injury involving a motor vehicle in the previous 12 months, 10% had sustained a minor head injury and 37% had fractured a limb.

These survey results are supported by a hospital-based study of injured children under the age of 12 years, conducted in four low-income countries. The study found that, among those suffering road traffic injuries, more than a quarter had incurred a concussion or other head injury, followed by various cuts, bruises, open wounds, fractures and sprains (see Statistical Annex, Table C.1 and Figure 2.3).

FIGURE 2.3

Injuries sustained by children[a] presenting to an emergency department as a result of a road traffic crash in four countries[b] in 2007



[a] Children were under 12 years.

[b] The four countries were Bangladesh, Colombia, Egypt and Pakistan.

Source: Statistical Annex, Table C.1.

Chest and abdominal injuries, although not as common as head and limb injuries, can be very serious because of the organs involved and the difficulties in managing such injuries. Multiple trauma has also been reported in approximately 10% to 20% of children involved in road traffic crashes (*14*).

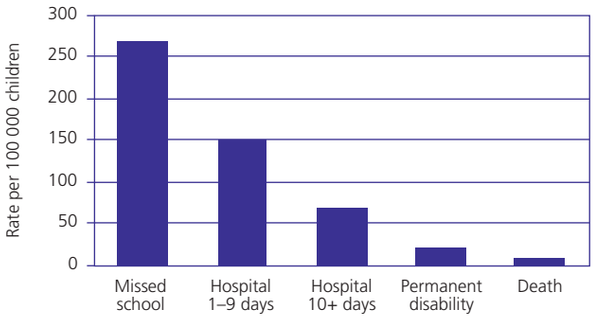
Consequences of road traffic injuries

Road traffic injuries are a leading cause of disability for children. Recent surveys in Asia show that road traffic injuries are one of the five leading causes of disability for children. The exact proportion of children disabled by road traffic injuries varies by age group and across countries (*15*). According to these surveys, the rate of permanent disability among children aged 1 to 17 years injured as a result of a road traffic crash was 20 per 100 000 children. In addition, significant numbers of children required hospitalization or missed school as a result of their injuries (see Figure 2.4).

Studies conducted among both adults and children highlight the fact that many individuals still retain some functional disability 6 to 12 months following a road traffic crash. Clearly, the type of injury sustained affects the period needed for complete recovery. Research in Bangalore, India, for instance, found that 14% of children who sustained a traumatic brain injury from a road traffic

FIGURE 2.4

Severity of road traffic injuries per 100 000 population among children aged 0–17 years, in five Asian countries[a]



[a] Bangladesh, China (Beijing, Jiangxi province), Philippines, Thailand, Viet Nam.

Source: Reference *15*.

crash still required assistance with day-to-day activities six months after the crash (*16*).

The outcome of a road traffic injury is also related to road user type. One study found that 72% of pedestrians, 64% of bicyclists struck by a car, and 59% of child vehicle occupants required assistance six months after a crash (*17*). In Canada, 22% of bicyclists injured without a motor vehicle being involved in the incident required subsequent assistance (*18*).

Disabilities and impairments impede the progress of children in their early years depriving them of education and social development. Children who sustain disabilities following a road traffic crash frequently require long-term care and their quality of life is often poor. The excessive strain placed on families who have to care for their injured children may result in adults having to leave their jobs, leading to conditions of poverty.

Psychosocial impact

A number of mental health conditions have been observed in children following a road traffic crash. These include phobias, post-traumatic stress disorder and anxiety, as well as behavioural problems. These psychosocial disturbances may be exacerbated by family impoverishment following a road traffic crash, particularly if a parent or caregiver was also involved in the collision and was severely injured or died. Injured children can thus experience high levels of psychosocial distress (*19*) and feel isolated in their suffering (*20*).

Several studies have reported high levels of distress in children during and immediately after a road traffic injury (*17, 21, 22*). One study reported that that within five days of a traumatic event, such as a road traffic crash, 98% of the children involved suffered post-traumatic stress disorder, depression or anxiety. One month after injury, 82% still had symptoms. Twelve months after injury, 44% were still having flashbacks, feared being injured again, or suffered mood disorders, body-image changes, sleep disturbances or anxiety (*23*). Another study found that a quarter of children were exhibiting post-traumatic stress disorder three months after the crash (*22*).

Road traffic crashes can also have a profound psychological effort on children not directly involved in the incident themselves but who lose a parent or caregiver (see Box 2.1). Results from Asia show that among orphans, 20% to 66% have lost a father, mother or both in road traffic crashes (*15*). The loss of a parent or parents can leave a child with long-term psychosocial problems as well as economic impoverishment.

Types of road user

Children suffer injuries while in a variety of roles related to different types of transport. They may be pedestrians, bicyclists, car occupants, motorcycle riders or motorcycle passengers, or passengers on public transport. In some countries, children work on the streets, usually selling merchandise, where they weave in and out of moving traffic.

BOX 2.1

Children orphaned through road traffic deaths

The Bangladesh Health and Injury Survey, a population-based survey of 171 366 households, was conducted in 2003. A verbal autopsy module was used, adapted from the WHO standards for verbal autopsy *(24)*, with specific questions on each type of injury. Data were analysed for the causes of death of parents of children aged 0 to 17 years.

Injury was a leading cause of death of parents of children under the age of 18 years. Some 4 300 mothers die from injuries in Bangladesh each year, leaving about 17 700 children without their primary caregiver. As shown in the table below, the leading cause of injury death for mothers is suicide (41%), followed by road traffic crashes (29%), burns (12%) and violence (10%).

CAUSES OF INJURY-RELATED DEATHS AMONG PARENTS OF CHILDREN AGED 0–17 YEARS

	Causes of all injury deaths (%)					
	Suicide	Road traffic injuries	Burns	Violence	Falls	Other
Mothers	41	29	12	10	3	5
Fathers	12	36	0	27	5	13

Source: Reference 8.

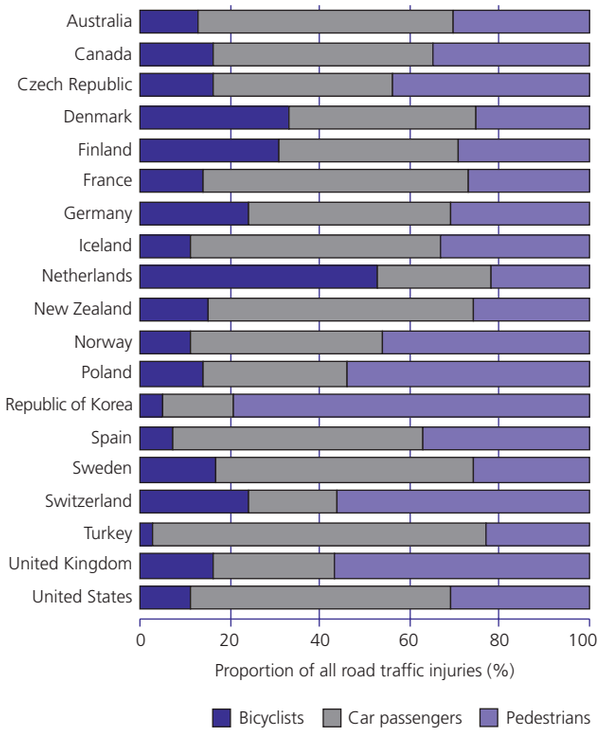
Around 7 900 fathers die from injury annually, leaving nearly 22 100 children in households that have lost their primary wage earner. The most common causes of injury death in fathers are road traffic crashes (36%), followed by violence (27%) and suicide (12%).

Children deprived of one or both parents are vulnerable to malnutrition, illness, impaired development, psychosocial trauma, exploitation and abuse. In Bangladesh, as in many countries, fatal injuries of parents are a significant cause of orphaning. This damages the children left behind and is a huge burden on society. As well as preventing injuries among children, societies need to take greater steps to reduce the incidence of injuries, both unintentional and intentional, among adults.

The patterns of road use among children vary by country, affecting the type of injuries they sustain (see Figure 2.5).

FIGURE 2.5

Proportion of fatal road traffic deaths among children[a] by type of road user in selected OECD countries



[a] These data refer to children under the age of 15 years.

OECD = Organisation for Economic Co-operation and Development.

Source: Reference *25*, reproduced with permission.

Pedestrians

Globally, pedestrians form the single largest category of children involved in road traffic crashes. In high-income countries between 5% and 10% of children suffering road traffic injuries are pedestrians, while in low-income and middle-income countries the proportion ranges from 30% to 40% (*26*). Child pedestrian injury is highest in Africa and Asia where it is usual for people to walk along roads (*12, 15*). Despite significant reductions in child pedestrian injury in many high-income countries, the prevention of such injury remains a problem, particularly among 5–14-year-olds.

Occupants

Children injured or killed while travelling in cars as occupants are a serious concern in high-income countries, where such cases can account for up to 50% of childhood traffic deaths (*27*). As motorization increases, child occupant deaths are also an emerging problem in many middle-income countries.

Bicyclists

In many countries, children are taught to ride bicycles as a form of recreation. In many parts of Asia, bicycles are also a common means of transport. This is reflected in the statistics. Bicyclists constitute 3%–15% of children injured in traffic collisions and 2%–8% of child traffic-related fatalities around the world (*26*). In some Asian countries, though, the latter figure can be as high as 33% (*28*). While there has been a decline in bicyclist deaths among children in high-income countries (*27*), bicycle-related injuries are increasing in many low-income and middle-income countries, particularly in South-East Asia and the Western Pacific (*28*).

Motorcyclists

Where motorcycles are commonly family vehicles, children may begin to travel on motorcycles at an early age, either sitting on the petrol tank or behind the driver. In some Asian countries, where motorized two-wheelers are the most common form of transportation and children are legally allowed to drive small-engine motorcycles from their 15th year, motorcycle crashes are the leading cause of mortality and morbidity among teenagers (*15*).

Young drivers

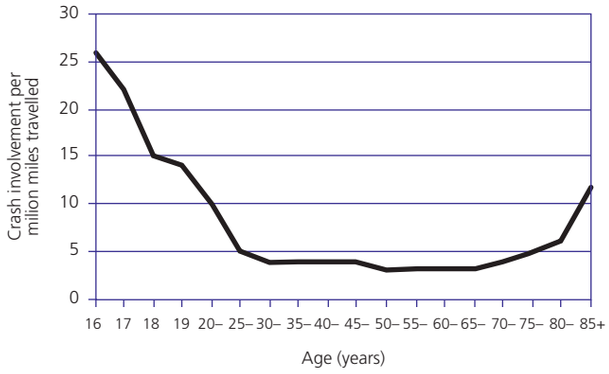
Injuries and fatalities among young drivers are a major problem in high-income countries, where a large study showed that crashes involving young drivers accounted for between 20% and 30% of all road traffic fatalities (*29*). In particular, young drivers are at high risk of a crash in their first year of driving by themselves. Research from Sweden shows that novice drivers are 33 times more likely to have a crash than other drivers (*30*), while in Western Australia, drivers on a provisional licence are 15 times more likely than older drivers to be involved in a crash (*31*). In the United States, the risk of a crash for a driver aged 16 years is five times the average risk for all ages (*32*) (see Figure 2.6). Although mortality rates among young drivers have decreased in most high-income countries in recent decades, the relative proportion of young drivers among all drivers killed remains high, confirming that greater prevention efforts are required among this category of road user.

Heavy vehicles

Only a few studies have specifically examined the risk to children involved in heavy vehicle crashes (*33*). Public transport vehicles for children are primarily buses, heavy vehicles and school transport vehicles. Unsafe buses in low-income and middle-income countries are frequently involved in major crashes involving children. In high-income countries, the greatest risk to school children is while alighting from a bus – rather than from a crash involving a school bus (*34, 35*).

FIGURE 2.6

Driver crash involvement per million miles[a] travelled by driver age, United States, 2001–2002



[a] 1 mile is approximately 1.60934 kilometres.

Source: Reference *32*, reproduced with permission.

Economic impact of road traffic injuries

The global losses due to road traffic injuries are estimated to be US$518 billion per annum (*36*), with the annual cost of road crashes in low-income and middle-income countries estimated at between US$65 billion and US$100 billion. This means that road traffic collisions and their consequences cost governments up to 3% of their gross national product (*1*). Information on the global cost of road traffic injuries exclusively among children is not available.

The direct and indirect costs of road traffic injuries, both for those directly involved and for national economies, are numerous. The direct and indirect costs include:

- permanent disabilities;
- loss of schooling;
- medical care;
- legal costs;
- vehicle repair costs;
- loss of income to parents, resulting from absence from work to care for the child.

In addition, there are long-term economic costs arising from: premature death; rehabilitation; the loss of healthy years in children; and the inability of those with serious disabilities to work to the full extent.

The poor, who are over-represented in road traffic crash statistics, are hardest hit by these costs. Findings from research in Bangladesh and India suggest that there is a further decline into poverty when the poor are injured. This is because additional resources are needed to care for the injured person, achieved by taking on extra work, selling assets or taking out further loans (*37*).

Limitations of data

Many countries do not have injury surveillance systems that provide reliable data on road traffic crashes and injuries. Indicators, particularly on non-fatal outcomes, are scarce and those that are used suffer from a lack of standard definition – particularly as regards what is meant by minor, moderate or severe injuries. There are frequent disparities between data – for example, between police and health-related sources – making comparisons difficult (*1*). These difficulties are made worse by the fact that there is widespread under-reporting of road traffic fatalities and injuries – both in health-related and police data.

In addition to these limitations, there is an additional problem of different age cut-off points when dealing with child-related road traffic injuries and deaths. This makes comparisons particularly difficult.

Solid data are needed to provide a basis for decision-making. Establishing a simple, cost-effective system or improving systems currently in use should be priorities in improving road safety. All the same, a current lack of reliable data should not prevent other necessary measures from being undertaken.

Risk factors

Most of the factors that increase the risk of road traffic injuries for the general population do so similarly for children. Thus children are affected by speeding and drink-driving, by not using safety equipment and by factors related to vehicle safety and the road environment. However, there are also risk factors that are specific to children. The road environment is constructed with consideration for adults. It is not built for use by children, and when children come into contact with it they are placed at greater risk than need have been the case. The set of risk factors that increase a child's susceptibility in road traffic can be considered within the conceptual framework of the Haddon Matrix (see Table 2.2).

Child-related factors

Physical development

A child's head, chest, abdomen and limbs are all in a state of growth. Their relative softness make a child physically more vulnerable to the impact of injury than an adult. Furthermore, the smaller physical stature of children can create problems, as it limits their ability to see or be seen over certain heights such as parked cars or large trucks – a known risk factor in child pedestrian injuries. Children's sensory facilities are also less fully developed. Their ability to synthesize information, from their peripheral fields of vision and their auditory sense, is limited, which can lead to their missing critical cues of danger, thus increasing their risk of road traffic injury (*38*).

Cognitive development

The developmental processes taking place in children have an effect on their ability to make safe decisions in the road environment, and these processes are closely related to age (*39*).

TABLE 2.2

Haddon Matrix applied to the risk factors for road traffic crash injuries among children

	Child factors	Vehicle and safety equipment	Physical environment	Socioeconomic environment
Pre-event	Age; gender; lack of supervision; risk-taking; impulsive behaviour; disobedience; lack of police enforcement.	Lack of roadworthiness of vehicle; poor lighting; poor state of brakes; speeding; overloading.	Poor road design; lack of public transport; no enforcement of speed limits; no safety barriers; lack of alcohol laws; poor infrastructure for pedestrian safety.	Poverty; single-parent family; large family size; poor maternal education; lack of awareness of risks among caregivers, childcare providers and educators.
Event	Size and physical development of child; lack of equipment to protect occupants, or equipment improperly used; underlying conditions in child.	Child restraints and seat-belts not fitted or incorrectly used; bicycle and motorcycle helmets not used; poor design of vehicle for protection in crashes; no rollover protection.	Roadside objects such as trees and poles.	Lack of safety culture in the car and on the road.
Post-event	Child's lack of resilience; child's general condition; lack of access to appropriate health care; post-injury complications.	Difficult access to victim; lack of trained health-care and rescue workers.	Lack of availability of adequate pre-hospital care, acute care and rehabilitation.	Lack of culture of supporting injured people; no first aid given at scene.

Young children aged between five and seven years have mastered the concepts of speed and distance (*40*). However, they exhibit poor skills in recognizing dangerous places to cross the road, relying exclusively on the visible presence of cars in the vicinity. They are also unlikely to assess the presence of oncoming traffic with accuracy. "Blind" sections of the road, obstacles by the road that could obscure a child from a driver's field of vision and complex road junctions are not perceived by young children as threatening situations (*39, 41*). Road traffic crashes involving young children include a large proportion of "dart and dash" cases. In such cases, a child pedestrian is injured through a "critical behavioural error", where it has failed to stop or slow down before attempting to cross the road. This type of behaviour is due to a child's "centration" – the inability of the child to switch attention from one task to another (*42*).

These cognitive processes are more developed in children aged 11 years and older who appear to be able to recognize a given road location as dangerous and show judgement that allows them to be safe on the roads (*43*). Children over the age of 12 years have the capacity to modify their behaviour when faced with a situation involving two tasks.

This is an area of ongoing research and new evidence relating to children's abilities on the road is regularly published. Two issues have recently arisen in this connection, both related to cognitive development.

- There is growing evidence that, although the visual processes needed for a child to cross a road are fully developed as infants, the full integration of visual signals into a meaningful context is not fully developed until children are around 10–12 years old (*44, 45*).
- Cognitive processes taking place in an adolescent's brain could affect their risk of road traffic crash as young drivers. Through the use of brain-imaging techniques, neurobiological research conducted over the past decade has found that parts of the frontal lobe – in particular the prefrontal cortex which governs judgement, decision-making, reasoning and impulse control – appears not to fully mature until the age of 20 or 25 years (*46*). While research linking this new evidence on brain development directly to driving has yet to be undertaken, these findings provide some insight into the biological mechanisms that may put many young drivers at risk.

Risk-taking behaviour

While young children may inadvertently take risks because they lack appropriate skills to do otherwise, older children and adolescents may actively seek out risk. Risk-taking behaviour may allow adolescents to feel a sense of control over their lives or else to oppose authority. Research shows that there are high levels of sensation-seeking behaviour among young adults and that there exists a need to maintain a heightened level of physiological arousal. Young people consequently seek new situations and experiences to maintain this level, irrespective of the risks inherent in the experience. Such sensation-seeking frequently focuses on risky behaviours, including while driving a vehicle or crossing a road. Sensation-seeking has been shown to rise between the ages 9 and 14 years, peaking in late adolescence or in early adulthood, and declining steadily with age (*47*).

Risk-seeking behaviour is a significant predictor of involvement in road traffic injury among child pedestrians as it is for young adolescent drivers aged 16–17 years (*48–50*). Across all ages and particularly among the young, sensation-seeking is more common among boys than among girls. Boys as young as 11 years have a greater

affinity for speed, risk-taking and competitive behaviour, all of which place them at an increased risk of road traffic injury (*51*).

A certain amount of risk-taking is a normal physiological attribute and is necessary for a child's growth and development. Children, though, often do not realize that they need to make a complex set of decisions to avoid harm. It is the responsibility of adults to understand the vulnerability of children in the road environment and their developmental limitations, and to ensure their safety by providing developmentally appropriate behavioural interventions.

Peer influence

As young children become adolescents, they enter a phase where the influence of their parents is reduced, and they begin to discover and assert their independence. This transition can be expressed in their lifestyle, and in an increasing conformity with certain social norms, that in turn influence their behaviour and decision-making. For many young people, peers are of significant importance and can be the primary source of the social norms with which they strive to conform (*29*).

Social norms, including peer pressure and the emphasis placed on rebellion in the culture of young people, can affect the manner in which young people drive a vehicle. Direct peer pressure may be exerted on the driver's behaviour through the influence of a passenger. Research has shown that young drivers experience higher peer pressure than older drivers to commit traffic violations such as speeding, driving under the influence of alcohol and dangerous overtaking (*52*). There is a close link between the presence of similarly aged passengers in the car and increasing risk levels. A number of studies have shown that young drivers, both male and female, drive faster and with a shorter following distance at road junctions if they have young passengers in the car (*51, 53*).

Gender

There is evidence of a strong relationship between gender, road safety behaviour and road traffic injury. Most studies conducted show a strong male bias, with the male-to-female ratio ranging between 3:1 and 5:1. This relationship holds true across different regions of the world and applies to fatal and non-fatal injuries.

A part of the predominance of boys in road traffic injury statistics can be accounted for by differences in exposure. Research on 10–12-year-old boy pedestrians has found that the amount of exposure, together with nature of the road environment, influences injury rates among this group, particularly those from poorer areas (*54*). However, exposure does not account for the entire difference. Among young drivers, men have more fatal crashes per kilometre driven than do young women, even taking into consideration their increased exposure levels. Factors thought to contribute towards this difference include increased risk-taking and sensation-seeking.

Type of road user

There is no specific age at which children can be said to be safe road users. Children understand and react to complex traffic situations in different ways from adults. Younger children have different information-processing and psychomotor abilities compared to older children. Adolescents are characterized by impulsiveness, curiosity and experimentation. Developmentally, children develop at different rates and the differences between individuals can be large.

Pedestrians

In many parts of the world the majority of children injured or killed on the roads are pedestrians, particularly in low-income and middle income countries. The physical and cognitive developmental factors already discussed increase the risk of a road traffic crash among child pedestrians, especially among younger children, where physical stature and cognitive limitations restrict their ability to make safe decisions. In many low-income and middle-income countries children use roads for playing and for conducting small roadside businesses, both of which increase their exposure significantly. Risk-taking behaviour and peer pressure may increase risk among adolescents who are pedestrians.

Occupants

For young children who are occupants of vehicles the main risk factor is the lack or improper use of a restraint. Children should be strapped in appropriate restraints based on their age, weight or height (Box 2.2). The rate of use of appropriate child restraints in motor vehicles varies considerably across countries – from nearly 90% in the United States (*55*) to almost zero in Oman (*56*). While many parents use car seats for infants, the use of appropriate seat restraints decreases markedly after a child has outgrown the infant device.

Adolescents and young adults have the lowest wearing rates for seat-belts around the world. In a survey of youth risk behaviour, only a third of 14–17-year-olds reported that they always wore a seat-belt as a passenger in a vehicle. More than a third noted that they had been a passenger with a driver who had been drinking alcohol (*60*). In addition, having passengers of around the same age increases the likelihood of a novice driver, aged 16–18 years, incurring a crash (*61*).

Bicyclists

The major risk to bicyclists relates to exposure (*62*). In most high-income countries, children ride bicycles for pleasure and so make up a small proportion of road traffic deaths, though many minor bicycle collisions

BOX 2.2

How child restraints prevent injuries to child passengers

In the first half of the 20th century, traffic safety efforts concentrated on preventing crashes by changing the behaviour of drivers. In the 1950s, concepts already prevalent in aviation safety, including safety-belts, started to be applied to motor vehicles. Properly fitted seat-belts were found to absorb the energy caused by a rapid deceleration in a crash. In addition, a safety-belt reduced the risk of ejection from the vehicle and – if it fitted properly – spread the forces from a crash over hard bones rather than softer internal organs. The first laws came in 1966, when the United States federal government introduced regulations requiring new vehicles to be equipped with seat-belts.

European engineers recognized that biological differences between adults and children would limit the effectiveness of seat-belts for children. In the 1960s, they came up, for the first time, with a design specifically for children. This was a seat with child-sized internal harnesses attached to the vehicle frame by the vehicle's safety-belt. Various designs to accommodate growing children followed quickly. In 1963, the first rear-facing infant seat was developed.

Despite the commercial availability by the late 1960s of both seat-belts and child restraint systems, their safety benefits were not widely publicized and their use remained low. As countries became increasingly motorized, the numbers of deaths from crashes continued to rise. In 1970, the Australian state of Victoria introduced a safety-belt law and by 1977, rates of seat-belt use in the state had increased to 90%. Other countries gradually followed with their own seat-belt laws.

In the United States, in the late 1970s, studies found that infant deaths were over-represented among child passenger fatalities *(57)*. The state of Tennessee, in 1978, was the first to adopt a child restraint law for all children under the age of four years. As a result, child restraint use increased from 8% to 30% and the incidence of deaths among child passengers was halved. By 1985, all of the United States and many other countries had introduced similar child restraint laws. Today, most of these laws have been amended to include requirements for the use of belt-positioning booster seats, that are effective in preventing injuries to children who have outgrown their child safety seats *(58)*.

Ideas about how best to protect child passengers continue to evolve with new scientific findings and new technology. It is important, however, always to follow the current guidelines for the safety of child passengers *(59)*. These guidelines urge that child restraint systems that have been certified as passing national standards should be used and that children should be placed in the rear seat. In rapidly motorizing countries, child deaths and injuries can be avoided through programmes and laws to promote child restraint use, through national standards to deliver the full benefits of the child restraint systems, and through a surveillance system to identify emerging hazards to children.

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are never reported to the police (*63*). However, in many low-income and middle-income countries where cycling principally exists as a mode of transport, the proportion of road traffic deaths is considerably higher. In Beijing, for example, about a third of all traffic deaths are those of cyclists (*28*).

Other risks associated with bicycling include:

- the lack of correctly worn helmets (*64*);
- riding in mixed patterns of traffic (*33*);
- cycling on pavements (*65*);
- the visibility of cyclists (*66*).

The rate of helmet wearing among child cyclists is low in many countries, even in developed countries. A study conducted in South Africa in the late 1990s showed that only 1.4% of children presenting to an emergency department following a bicycle-related injury had worn a helmet at the time of the collision (*67*), although in those provinces where there were laws on helmet wearing, the rates were higher (*68*).

Motorcyclists

As with other types of road users, the greatest risk for children on motorcycles relates to exposure. In many countries children travel as passengers on a motorcycle from a very young age. The rates of helmet wearing among these small children is very low – partly as a result of the lack of appropriately sized helmets, or of their cost.

In many countries adolescents are legally entitled to drive a motorcycle with a restricted engine size from the age of 15 years. This age, though, coincides with a period in the child's development in which risk-taking behaviour is known to occur. Unsurprisingly, in some countries up to a third of all motorcycle deaths are young riders or their passengers (*69*). The use of helmets among motorcyclists and their passengers is low in many countries and is a significant risk factor for head injuries (*70*). In Viet Nam, for instance, helmet wearing rates among adolescent and young adult riders are generally lower than those among older adults (*71*).

Studies have shown that helmet wearing is highly dependent on the presence of a law mandating helmet use (*60*). The absence of universal helmet laws that cover all ages, together with poor enforcement and high prices for standard helmets, may contribute to the low prevalence of motorcycle helmet use in many places.

Young drivers

Adolescent and young drivers are a special risk group. A number of countries have reported increased collisions and deaths among novice drivers, particularly during their first year of driving (*72–75*). For a given distance driven, 16-year-old drivers are more than twice as likely as drivers aged 20–24 years, and four times as likely as drivers aged 25–29 years, to be involved in a fatal passenger vehicle crash (*76*). A number of interrelated factors appear to place young drivers at an elevated risk for road traffic injury.

- Age appears to be independent of the level of driving experience (*29, 75, 77*). Novice drivers aged 16–19 years have more crashes than novice drivers aged 20 years and over with the same amount of driving experience (*77*). However, there is a sharp decrease in crash risk during the first few years of driving, mainly associated with experience rather than age.
- Risky behaviours among young drivers include the following.
  - *Drinking and driving*. Alcohol significantly impairs driving ability among adolescents – typically at lower blood concentration levels than is the case for adults. New evidence suggests that the physiological response of adolescents to alcohol might be different to that of adults (*78*), making adolescents less sensitive to signals that their ability is impaired. Research in New Zealand found that drivers aged under 20 years were five times more likely to have elevated blood alcohol concentration levels compared with drivers aged 30 years and above (*79, 80*). In the United States, 30% of adolescents reported driving with an intoxicated driver in the previous month. One in 10 admitted to drinking and driving themselves (*81*).
  - *Speeding*. Adolescents are more likely to drive at excessive speed than are older adults (*82*). In a survey of 20 000 drivers aged 16 to 24 years, researchers found that the younger drivers were significantly more likely than the older ones to drive at more than 20 km/h above the speed limit (*83*).
  - *Non-use of seat-belts*. Compared with other age groups, adolescents have the lowest rate of seat-belt use. In 2005, 10% of high school students in the United States reported they rarely or never wore seat-belts when in a vehicle with someone else (*81*).
  - *Distraction*. Using a mobile phone, iPod or other electronic device, even if it is operated using hands-free devices, leads to slower information processing and consequently an increased risk of a crash (*84*). The risk is even greater than that caused by the distraction of two or more passengers in the car (*85*).
  - *Fatigue*. Adolescent drivers who lack adequate sleep are at greater risk of crashing. Fatigue can also exacerbate the effects of other risk factors such as alcohol, speed and inexperience (*86–88*).
- Young drivers of both sexes have a higher proportion of road traffic crashes in the evenings and early mornings. Many of these crashes involve only a single vehicle.
- The presence of other adolescents in the vehicle with an adolescent driver is one of the strongest predictors of a crash (*73, 82, 89–91*).
- There is a tendency among young drivers to violate traffic rules (*92*). A study in India found that 20% to 30% of traffic violations occurred among drivers less than 20 years of age, with more than a third of these drivers either unlicenced or having obtained a licence without taking a mandatory test (*93*).

Lack of supervision

Differences in parents' understanding of what activities are safe, given the particular age of the child, may partly explain the variations by age, gender and socioeconomic status in the patterns of road traffic injury among children across the world. The exact role, though, that a parent's perception of risk plays in determining the risk of a child incurring a road traffic injury is not clear. Attitudes to driving and road use appear to be formed at an age as early as 11 years, suggesting that a parent's perception of risk has the potential to influence a child's behaviour on the roads (*51*). However, there has been little research to date attempting to quantify the role that parental perception plays in a child's risk for road traffic injury.

Lack of adult supervision has often been cited as a risk factor among children for road traffic injury. However, it is just one of several interrelated risk factors. There are a number of characteristics associated with parents or caregivers with a limited ability to supervise children. These include being a single parent, being a working parent, and being a parent affected by illness or depression (*94*). Such characteristics are found in families across the world, and are fairly independent of the economic status of a country.

Nonetheless, if there is adult supervision, the probability of a child incurring road traffic injury is significantly reduced. A Malaysian study found that the risk of injury was reduced by 57% among children supervised by their parents (*95*). Another study, in Canada, found that lack of parental supervision increased the risk of injury to child pedestrians and cyclists by a factor of 2.6 (*96*). Research that examined the risk of child pedestrian injury in connection with specific supervision practices showed a strong positive association between pedestrian injury and a lack of supervision both after school and on the journey to school (*97*).

Poverty

The socioeconomic status of a family affects the likelihood of a child or young adult being killed or injured in a road traffic crash, with those children from poorer backgrounds at greater risk. This relationship is true not just between richer and poorer countries, but within countries as well. Data from both Sweden and the United Kingdom, for instance, show that the risks of children and young adults for road traffic injuries are higher if they are from poorer families (*98–100*). In Kenya, the choice of transport used is often related to a family's income – with those from low-income families more likely to be vulnerable road users (*101*). A study in Mexico found that family size was strongly associated with the risk of pedestrian injury among children (*102*).

Vehicle-related factors

Given the small stature of children, poor vehicle design is an important risk factor for child road traffic injury. The standard design of a vehicle can have a major effect on the risk and severity of injuries sustained by a child pedestrian, particularly if the child's head makes contact with the rigid windshield (*103*). Vehicle designers are now examining ways to reduce the severity of pedestrian injuries. In particular, bumpers are being redesigned so as to prevent a pedestrian's head making contact with the front window, by allowing the impact to be absorbed by a softer bonnet (*104*). The adaptations of vehicle design that have successfully reduced the incidence and severity of injuries in collisions between adult pedestrians and vehicles are now being modified to benefit children.

"Back-over" injuries – usually in a driveway or parking lot – result when a car is reversed over a small child. Children aged between 1 and 3 years are at particular risk because of their small size and their inability to alert the driver. Unfortunately, with the increased demand for sports utility vehicles, such injuries are becoming more common (*105, 106*). Many vehicles are now being fitted with reverse backup sensors that could help reduce the incidence of such injuries (*107*).

As regards bicycle-related factors, about three quarters of the crashes in the Netherlands involving passengers – often children – carried on bicycles are associated with feet being trapped in the wheel spokes, and 60% of bicycles have no protective features to prevent this from occurring (*108*). Ergonomic changes in the design of bicycles can thus lead to an improvement in bicycle safety (*108, 109*).

Environmental factors

It is normal for children to carry out activities in the road environment – such as cycling, walking, running, playing and other common group activities. It is also important for their healthy development that children, from an early age, undertake such activities. For this reason, it is important for the road environment to be safe so that these activities can be undertaken without the child's safety being put at risk.

Motorization and urbanization are proceeding rapidly in much of the world today. Increased and more rapid mobility tend to be the goals, while safe mobility – and particularly the safety of children – are rarely taken into account. A number of specific environmental factors increase the risk for children using the road system. These factors include the following:

- sites with a volume of traffic exceeding 15 000 motor vehicles per day;
- poor planning of land use and road networks, including:
  - long, straight through-roads that encourage high vehicle speeds, together with mixed land use made up of residential housing, schools and commercial outlets (*110, 111*);
  - a lack of playgrounds, resulting in children playing in the road;
  - a lack of facilities to separate road users – such as lanes for bicyclists and pavements for child pedestrians (*112, 113*);
  - the existence of street vendor businesses, in which children may work;
- a lack of safe, efficient public transportation systems;
- inappropriate speed, particularly in residential areas where children play or walk to and from school (*97, 113–115*);

Lack of prompt treatment

Good recovery from road traffic injuries depends upon the availability, accessibility and quality of trauma care services. Such services are either not available or else are limited in scope and capacity in many low-income and middle-income countries. The surveys conducted in Asia brought out the fact that numerous children are injured who do not receive medical care. In Beijing, this ratio of those receiving care to those injured was 1:254, while in Thailand it was 1:170 (*15*).

The most critical problems in relation to pre-hospital and emergency care in many low-income and middle-income countries are (*116, 117*):

- a lack of first-aid services and trained personnel;
- unsafe modes of transportation to reach emergency care;
- the long delay between the time of injury and reaching a hospital;
- inappropriate referral services;
- the absence of a triage system.

The availability of good rehabilitation services is also an important requirement for the proper recovery of children following a road traffic injury. Again, such services may be limited in many countries due to the lack of rehabilitation personnel, the necessary infrastructure and the availability of guidelines and protocols for rehabilitation.

Interventions

Much has been written over the past decade about how best to reduce the incidence of road traffic injuries. The *World report on road traffic injury prevention* describes proven interventions and makes six recommendations to prevent road traffic injuries at country level (*1*). Promoting the systems approach, the report's recommendations are equally applicable to the prevention of road traffic crashes involving children. There are a number of interventions, though, that focus specifically on children.

The systems approach is of particular value in child road safety since it moves away from the idea that children should adapt their behaviour to cope with traffic, in favour of an approach that recognizes that children's needs should be addressed in the design and management of the whole road system.

> Success in improving safety for children is most likely to be achieved through a holistic approach combining measures to address the behaviour of all road users, to improve the road environment and to design vehicles that better protect both their occupants and those at risk outside the vehicle *(27)*.

The following sections discuss interventions that target younger road users.

Engineering measures

Creating a safe environment for children requires that space for walking and cycling is given priority and not treated as an afterthought, after space for motorized traffic has been designed. The routes that children are likely to take to reach schools, playgrounds and shops, and how these routes can be integrated into a logical, coherent and safe network for walking and cycling, need to be considered (*118*). Greater attention should be given to how the built environment can safely cater for the healthy pursuits of walking and bicycle riding, while at the same time focusing on sustainable public transport systems.

Reducing speed

The policies of both Vision Zero in Sweden and sustainable safety in the Netherlands promote the design of roads and the setting of speed limits that are appropriate for the function of the road (*119, 120*). Survival rates for pedestrians and cyclists are much higher at collision speeds of below 30 km/h (*1*). This speed should be the norm in residential areas and around schools. Various measures to achieve appropriate speeds should be considered (*26*), including:

- traffic-calming measures that reduce the speed of traffic through infrastructural engineering measures, such as:
  - speed humps;
  - mini-roundabouts;
  - designated pedestrian crossings;
  - pedestrian islands;
- visual changes – such as treating the road surface, and improving the road lighting;
- the redistribution of traffic – by blocking roads, and creating one-way streets near schools.

Where a higher speed limit is allowed there should be provision to keep pedestrians and cyclists separate from traffic by using single-lane roundabouts, footways, pedestrian signal phasing and pedestrian refuge islands, and to improve safety with better street lighting (*121*).

Managing speed is problematic in many low-income and middle-income countries, where the effectiveness of many infrastructural measures proposed for high-income countries has yet to be tested (*122, 123*). Some speed reduction measures have indeed been shown to be affordable and sustainable in urban areas, such as successful introduction of speed humps in Ghana (*124*). The problem is how to protect vulnerable road users, particularly children, on rural roads, many of which lack essential infrastructural requirements.

Safe play areas

Children need access to safe spaces for play and physical exercise. If such spaces are not available, children will be tempted to play on the streets. Play spaces should be secure and well maintained, with features that children find interesting. Designing safe play areas should be incorporated into urban planning and the development of school facilities and residential complexes. In the Dominican Republic, UNICEF is working with local government authorities to develop safe play areas, under the "Child Friendly Cities" programme. Working in consultation with children and adolescents, a team of architects have planned parks where children can play safely (*125*).

Safe routes to school

Much effort has been spent on designing ways of getting to school, particularly for children of primary-school age. The measures include the provision of buses to transport children to school and encouraging children to walk to school, using the concept of "walking buses". In the latter, adult volunteers accompany groups of children, who walk along safe routes wearing conspicuous, possibly fluorescent, vests. Walking buses teach children how to walk safely, as well as teaching the health benefits of walking. They also reduce traffic congestion and pollution, particularly near schools (*126*). Although this measure has been implemented in a number of developed and developing countries, with clear health and social benefits (*127*), its effectiveness in reducing the incidence of child traffic injuries has yet to be calculated.

Some schools in high-income countries have engaged a "school travel coordinator", who advises teachers and parents on the safest routes to school. However,

a randomized control trial conducted in the United Kingdom failed to show that the preparation of school travel plans had an effect on how children travelled to school (*128*).

Many countries have introduced school safety zones, that include car-free areas, speed reduction measures and adult supervision to cross the road safely. In Thailand, for example, the areas around schools have been comprehensively improved and educational programmes introduced on safe routes to school. In Bangalore, India, the focus has been on better public transport, making vehicles park or stop at a given distance from the school, dedicated school buses and pedestrian crossings near selected schools, sometimes overseen by traffic wardens (*129*).

Separation of two-wheelers

Child cyclists need to be separated physically, by barriers or kerbs, or else by the demarcation of white lines, from other road users (*130*). In Denmark and the Netherlands, where there are large numbers of cyclists, bicycles are a feasible means of child transport if safety concerns are properly addressed. A meta-analysis of the effects of cycle lanes found an estimated 4% reduction in the incidence of injuries (*122*).

Exclusive motorcycle lanes, separated from the main carriageway by a raised central reservation, have been shown to reduce the likelihood of crashes. In Malaysia, where there are large numbers of young motorcyclists, reductions in crash rates of 27% have been recorded since motorcycles were separated from the rest of the traffic (*131*).

Vehicle design

Vehicle design and standards contribute to the safety of children both inside and outside the vehicle. Primary safety measures for vehicles – to prevent a crash – such as braking and lighting systems, improve road safety in general but are not specifically designed for children. Some secondary safety measures, though, are child-specific. They may be either active or passive.

- Modern vehicles are designed with energy-absorbing *crumple zones* and *side impact bars* to limit the extent to which the vehicle will intrude into the passenger compartment in the event of a collision, thus reducing potential injuries to children (*1*).
- *Redesigning car fronts* has the potential to reduce injuries to pedestrians, and to children in particular, as they are vulnerable to head injuries on impact (*1*). The New Car Assessment Programmes in Europe, the United States and Australia include ratings for pedestrian protection, but most vehicles still obtain low scores. A new European Directive will, by 2010, require new car models to pass a crash test incorporating protection requirements for pedestrians.
- Motor manufacturers should help protect children in vehicles by providing suitable facilities to fit *child restraints*. Vehicles with these improved designs will result in children being less likely to strike the car's interior in case of an impact (*132*).
- Children are at risk when vehicles are reversing. The development of *better visibility aids*, such as cameras, and use of *audible alarms* and *reversing lights* can all help prevent injuries caused in this way (*107*).
- *Alcohol interlock systems* are beginning to be used in some countries. They require a driver to blow into a device before starting the car. The ignition will not function if alcohol is present. Such devices have led to reductions of between 40% and 95% in the rate of repeat offending under drink-driving laws (*1*). The devices are therefore valuable for adolescents who drink and drive.

Safety equipment

Child restraint systems

Appropriate child restraint systems are designed to take account of the child's developmental stage. Like seat-belts, they work to secure the child to the vehicle in a way that, in the event of a crash, distributes forces over a broad body area, thus reducing the chance of a severe injury occurring. Three types of restraint systems for child passengers are used:

- rear-facing restraints for infants;
- forward-facing child restraints;
- booster cushions or booster seats, for older children.

These systems take into account a child's physical dimensions and proportions.

Child restraint systems are very effective at preventing fatalities, and are the most important "in-vehicle" safety measure for children. In the event of a crash, if restraint systems are properly installed and used, they can:

- reduce deaths among infants by around 70% (*133*);
- reduce deaths among small children, aged 1–4 years, by 54% (*133*);
- reduce the chances of sustaining clinically significant injuries by 59% among children aged 4–7 years who are strapped in booster seats, as compared to the rate of injuries sustained using ordinary vehicle seat-belts (*134*).

Despite the overwhelming evidence of their effectiveness, though, many children are not restrained in age-appropriate child or booster seats.

In many high-income countries the use of child restraints is common, with usage rates as high as 90%. Elsewhere, though, child restraints are still rarely used. Choosing and installing the appropriate child restraint system is important. Even in countries where the use of child restraints is common – such as in Sweden, the

United Kingdom and the United States – restraints are frequently used inappropriately. A child may, for instance, be restrained in a device that is wrong for its age or weight, or the straps or harnesses may be inadequately secured or may be left entirely undone. In all these situations, the child is placed at increased risk of both fatal and non-fatal injuries (*133, 134*).

In many places, the use of child restraints may be limited by access or cost, or else may not be practical because of the many children in the family. In addition, parents need to be aware of what type of seat to choose, where to place it and how to install it. Research in Greece found that 88.4% of parents placed their children unrestrained on the back seat, while 76.1% of those who used a restraint did not do so consistently (*135*).

A number of measures have been shown to increase the use of child restraints.

- Mandatory laws on child restraint use and their enforcement can lead to reductions in the rate of severe or fatal crash injuries.
- Public awareness can be raised through publicity campaigns emphasizing the need for appropriate restraints for children of different ages (*136*). Such campaigns are most effective when backed up by enforcement.
- Appropriate restraints can be subsidized or distributed free to families. Loan schemes have been used in some countries, thus increasing both the accessibility and affordability of appropriate restraint systems (*137, 138*).

A rear-facing child safety seat should never be placed in front of an airbag (*139*). Recent research suggests that children whose restraints are placed in the centre rear seating position incur less injuries than those placed on the outer seats, though this contradicts earlier studies that found that the centre seat was a less safe position (*140, 141*). Although children are best protected when secured in age-appropriate child restraints, where such restraints are not available it is still better to use an adult seat-belt on the child than to leave the child wholly unrestrained on the back seat (*142, 143*).

Seat-belts

For children over the age of 10 years, or above 150 cm in height, normal seat-belts should be used. Like child restraints, they serve to keep the child away from the vehicle structure in the event of a crash, prevent ejection from the vehicle, and distribute the forces of the crash over the strongest parts of the body.

Wearing a seat-belt reduces the risk of being ejected from a vehicle and suffering serious or fatal injury by between 40% and 65% (*144*). However, rates of seat-belt use vary widely between countries, in large part as a result of the differing enforcement of seat-belt laws (*1*). In general, though, seat-belt use among adolescent passengers and drivers is noticeably less than among older occupants (*29*).

As with child restraints, seat-belt use can be improved through:

- introducing and enforcing a law mandating seat-belt use;
- requiring all vehicles to be fitted with appropriate seat-belts;
- conducting public awareness campaigns on seat-belts, targeted at young people.

Such measures can increase awareness about the benefits of wearing seat-belts and help make seat-belt use a social norm among young people.

Bicycle helmets

A child's brain is particularly vulnerable to injury. Approximately two thirds of hospital admissions among cyclists are for head injuries, and three quarters of deaths among injured cyclists are from head injuries (*64*).

Helmets for cyclists afford protection from head injury in both traffic crashes and falls. The strongest evidence for the effectiveness of helmets comes from case-control studies. A systematic review of five such studies found that helmets reduced the risk of head and severe brain injury by between 63% and 88%, among cyclists of all ages (*64*). The use of cycle helmets is particularly important for older children because of their increased exposure to traffic. Helmets should be designed to match the age of the child, and when purchasing helmets parents should ensure that they are the appropriate size and fit the child's head.

A number of measures have been shown to increase the use of cycle helmets among children, including:

- laws on bicycle helmet use and their enforcement;
- the promotion of bicycle helmets among children;
- public awareness campaigns.

Although the question of bicycle helmet use as it relates to adult use has been controversial (*26*), promoting helmet use among children, whose basic motor skills are still developing, is more generally accepted. In the Netherlands, for instance, the road environment has been modified to make it very safe for cycling. Although there is no law on bicycle helmet use, Dutch crash data show that children in the 4–8-year age group are particularly likely to be involved in bicycle crashes and suffer head injuries, and thus helmet use among children is strongly promoted (*145*). While some countries, such as Australia and the United States, have introduced and enforce mandatory bicycle helmet laws for all cyclists, others have laws stipulating an age below which children must wear helmets (*27*). Data from before and after such laws were passed show an increase in helmet use – suggesting that reductions in head injury rates can be achieved through this strategy (*27*).

Motorcycle helmets

In most high-income countries young children are rarely seen on the backs of motorcycles. However, in many places, especially in parts of South-East Asia, children are routinely transported as passengers on motorized two-wheelers. It is therefore important to protect these children by ensuring that they wear appropriate helmets (Box 2.3).

Helmets, as already stated, reduce the risk of serious head and brain injuries by lessening the impact of a force to the head. Wearing a helmet is the single most effective way of preventing head injuries and fatalities resulting from motorcycle crashes (*26*).

Wearing a helmet on a motorcycle (*70*):

– decreases the risk and severity of injuries by about 72%;
– decreases the likelihood of death by up to 39%, with the probability depending on the speed of the motorcycle involved;
– decreases the health-care costs associated with crashes.

A number of factors work against the wearing of helmets among child motorcycle passengers, including the following.

· Passengers on motorcycles may be exempt from mandatory helmet wearing laws or exempt from fines.
· Standard child helmets may not be available.
· The cost of purchasing child helmets may be prohibitive. Studies have shown that in some low-income countries, to afford a motorcycle helmet, factory workers have to work 11 times longer than their counterparts in high-income countries (*146*).
· Risk-taking behaviours among adolescent motorcycle riders may result in their not wearing helmets. In a study in Brazil, those under 18 years were significantly less likely than older people to wear a helmet, particularly if they had been consuming alcohol (*147*).

Conspicuity

Conspicuity is the ability of a road user to be seen by other road users. Vulnerable road users are at increased risk for road traffic injuries if they are not seen in time for the other road users to take evasive action and avoid a collision. Children, whose small stature means that they are less likely to be seen by motorists, are at even greater risk of not being seen.

Improving the visibility of non-motorized road users is one way to reduce the risk of a road traffic crash, as it gives drivers more time to notice and avoid a collision. Interventions to increase conspicuity include the following.

· Retro-reflective clothing or strips on backpacks can increase the visibility of both pedestrians and

BOX 2.3

Getting helmets on children's heads: the experience of Viet Nam

Since 1999, the Asia Injury Prevention Foundation in Hanoi has worked hard to get more people on motorcycles in Viet Nam to wear helmets and by doing so cut the rate of road traffic injuries among children. It has staged public awareness campaigns, lobbied the government, helped develop helmet standards for both adults and children, distributed child helmets along with information on their use, and pushed to increase the production of helmets.

At the end of 2007, the Vietnamese government passed a law making helmet wearing compulsory for drivers and passengers on motorcycles. Following its introduction, rates of helmet use soared to over 90%. At the same time, hospitals began reporting reductions in the number of deaths and brain injuries resulting from motorcycle crashes.

Soon, however, certain problems arose. It was pointed out that although helmets for children under 14 years were required by the new law, there was no provision to fine motorcycle drivers carrying children who were not wearing helmets. Furthermore, some doctors publicly questioned whether helmets might have an adverse effect on the development of a child's skull, suggesting that the weight of a helmet could lead to serious neck injuries among children involved in collisions. As a result, parents were less enthusiastic about putting helmets on their children's heads.

While the proportion of adult motorcyclists using helmets remained at over 90%, helmet use among children under the age of 7 years fell to between 10% and 25% in the large cities. Most parents quoted the risk of serious neck injury when asked why they avoided helmets for their children.

An effort is currently being made to tackle this problem, with measures including:

– public education on the facts regarding children and helmet use, including publishing in newspapers assurances signed by international experts;
– collaboration with the government to remove the loophole in the law, whereby drivers were not penalized if their child passengers were without a helmet;
– further research on standards for child helmets.

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cyclists. Although this intervention aids visibility, its actual effectiveness in reducing injuries still needs to be evaluated (*148*). Some programmes using this technique, though, are beginning to show promise (*149–151*).

- Daytime running lights for motorcyclists have been shown to be effective in reducing fatalities in countries, including Malaysia and Singapore, that have large numbers of motorcycles (*152, 153*).
- The colour of the helmet seems to have an effect on the conspicuity of motorcyclists. A case–control study in New Zealand found that retro-reflective or fluorescent clothing, white helmets and daytime running lights were all effective in reducing crashes (*154*).

Legislation and standards

Setting and rigorously enforcing road safety regulations may prevent up to half of all deaths and serious injuries (*155*). As with all other road safety interventions, most laws which are designed to prevent crash injuries in the general population will also help reduce the incidence of child road traffic injuries. Some laws, though, are specific to children and young people.

Motor vehicle licensing

In most countries the minimum age for obtaining a licence allowing unaccompanied driving is 18 years, though in some places the minimum age is as low as 16 years (*1*). Driver licensing systems exist to regulate the entry of new drivers and to control the conditions under which they learn to drive. These systems involve both a test on theory and a practical driving test, usually conducted in normal traffic during the day. The driving test is intended to ensure that new drivers fulfil certain minimum performance standards and to identify drivers who are unfit to drive (*122*).

Novice drivers are over-represented in crash statistics. As a result, many countries have introduced graduated driver licensing systems that place restrictions on new drivers, typically for the first two years of their driving (see Box 2.4). As well as restricting young drivers, the graduated driver licensing system serves to increase the amount of accompanied driving time an adolescent has – something that has been shown to produce positive results in preventing crashes (*53*).

Motorized two-wheeler licensing

In many countries children over 14 years of age are allowed to drive light mopeds with a maximum speed of 25 km/h, while more powerful mopeds, with a maximum speed of 45 km/h, and motorcycles are only permitted at 16 years. Raising the age limit for all powered two-wheelers from 16 to 18 years has been found to be effective in reducing the number of road traffic casualties (*156, 157*).

Drink-driving laws

Various methods have been adopted to restrict drinking and driving among younger drivers, including the following.

- *Setting lower blood alcohol concentration limits* for younger drivers. The risk of a crash for inexperienced young adult drivers starts to rise at significantly lower blood alcohol concentration levels than is the case for older drivers. For this reason, many countries have set a lower blood alcohol concentration limit – usually between zero and 0.02 g/dl – for drivers under the age of 21 years. These lower limits may cut the incidence of crashes among young or novice drivers by between 4% and 24% (*158*).
- *Enforcing blood alcohol limits*. Consistent enforcement of blood alcohol concentration limits is essential for the law to be effective. There are two basic ways in which this can be done.
  - Sobriety checks, or selective breath-testing. In these checks, drivers are stopped at checkpoints or roadblocks and only those suspected of being over the alcohol limit are tested. This approach has been shown to be effective in cutting the number of alcohol-related crashes by about 20% (*159*).
  - Random breath-testing. This involves stopping drivers at random and breath-testing them. Australia, New Zealand and some European countries use this strategy with excellent results (*160*). An Australian study has found random breath-testing to be twice as effective as conducting sobriety checks at selective checkpoints (*161*).
- *Raising the legal drinking age*. Minimum drinking-age laws specify an age below which the purchase or public consumption of alcoholic beverages is illegal. The laws may also include penalties for the possession or consumption of alcohol by those under that age. Evidence from the United States, where over the last few years every state has raised the legal drinking age to 21 years, suggests that laws on the minimum legal drinking age have reduced drinking, driving after drinking, and alcohol-related crashes and injuries among young people (*158, 162*). However, in many places, the enforcement of the law is very lax.

Child restraints

Mandatory child restraint laws and their enforcement lead to an increase in the use of child restraints, and some studies show a corresponding reduction in traffic-related deaths and injuries among children. In some countries a penalty-point system is used to encourage people to comply with the legislation. In Latvia, the law on the use of child seats was revised in 2006 so that the penalty points could be incurred for failing to use a restraint.

The effectiveness of such laws, though, will depend on how correctly child restraints are used. A study in Japan

BOX 2.4

Graduated driver licensing programmes

Beginner drivers of all ages lack skills in driving and in recognizing possible dangers, and are therefore at increased risk of a crash. In the case of newly-licensed adolescent drivers, their immaturity combined with limited driving experience can result in a disproportionately higher rate of crashes. Graduated licensing systems are schemes that allow for a controlled and supervised phasing-in of full driving licences for young novice drivers. The schemes protect beginners while they are learning, allowing them to obtain experience on the road under conditions of low risk. Graduated driver licensing is widely used in many high-income countries. Although the schemes vary between countries, most of them consist of a three-stage model.

- Stage 1: an extended period as a learner driver. The purpose of this stage is to increase the amount of supervised driving experience before receiving a full licence.
- Stage 2: a provisional or intermediate licence. Such a licence will contain temporary provisions, such as restrictions on unsupervised driving, late-night driving and driving with young passengers.
- Stage 3: a full licence.

In many countries, progressing from one stage to another requires a certain number of supervised driving hours. There may also be stipulations that a proportion of these hours should be conducted at night-time.

The areas that graduated driver licensing schemes typically address include the following.

- *Alcohol restrictions*. Permitted blood alcohol concentrations limits range from zero in some countries to levels somewhat below the levels for experienced drivers – for instance, 0.02 g/dl, against 0.05 g/dl for drivers with full licences.
- *Passenger restrictions*. In the first phase, most graduated driver licensing systems do not allow passengers in the same vehicle. In the second stage, passengers are usually allowed, but only if a parent or supervisor is present during the first three months, after which only immediate family are permitted as passengers.
- *Seat-belt use*. Almost all graduated driver licensing systems require that drivers and other occupants wear seat-belts.
- *Speed*. In some countries, drivers at the learning stage are prohibited from driving on any highway with a speed limit of over 80 km/h.
- *Restrictions on driving at night*. Drivers in the first stage are prohibited in some places from driving between midnight and 05:00.
- *Mobile phone use*. A number of countries have recently introduced restrictions on mobile phone use, even with hands-free devices.

Evaluations of graduated driver licensing systems have reported significant reductions in crashes and fatalities. Estimates of their effectiveness have ranged from 4% to 60%, reflecting differences in the systems, in the drivers' ages and in the methodologies used in the evaluations *(163, 164)*. Recent data from the United States have shown a 23% reduction over a decade in crashes among 16-year-olds, with greater reductions for night-time driving and driving with occupants. The single most effective provision within graduated driver licensing schemes appears to be the extension of Stage 1, the learner period, which delays unsupervised driving *(165)*.

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tried to assess the impact on child injuries of laws mandating the use of child restraints. Despite overall increases in the use of child restraints, overall rates of fatalities and serious injuries among children aged 1–5 years did not change after the law was introduced, possibly because the restraints were not being used properly (*166*).

Helmets

Legislation and the enforcement of mandatory helmet use for moped and motorcycle users is an effective intervention measure, particularly where accompanied by public awareness campaigns. In countries where these laws are enforced, helmet-wearing rates have been found to increase to 90% or higher. In places where existing laws have been repealed, wearing rates have fallen back to generally under 60% (*26*). Standards for helmets should also be enforced, including provisions for helmets for children. Some countries, such as Malaysia, have already extended their standards to include helmets designed specially for children (*26, 152*).

Developing education and skills

Education can improve skills, behaviour and attitudes. A systematic review of safety education for pedestrians found an improvement in behaviours and attitudes that predispose people to risk-taking, but none of the studies reviewed actually recorded a reduction in injuries (*167*). Follow-up longitudinal studies would be needed among those children whose attitudes were changed by educational approaches to see if their risk of injury was diminished (*168*), though such a study would be long and expensive.

Traditionally, road safety education has been conducted in the classroom and has often involved an approach based on teaching children the rules of the road. What has usually been absent in educational programmes is the

application of modern ideas on educational and behaviour change. Social scientists working in injury prevention have in recent times taken an increasingly ecological approach, one that involves the interaction between the fields of child development, educational theory and behavioural theory (*169*).

Younger children

Current research on road safety education suggests that an approach that stresses behaviour, focusing on the development of practical skills, is more likely to be effective for younger children. Children learn best through methods that develop problem-solving and decision-making skills. Young children also learn by example.

In any case, education is an important ingredient of any comprehensive effort to prevent injury. Some examples of effective educational approaches include the following.

- *Roadside skills development* for 6–8-year-olds. Such programmes include the Kerbcraft pilot programme in the United Kingdom that teaches a number of basic skills, such as finding a safe place to cross, crossing safely near parked vehicles, and crossing safely at junctions (*170*).
- *Simulated environments* that teach pedestrian and cycle skills in a safe setting off the road. Examples include the "Safety City" programmes in New York City and Puerto Rico, and traffic gardens in the Netherlands. Such programmes need to be used as part of a progressive programme, as they cannot address real interactions with traffic.
- *Basic cycle skills* can be taught both on and off the road. The Oregon bicycle education curriculum has ten modules, half of them conducted on the road. While skills are developed, evidence as regards the extent of injury prevention is lacking (*171*).
- *Conspicuity* is covered in many pedestrian educational programmes. In Norway, children receive caps, vests or bags in bright colours with retro-reflective materials to make them more visible, especially on dark winter evenings. In South Africa, the Drive Alive Pedestrian Visibility Campaign that does public education work has campaigned for laws to make it compulsory for all school uniforms to contain retro-reflective material, so as to increase the visibility of child pedestrians (*149*).

Adolescents

By the time children reach adolescence they should have mastered the skills needed to act safely as pedestrians and cyclists, though some choose to engage in risk-taking behaviour. This is a difficult age group to reach through educational approaches and some methods may even be counterproductive. Greater involvement of adolescents in designing programme may be helpful (*172*), as may the use of television programmes, such as "Soul City" (*173, 174*), theatrical presentations, games and peer education.

Young drivers

The controversy over the effectiveness of school-based driver education has a long history (*139*). Both the randomized controlled trials conducted in 1999 (*175*) and those done by the Cochrane Injuries Group in 2001 (*176*) found that driver education did not reduce the number of traffic crashes or violations among students. On the contrary, driver education programmes can lead to earlier driving by novices, resulting in more crashes (*139*) offsetting any benefits from driver education programmes. A more recent randomized trial of the effectiveness of post-licence driver education in preventing road traffic crashes has also found no evidence of effectiveness (*177*).

Emergency and trauma care

Most initiatives for cutting the incidence of road traffic injuries focus on preventing crashes and on restricting the extent of their consequences. Much, though, can be done to reduce the number of deaths and injuries from road traffic crashes by strengthening the emergency medical services – including pre-hospital care, hospital care and rehabilitation.

Pre-hospital care

At the scene of the crash, prompt, efficient and effective pre-hospital care can save many lives. In places where formal emergency medical services exist, usually with ambulances, they are most effective if their equipment, training, infrastructure and operations are standardized. These emergency vehicles need to be equipped with supplies and medical devices for children as well as for adults – such as airway tubes, cervical collars and blood pressure cuffs. Staff need to be trained on how to evaluate and manage injured children, and to recognize that what is normal in an adult may not necessarily be normal in a child. Where no pre-hospital trauma care system exists, the first and fundamental tier of the system should be established by teaching interested volunteers the basic techniques of first aid (*178*). In many countries, organizations such as the International Federation of Red Cross and Red Crescent Societies, and the St John's Ambulance teach young people how to recognize an emergency, call for help and provide basic first aid until formally-trained health-care personnel arrive.

Setting up a new emergency medical service may be a valuable step, especially along busy roads with high crash rates. These services, though, can be costly. In all cases, and especially where there are no formal emergency medical services, pre-hospital care can be improved by building upon existing – even if informal – systems of pre-hospital care and transport (*178*).

Trauma care

Entry into the hospital is the second stage at which the life of an injured child can be saved (*179*). Improving the organization of trauma care services is an affordable and sustainable way of raising the quality and outcome of care. This involves improving the human resources that are required to provide care – including skills, training and staffing – and the physical resources, including equipment and supplies. The essential elements of trauma care need not be expensive, though the cost of care is often a barrier to access, especially where user fees are required in advance of services in emergency situations.

Rehabilitation

Many injured survivors of traffic crashes lead lives of disability. Much of this disability, particularly among young people, could be avoided with improved rehabilitation services. This includes improved services in health-care facilities and improved access to community-based rehabilitation. Such rehabilitation services need to be strengthened everywhere, so as to reduce the prevalence of disability after injury and to help those with persistent disabilities to lead full and meaningful lives.

Potentially harmful interventions

Airbags deployed in the event of a sudden deceleration are designed to supplement, and not to replace, the protection provided by a seat-belt. Although they have proven benefits for adults, airbags pose serious risks for children. Available data indicate that, on average, children under the age of 13 years are more likely to be harmed by an airbag than to be helped by it. Children should not sit in the front passenger seat of cars with airbags unless there is absolutely no alternative or unless the airbag has been deactivated (*180*). In most high-income countries, parents are warned about the danger of airbags to children and advised on the correct seating positions to be used in vehicles where airbags have been fitted. A rear-facing child safety seat should *never* be placed in front of an airbag (*139*). Current research is focusing on new technological solutions that will detect the presence of a child and adjust the deployment of the airbag or deactivate it. Newer airbag designs have cut the number of injuries to children, without wholly eliminating such injuries, but have provided no additional benefit to adults (*181*).

Evaluating interventions

There is no single blueprint for road safety. Many of the interventions discussed in this chapter have been evaluated only in high-income countries. It is quite possible that they will also work in low-income or middle-income countries, but their feasibility, acceptability and effectiveness in these countries have yet to be tested. While some countries have begun to implement and evaluate road safety interventions in general, few countries have evaluated child-specific road safety interventions and fewer still have looked at their cost-effectiveness. More evaluation studies are needed, so as to obtain compelling evidence that will persuade policy-makers to prioritize road traffic injury prevention, particularly as it affects children.

Conclusions and recommendations

Around 10 million children annually are estimated to be injured or disabled as a result of road traffic injuries. Road traffic injuries are the leading cause of death in children aged 10–19 years, and are also the leading cause of disability among children generally. Over the next 15 years, significant increases in road traffic casualties are predicted, particularly in low-income and middle-income countries. In India and China in particular, in that period, the annual incidence of road traffic fatalities is expected to at least double.

The road environment is constructed in most cases without consideration for children. Children on the road are therefore at greater risk than they need have been. Rises in motorization and urbanization are both fuelling road traffic tolls in many countries.

A child is more susceptible to road traffic injuries because of a smaller height and other less developed physical characteristics, including sensory facilities. Young children may unknowingly take risks on the road because they lack appropriate skills to act safely. Older children and adolescents may actively indulge in risk-taking behaviours, that are exacerbated by peer pressure. Children from poorer backgrounds are generally at greater risk of road traffic injury.

Recommendations

Traditionally, road safety measures for children have focused largely on road safety education – with the assumption that children must be taught how to adapt their behaviour to the demands of a motorized society. However, when used in isolation, without considering the safety of vehicles and road environments, educational measures do not deliver tangible and sustained reductions in deaths and serious injuries.

The systems approach has proved valuable in delivering greater road safety for children. It moves away from the idea that children should adapt their behaviour to cope with traffic, in favour of an approach in which children's needs are addressed in the design and management of the whole road system.

Large gains can be made in terms of injuries avoided and lives saved if proven and effective strategies – increasingly used in high-income countries – are adapted to the context of low-income and middle-income countries where children are at considerably higher risk (see Table 2.3). In line with the systems approach, the following actions are recommended to reduce the toll of child road traffic injury, death and disability.

TABLE 2.3

Key strategies to prevent road traffic injuries among children

Strategy	Effective	Promising	Insufficient evidence	Ineffective	Harmful
Introducing (and enforcing) minimum drinking-age laws	■				
Setting (and enforcing) lower blood alcohol concentration limits for novice drivers and zero tolerance for offenders	■				
Utilizing appropriate child restraints and seat-belts	■				
Wearing motorcycle and bicycle helmets	■				
Forcing a reduction of speed around schools, residential areas, play areas	■				
Separating different types of road user	■				
Introducing (and enforcing) daytime running lights for motorcycles	■				
Introducing graduated driver licensing systems	■				
Implementing designated driver programmes			■		
Increasing the visibility of pedestrians			■		
Introducing instruction in schools on the dangers of drink-driving			■		
Conducting school-based driver education				■	
Putting babies or children on a seat with an air bag					■
Licensing novice teenage drivers					■

Source: references *1* and *139*.

- *Reducing speed*. Survival rates for pedestrians and cyclists are much higher at collision speeds of below 30 km/h. This speed should be the norm in residential areas, around schools and other play areas.
- *Separation of two-wheelers*. Child cyclists should be separated physically from other road users – for instance, by using dedicated cycle lanes. Exclusive motorcycle lanes, separated from the main stream of road traffic by a raised central reservation, have been shown to reduce motorcycle casualties and should be considered.
- *Vehicle modifications*. Several modifications are already being introduced in many high-income countries. This process needs to be accelerated in high-income countries, and considered, where resources allow, in middle-income and low-income countries.
- *Child restraint systems* should always be used in cars. These include: rear-facing restraints for infants; forward-facing child restraints; and booster cushions or booster seats, for older children.
- *Seat-belts*. For children over the age of 10 years, or above 150 cm in height, normal seat-belts should be used.
- *Bicycle helmets*. Appropriate helmets always should always be worn by children cycling on the roads as their heads are even more susceptible to injury than adults.
- *Motorcycle helmets*. Wearing a helmet is the single most effective way of preventing head injuries and fatalities resulting from motorcycle crashes. All drivers and passengers on motorcycles, irrespective of their ages, should wear approved helmets, appropriate for their head size and in a conspicuous colour.
- *Drink-driving laws*. Strict laws on drink-driving should be introduced and enforced. Methods include:
  - setting lower blood alcohol concentration limits for young drivers;
  - undertaking sobriety checks, or selective breath-testing;
  - undertaking random breath-testing;
  - raising the legal drinking age.
- *Daytime running lights* for motorcyclists have been shown to be effective in reducing fatalities in several countries, and should be considered as a preventive measure.
- *Novice drivers*. Countries should consider introducing graduated driver licensing systems that place restrictions on new drivers, for the initial period (possibly two years) of their driving.
- *Teaching knowledge and skills*. For younger children in particular, education is an important ingredient of any comprehensive effort to prevent injury. Measures include:
  - roadside skills development for 6–8-year-olds;

– simulated environments that teach pedestrian and cycle skills in a safe setting off the road;
– basic cycle skills, taught both on and off the road.

In addition to the various primary prevention measures recommended above, emergency medical care – both pre-hospital and hospital care – as well as rehabilitation services should be improved and equipped with the child in mind. Furthermore, emergency health-care staff should be trained on how to evaluate and manage injured children.

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DROWNING

RUBY'S STORY

Christmas is a joyous time for most, but for parents Scott and Amanda and older sister Abby, Christmas Eve 2006 was the day they found their 14-month-old daughter Ruby face down in their home pool grey, lifeless and without a heartbeat. The family was preparing for Christmas when Scott and Amanda realized Ruby was missing. Scott's first instinct was to check the pool which had a makeshift fence while they were landscaping, but he couldn't see her and returned inside to continue looking.

Unknown to them, children sink when they drown and Ruby was actually at the bottom of the pool. It wasn't until Amanda re-checked the pool from a different angle that she discovered every parent's worst nightmare. Ruby was pulled from the water and Scott began CPR while Amanda frantically called an ambulance which took 40 minutes to reach their house. Fortunately Amanda had her GP's home number and she and her husband – both doctors – rushed to assist. Ruby was given CPR but still remained unresponsive and without a heartbeat. As a last resort the lifesaving decision was made to give her an adrenalin injection straight to the heart. To everyone's relief her heart began to beat and she was rushed to hospital.

Ruby was given a 10% chance of survival and Scott and Amanda were warned that if she did survive long-term brain damage was highly likely. But after spending Christmas day in an induced coma and a total of three weeks in the Paediatric Intensive Care Unit and Neurological ward, against all odds, Ruby made a miraculous recovery.

Ruby slowly regained her strength and learned to crawl and walk again and has begun to talk. Her fine motor skills were affected so she visits with an occupational therapist and physiotherapist every two weeks. The family have been told that it is now a matter of ensuring Ruby meets milestones and that if there is any long-term neurological damage it is likely to become evident when Ruby starts school.

Although Ruby's survival and miraculous progress are not typical of children who have experienced a non-fatal drowning, the circumstances in which it occurred are very common. A lapse in adult supervision even for very short periods of time is a major contributing factor to children drowning. Big sister Abby was also deeply affected by the incident and Amanda says that she is an extremely anxious mother now, and so much more aware of potential hazards. Amanda says: "Before this happened I was very relaxed as a mum, maybe too much so, and thought that nothing would ever happen to my child. It's terrifying how quickly things can happen. I don't even want to dwell on what could've been, we are amazingly lucky. So many people have stories that don't all turn out as well as ours."

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Chapter 3
Drowning

Introduction

Water touches every aspect of children's lives. They need it to grow, they are comforted by it, they are cleaned and cooled by it – and without it they cannot survive. Water to most children means fun, play and adventure – in a pool, pond, lake or simply in the road following a rain storm. Water, though, can be a dangerous medium. A small child can drown in a few centimetres of water at the bottom of a bucket, in the bath, or in a rice field. Drowning is an injury that displays epidemiological patterns that change according to age group, body of water and activity. In most countries around the world, drowning ranks among the top three causes of death from unintentional injury, with the rates highest among children under five years of age.

This chapter describes the magnitude of the phenomenon of childhood drowning around the world, in terms of deaths, morbidity and disability – pointing to the likelihood that the true size of the problem has been substantially underestimated. It summarizes the risk and protective factors, with the Haddon matrix as a framework, and sets out the various prevention strategies, both proven and promising. The chapter concludes with recommendations, urging that confronting this preventable injury should be made a priority and given proper resources for research and prevention efforts.

For the purpose of this chapter, drowning refers to an event in which a child's airway is immersed in a liquid medium, leading to difficulty in breathing (*1*). This event may result in death or survival. The definition used in this report – *the process of experiencing respiratory impairment from submersion/immersion in liquid* (*2*) – is one agreed upon by experts at a recent world conference on drowning. This definition is simple and comprehensive, encompassing cases that result in either death, a certain level of morbidity or no morbidity (*2*).

High-income countries, such as Australia and United States, have seen dramatic reductions in death rates from drowning, which have most likely come about as a result of both changes in exposure to risk and the implementation of specific interventions (*3, 4*). The lessons learned from these countries may be applicable to other countries around the world in helping to develop prevention programmes.

Epidemiology of drowning

According to the WHO Global Burden of Disease estimates, 388 000 people died in 2004 as a result of drowning around the world, of whom 45% were under the age of 20 years (see Statistical Annex, Table A.1). Fatal drowning ranked 13th as the overall cause of death among children under 15 years old, with the 1–4 year age group appearing at greatest risk. The overall global rate for drowning among children is 7.2 deaths per 100 000 population, though with significant regional variations. The drowning rate in low-income and middle-income countries is six times higher than in high-income countries (with rates of 7.8 per 100 000 and 1.2 per 100 000, respectively).

For those children who survive drowning, many are left with long-term consequences and disability that create enormous difficulties for families, with prohibitively high costs of health care. Global data show that approximately 28% of all unintentional injury deaths among children are due to drowning and 1.1% of all disability-adjusted life years (DALYs) lost for children under 15 years of age in low-income and middle-income countries are from non-fatal drowning (see Statistical Annex, Table A.2).

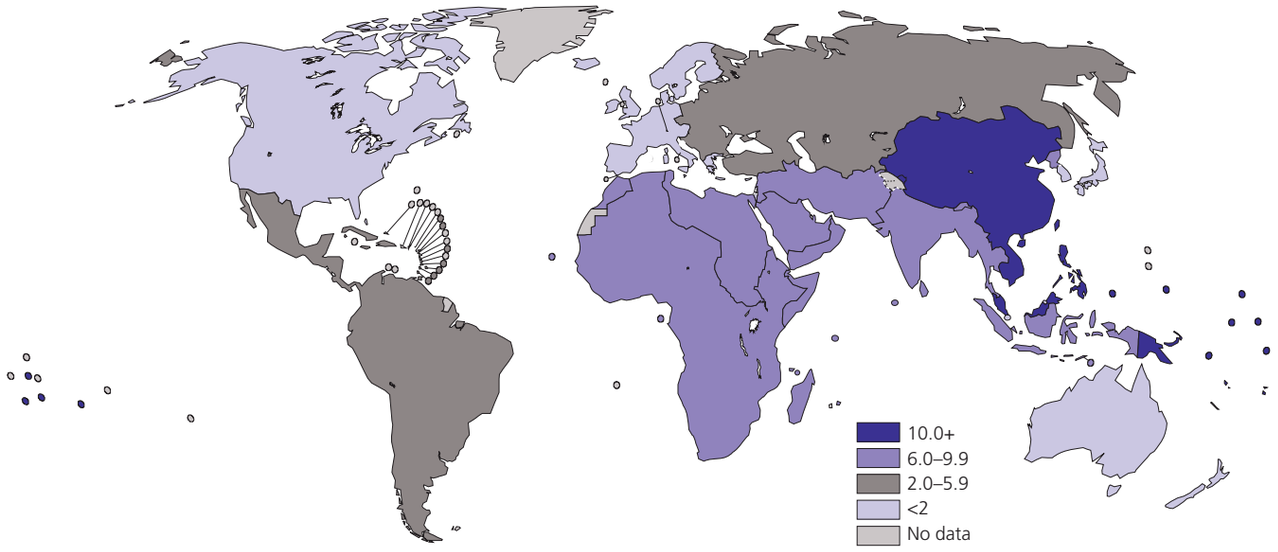
Available data show that there are substantial differences in drowning fatality rates across the globe. Comparisons, though, are difficult because of the use of different definitions, different categories counted or excluded in the data, the frequent lack of comprehensive national data and the variable quality of data. For some countries, mostly high-income ones, the pattern of fatal drowning is well documented. It now appears that there can be considerable differences both within and between countries and regions with regard to the nature and scale of childhood drowning. Although drowning rates have declined significantly in recent decades in some high-income countries, there are few established risk factors along with proven preventive strategies. This highlights the need for well-designed research to study the causes and origins of drowning injuries and to evaluate prevention measures.

Mortality

In 2004, approximately 175 000 children and youth under the age of 20 years died as a result of drowning around the world. The overwhelming majority, 98.1% of these deaths, occurred in low-income and middle-income countries (see Statistical Annex, Table A.1). The low-income and middle-income countries of the WHO Western Pacific Region have the highest rate of drowning deaths (13.9 per 100 000 population), followed by the African Region (7.2 per 100 000), the low-income and middle-income countries of the Eastern Mediterranean Region (6.8 per 100 000) and the South-East Asia Region (6.2 per 100 000) (see Figure 3.1).

FIGURE 3.1

Fatal drowning rates per 100 000 children[a] by WHO region and counry income level, World, 2004



Africa	Americas		South-East Asia	Europe		Eastern Mediterranean		Western Pacific	
LMIC	HIC	LMIC	LMIC	HIC	LMIC	HIC	LMIC	HIC	LMIC
7.2	1.3	3.4	6.2	0.6	4.0	6.2	6.8	1.2	13.9

[a] These data refer to those under 20 years of age.

HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

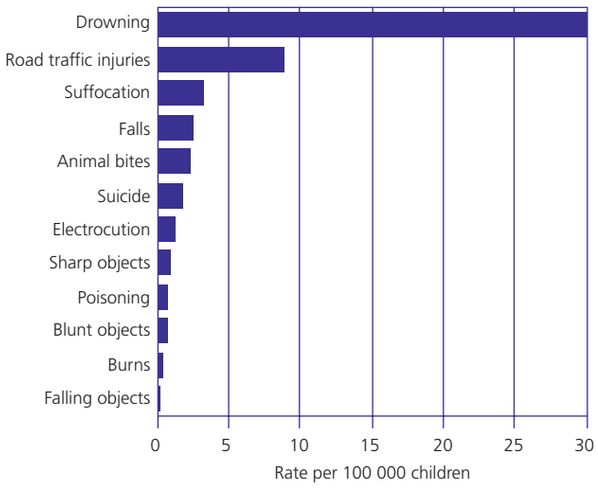
The overall death rate in high-income countries is 1.2 per 100 000 population. However, the high-income countries within the Eastern Mediterranean Region have a rate of 6.2 per 100 000 – comparable to that of the low-income countries of the South-East Asia Region. Even within high-income countries, there appears to be considerable variability. According to the International Lifesaving Federation, drowning rates for Australia, Germany, Sweden and the United Kingdom in 2003 ranged between 0.6 per 100 000 and 1.5 per 100 000 – with children under the age of 18 years accounting for between 8% and 28% of these deaths (*5*).

The actual number of drowning deaths in the world is likely to be much higher than the Global Burden of Disease figures suggest, particularly in certain regions of the world. In South and East Asia, for example, recent community surveys in five countries have indicated that drowning has been greatly underestimated by traditional methods of surveillance. In the countries studied, drowning was the leading cause of death among children under the age of 18 years (*6*). The death rate for drowning in these five countries was 30 per 100 000 population (see Figure 3.2), in stark contrast to the rate obtained by the Global Burden of Disease project of 6.6 per 100 000 population for the South-East Asia region and 13.9 per 100 000 for the Western Pacific Region in which these countries are located. For example, the Bangladesh study found that the incidence of drowning fatalities among children aged 1 to 4 years was 86.3 per 100 000 children (*7*). In the Thai study, the rate for 5–9-year-olds was 31.2 per 100 000 population, with two-year old males having a drowning rate of a staggering 106.8 per 100 000 (*8*). One possible reason for this disparity is that the Global Burden of Disease estimates of death rates from drowning exclude submersions as a result of floods and water transport incidents. This exclusion is likely to lead to a significant underestimate of the death rates in low-income countries experiencing seasonal or periodic flooding (*9*).

Variability in drowning mortality rates within a region or within a country is also apparent. A possible explanation here is the exposure to open water. In Bangladesh, for example, a country with hundreds of rivers and tributaries, drowning was found to be the leading cause of death for children aged 1 to 9 years of age (*7*). Data from Beijing, China, on the other hand, showed a very low rate of drowning mortality (2.6 per 100 000 population) (*10*), possibly due to the fact that Beijing and its neighbouring districts have fewer bodies of water. However, in largely rural Guangxi province, which borders the ocean, drowning mortality rates are high – approaching 30 per 100 000 for children aged 0 to 4 years of age (*11*).

FIGURE 3.2

Fatal injury rates per 100 000 children aged 0–17 years in five[a] Asian countries

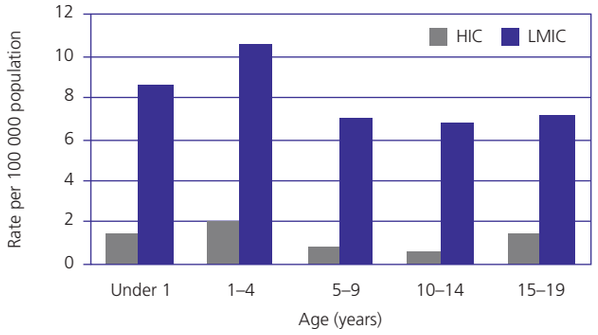


[a] Bangladesh, China (Beijing, Jiangxi), Philippines, Thailand, Viet Nam

Source: reference *6*.

FIGURE 3.3

Fatal drowning rates per 100 000 children by age and country income level, World, 2004



HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

Age

The death rates for drowning, by age group, for children and young people less than 20 years old show a rather higher rate in children in the 0–4-year age bracket, as compared with the rates for the other five-year age groups (see Figure 3.3).

Data from the studies conducted in South and East Asia show that drowning accounted for 90% of all injury deaths for children aged 1–4 years and over 50% of injury deaths for children aged 5–9 years (*6*). In Bangladesh, 26% of all deaths in children between the ages of 1 and 4 years are due to drowning (*12*).

Drowning is the leading cause of injury death in children aged 1 to 2 years in the United States (*13*) and among 1–14-year-olds in China (*14, 15*). In Brazil, drowning is the leading cause of injury death in 1–4-year-olds, and 26% of all unintentional injury deaths in children aged 0 to 14 years are from drowning (*16*).

Gender

Boys are overrepresented in every region of the world with regard to drowning death rates (see Table 3.1). In 2004, the overall fatality rate for boys under the age of 20 years was 9 per 100 000 population, nearly twice as high as the rate for girls (5.2 per 100 000 population). A similar skewing towards boys was found in the South and East Asian surveys (see Statistical Annex, Table B.1).

Location

Every year 70 Member States – mainly middle-income and high-income countries – submit to WHO mortality data that include the fourth digit of the International Classification of Disease codes, which allows disaggregation into subtypes of drowning. Analysis of these data show that even in these relatively better-off countries, information on where the drowning occurs is poorly documented. In more than 50% of cases the place is given as "unspecified", making analysis of place of drowning difficult (*17*).

Some countries, however, do have alternative sources of data. In Brazil, for instance, more than 60% of drowning occurs in natural bodies of water (*16*), while in South Africa the location of drowning is strongly related to socioeconomic status. Among wealthier communities

TABLE 3.1

Fatal drowning rates per 100 000 children[a] by sex, country income level and WHO region, World, 2004

	Africa	Americas		South-East Asia	Europe		Eastern Mediterranean		Western Pacific	
	LMIC	HIC	LMIC	LMIC	HIC	LMIC	HIC	LMIC	HIC	LMIC
Boys	9.0	1.8	5.0	7.1	0.8	5.5	10.7	9.0	1.7	17.5
Girls	5.4	0.7	1.8	5.2	0.3	2.4	1.6	4.5	0.7	9.9

[a] These data refer to those under 20 years of age.
HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

in South Africa, swimming pools and the sea are the major sites of drowning, while for poorer communities the majority of drowning among children occurs in rural areas, typically in rivers, lakes and dams (*18*).

The place of drowning is also related to age. In the United States, infants most commonly drown in baths and buckets, 1–4-year-olds in swimming pools, and children over 5 years of age most often in pools, rivers and lakes (*19, 20*). Most young children who drowned in pools were last seen in the home, had been out of sight for less than five minutes, and were in the care of one or both parents at the time (*21*).

In some industrialized countries such as the United Kingdom, despite a reduction in overall drowning rates among children, the number of children dying in garden ponds or other ornamental water features has increased over the past decade (*22*).

Morbidity

Estimates of the number of serious non-fatal cases of drowning are more difficult to obtain. Reporting of non-fatal cases is generally less standardized and reporting to a central health statistics system is often not mandatory. This is true of most countries, regardless of income, although some countries are able to provide estimates from hospital data. Nevertheless, for children aged 0–14 years, WHO global estimates for non-fatal drowning range between 2 and 3 million.

Among reported drowning cases, case fatality rates are high. Once a drowning is significant enough to warrant reporting, there is a high likelihood that the event has resulted in death or significant disability. For each fatality, it is estimated that there are between one and four non-fatal events serious enough to result in hospitalization (*23*). Improvements in medical treatment are unlikely to change this pattern significantly in the near future. There is thus a need to focus on primary prevention, rapid and effective rescue, and immediate resuscitation in cases of drowning.

Consequences of non-fatal drowning

The long-term health consequences of non-fatal childhood drowning are not well known, as few studies have assessed functional outcome after drowning (*23–25*).

An Australian study on drowning for the five-year period 1999–2000 to 2003–2004, for hospital admissions of all ages, showed on average that 22.3% of cases were left with severe or persistent respiratory or neurological consequences (*26*). The study also indicated that at least 5% of child survivors from drowning who had been admitted to hospital were discharged with severe neurological deficits (meaning that they would survive in a vegetative state). In the early 1990s, a British study reported that among all drowning cases in children younger than 14 years of age who were admitted to hospital, 8% died and 5% had a severe neurological deficit (*27*). Similar findings were reported from a South African study, which found that 12% of children admitted for drowning subsequently died and 6% suffered from a severe neurological deficit (*28*).

In studies in both the United States (*23*) and the United Kingdom (*27*), all children who had suffered drowning and who were alert on admission to hospital fully recovered. In the United States review, half of all children who were confused or comatose on admission had a poor outcome, 35% died and 15% had a severe neurological deficit (*23*). A high proportion of child drowning cases with poor outcomes has also been observed in a paediatric respiratory care unit in Thailand, where the mortality rate was 26% and 36% suffered from neurological long-term consequences (*29*).

Due to differences in patient populations and study designs, the figures on the health consequences of non-fatal childhood drowning are not properly comparable across countries. Moreover, many studies lack detailed information on functional outcomes. There is a need for studies measuring the consequences of drowning in childhood – and non-fatal drowning in particular – using comparable methodologies and international guidelines (*30*). This would allow for sound estimates of the prevalence of brain damage and other permanent disabilities resulting from non-fatal drowning in childhood.

Impact on families and communities

The lifelong health consequences of non-fatal drowning have a great impact on families, and include psychosocial consequences for those who have suffered drowning, their siblings, parents and other caregivers.

Disability-adjusted life years (DALYs) lost for drowning vary widely (see Statistical Annex, Table A.2). For children younger than 15 years, the higher figures come from low-income and middle-income countries of the WHO Western Pacific Region, where drowning is responsible for 4% of DALYs, from all causes (see Statistical Annex, Table A.2).

The impact of drowning on communities can be further estimated in terms of potential years of productive life lost and valued years of potential life lost. Both these measures estimate the loss of productivity due to premature death before the usual age of retirement at 65 years. The cases of Bangladesh, China and Viet Nam provide good examples of the huge impact on the economy of drowning (*6*). A study in China showed that injury death by far exceeded other major diseases – such as heart disease, cancer and infectious diseases – as a contributor to losses in production. The study also found that drowning ranked second, after motor vehicle traffic injuries, among all causes of injury, in terms of both potential years of productive life lost and valued years of potential life lost (*31*).

Economic impact of drowning

Studies to assess the costs of injury in several parts of the world (*32–36*) have up to now largely neglected or

else underestimated the economic impact of drowning. In spite of the scarcity of accurate and comparable data, available estimates indicate that non-fatal drowning may have serious economic consequences. Specific studies into the costs of hospitalizations for non-fatal drowning in the United States (*34, 36, 37*) have shown that while most cases can be discharged on the same day or after a single night's stay, a small proportion need to receive intensive treatment for very long periods. For this reason, the mean direct costs associated with hospitalization have been reported at $US 13 000 to $US 14 000 per case (*36, 37*). For cases with severe long-term consequences, such as brain damage, treatment costs alone can exceed $US 100 000. In a cost of injury study undertaken in Australia, non-fatal drowning was found to have the highest average lifetime cost – an estimate that includes direct and indirect costs – per patient of any injury type (*38*). Studies of the impact of childhood drowning on families and communities show that the cost is highest for those low-income and middle-income countries in which families rely on older children for income (*39*).

Limitations of data

Statistics on drowning are based on a broad range of data sources. Although much progress has been made around the world in collecting data, the availability and quality of data on drowning varies greatly between countries, depending on the surveillance systems in place and the availability and quality of other statistical resources. Data on drowning deaths are lacking or unreliable in many low-income and middle-income countries, despite periodic surveys or local data that suggest that these countries have the highest rates of fatal drowning (*40*).

Even in countries where counts of drowning deaths appear relatively complete, important basic details about the event are often lacking, including information on the location of drowning, the intent and the circumstances. There are two main reasons for this lack of information. First, the data collection systems employed may not capture all the relevant information – such as the age of the person concerned and their swimming ability, the type of water in which the drowning occurred, the cause of immersion, whether there were immediate attempts at resuscitation, and the presence of any barriers. Second, the information may not be available at source. Many incidents are not witnessed and it is not always possible to reconstruct the specific circumstances around the event (*41*).

Both lack of information and misclassification have an effect on overall estimates of the impact of drowning. In cases where a person survives drowning for a period of time in hospital, but dies some days later, the primary cause of death may be coded as something other than drowning – for example, as respiratory failure. Underreporting also occurs because of the ways that intent can be classified (*42*).

Many countries classify deaths according to the International Classification of Disease (ICD) E-codes. These data are then used to characterize drowning in the region. The most recent (tenth) revision of the ICD is an improvement over previous editions of the ICD in that the newer codes are more specific as to the location of drowning. However, most countries do not use the fourth character of the ICD code which details where the drowning occurred.

Risk factors

Knowledge of risk factors is a critical prerequisite for the effective prevention of drowning (see Table 3.2). Available studies on drowning suggest that people living in countries – particularly countries that are densely populated – with a large amount of open water are at a higher risk of drowning. Other risk factors, such as gender and age, appear to be almost universal.

Child-related factors

Age and development

As already stated, children under five years of age appear to have the highest drowning mortality rates worldwide, with rates among all age groups peaking in 1–4-year-olds. In late adolescences another, smaller peak is seen. This pattern is generally consistent across the world. The likely explanations for these peaks relate to developmental processes in young children and experimentation among adolescents, especially with substances such as alcohol.

With child drowning, risk and circumstances are generally related to the developmental stage of the child. Because infants under one year of age are usually unable to access water by themselves, unintentional drowning at this age is mostly the result of a child being left alone or with an unqualified caregiver – such as a young sibling – in or near water. By contrast, children who are more mobile and inquisitive, but still too young to have developed an awareness of hazards or avoidance skills, often wander away from the supervising adult and fall or climb into a nearby body of water (*3, 43–45*). Often the parent or caregiver is unaware that the child has approached or has fallen into the water (*46*).

The increased risk during adolescence is possibly as a result of less supervision and increased independence, increased risk-taking and greater exposure to open water during work or leisure (*6, 26*).

Gender

Based on global data, rates of fatal drowning are higher in males than females. This is true in all age groups with the exception of infants less than one, where rates among females are higher than males (see Table 3.3). Infanticides of females, misclassified as unintentional events, may be a factor here. Among males, drowning death rates peak

TABLE 3.2

Haddon Matrix applied to the risk factors for childhood drowning

Phases	Factors			
	Child	Agent	Physical environment	Socioeconomic environment
Pre-event	Developmental issues; gender; vulnerability; underlying medical condition, e.g. epilepsy; lack of supervision; lack of knowledge about water risks; need to access water for functional purposes, e.g. drinking, washing or fishing; transport on water; recreational use of water; alcohol consumption by adolescent swimmers or caregivers	Unprotected water hazards; unsafe watercraft; overloaded watercraft	Lack of barriers; unfamiliar environment; slippery, uneven, unstable or steep surfaces near or in water; weather conditions, e.g. floods; strong sea currents; inadequate physical infrastructure, such as bridges or safe crossings; lack of safe water supplies; lack of warning of severe weather	Lack of supervision or child care; reliance on peer or older child supervision; poverty; large families; unemployed or illiterate parents; failure of authorities to remove or protect hazards; lack of pool-fencing legislation; lack of water safety instruction and community awareness programmes
Event	Child not wearing personal flotation device; rescuer unable to swim; lack of swimming and/or water survival skills; overestimation of swimming ability; lack of strength; lack of comprehension of situation; panic response; swimming alone; lack of personal alerting devices or knowledge of emergency signals (such as waving arms)	Deep water; strong river water current; ocean rip current; very cold water; big waves; lack of personal flotation devices or other life-saving devices in boat; lack of lifeguards	Variable water depth; unstable footing; lack of escape mechanism, e.g. ladder, ropes, flotation device; snags in water	Poor access to information and resources for minimizing risk; inadequate communications or infrastructure to call for emergency health services
Post-event	Delay in rescue; inaccessible first-aid kits; lack of knowledge by caregiver about what to do immediately; lack of alerting mechanisms (such as mobile phone, flares)	Victim carried away from shore by current	Long emergency or fire department response time; inadequate rescue and treatment skills; poor access to water; inadequate transport for prompt medical care	Inadequate care; poor access to acute care hospitals and rehabilitation services; little community support for victims and families

in the 1–4-year age group. In females, rates are highest in infants and decline thereafter. The greatest difference in drowning death rates by gender occurs in adolescents aged 15–19 years, where rates among males are 2.4 times greater than rates among females.

This gender pattern is seen across the world, irrespective of a country's wealth (*4, 47, 48*). Males in the WHO African and Western Pacific Regions have the highest drowning-related mortality rates worldwide (*39*). In most regions, with the exception of the Americas and the Eastern Mediterranean, males' death rates from drowning are roughly double those of females.

TABLE 3.3

Fatal drowning rates per 100 000 children by age and sex, World, 2004

	Age ranges (in years)					
	Under 1	1–4	5–9	10–14	15–19	Under 20
Boys	6.4	11.8	7.8	8.3	9.3	9.0
Girls	9.8	7.6	4.9	4.0	3.8	5.2

Source: WHO (2008), Global Burden of Disease: 2004 update.

The reason for this may be that boys are more involved than girls in work that takes place in or near open bodies of water, and that they indulge to a greater extent in recreational aquatic activities. This is illustrated by the high number of young males who drown in Uganda while working on fishing boats (*49*). There is some evidence from high-income countries that greater risk-taking behaviour also contributes to higher drowning rates among boys. There is also evidence that, during aquatic activities, they are more likely than girls to swim alone, to swim at night and to consume alcohol when swimming or boating (*47, 50–53*).

Poverty

As previously noted, even within a given region of the world, there are considerable differences in drowning mortality rates between high-income and low-income countries. This is also the case within certain countries. A lack of educational opportunity, associated with poverty, may be one factor involved. There is some evidence to suggest that drowning in children is affected by the level of education of the family head or the caregiver. A study in Guadalajara, Mexico, for example, found that the risk of a child aged 1 to 4 years dying from drowning was higher

among those children from households where the head of the family had not completed elementary school (*54*). In Bangladesh, children whose mothers had only primary education were at significantly greater risk of drowning compared to children whose mothers had secondary or higher education (*9*). Against this, the study of child drowning in Xiamen, China found that the educational level of the father or mother was not a risk factor for drowning mortality (*55*).

Within countries, social and demographic factors also appear to affect the risk of drowning. Evidence from child drowning studies in low-income and middle-income countries such as China (*6, 11, 55*) Uganda (*24*) and Bangladesh (*9, 12*) consistently show that rural children have much higher drowning rates than those in urban areas. Many of these deaths occur in fishing communities where water transport takes place in non-motorized watercraft (*49*). In Bangladesh, the annual drowning rates in children aged 1–4 years are 136.9 per 100 000 in rural areas and 18.9 per 100 000 in urban areas (*7, 9, 12*). Case-control studies conducted in this country (*9, 12*) also found that child drowning risk increased as maternal age and family size increased. This pattern, though, was not observed in the study of child drowning in Xiamen, China (*55*).

Within high-income countries, there are suggestions of large discrepancies in fatal drowning rates between population subgroups, with an increased risk of between two and four times for children and young people from racial or ethnic minority groups (*13, 56, 57*). In the United States, ethnic minorities and foreign-born young men have higher rates of drowning compared with their white counterparts (*56, 58*). In the Netherlands, ethnic minorities experience a nearly three-fold higher risk of drowning death than the native Dutch population (*57*). The factors that contribute to disparities in risk of drowning among different ethnic groups are not well understood. Suggested explanations include differences in swimming ability and experience in the water, lack of opportunities to learn to swim, and lack of supervision in environments where population groups are at high-risk swim (*58, 59*).

Underlying conditions

Epilepsy is known to increase the risk of drowning death in all sources of water, including baths, swimming pools, ponds and other natural bodies of water (*60, 61*). A case-control study conducted in Norway found that children with epilepsy were significantly more at risk of submersion and drowning than children who did not have epilepsy, in both baths and swimming pools (*62*). In this study, though, it was found that no child died of submersion if an adult was present. In Sweden, 10% of those with a history of epilepsy died from drowning over the period 1975–1995 (*63*). Other conditions that are likely to increase the risk of drowning are autism (*22, 64*) and certain cardiac arrhythmias, although the latter are less frequent in children (*65*).

Agent factors

Lack of safety equipment

The lack of availability or accessibility of safety equipment in water transportation vessels are additional risk factors. Flotation devices such as life jackets are indispensable on all vessels, whether used for transportation or for pleasure. In the United States, for example, in 2005 the Coast Guard received reports for 4969 boating incidents. In these incidents, 3451 participants were reported injured and 697 died. Among those who drowned, 87% were not wearing life jackets (*66*). In addition to the lack of flotation devices, the poor maintenance of such equipment is an additional risk.

Safety equipment used by children while swimming should meet minimum safety standards. Items such as supporting rings or "water wings" may give parents a false feeling of safety, resulting in lapses in supervision with devastating consequences. The use of blow-up toys, rafts and air mattresses has also been recognized as being unsafe (*67*).

Unsafe vessels on water

There are regular media reports of the deaths of adults and children as a result of being transported in unsafe or overcrowded boats. Many of these boats are unseaworthy and will have been further compromised by turbulent weather conditions. These incidents account for unknown numbers of drowning deaths every year. In low-income countries, the capsizing of boats, launches and ferries is sadly commonplace, especially during the rainy season and at periods, such as national holidays, when there are high levels of mobility.

Alcohol consumption

Risk-taking behaviour figures strongly in unintentional drowning cases, particularly among adolescents. Alcohol use has been linked to between 25% and 50% of adolescent and adult deaths associated with water recreation (*68*). Alcohol influences balance, coordination and judgement, and its effects are heightened by exposure to the sun and heat (*69*). Alcohol consumption by parents and other caretakers while supervising children in water should also be considered. While many studies have investigated the direct contribution of alcohol to drowning, little work has been done to estimate the risk to children of alcohol consumption by those supervising them (*40*).

Estimates of the extent of alcohol involvement in drowning vary widely. This is because of differences in recording age groups or incomplete testing. Apart from affecting judgement and performance, alcohol is believed to have direct physiological effects that may affect survival once submersion has occurred – through mechanisms such as increasing hypothermia and retarding the protective

involuntary muscular contraction of the laryngeal cords (*70*).

Environmental factors

Type of body of water

Perhaps the strongest risk factor for child drowning mortality is exposure to a "risky" body of water. Patterns of child drowning across countries generally reflect the type of water to which the child is exposed. In low-income and middle-income countries, most drowning deaths happen during daily activities that involve playing, working, washing, collecting water and crossing water – for instance, to reach school. The bodies of water involved include ponds, ditches, lakes, rivers and water collecting systems, both above and below ground, such as buckets, barrels, wells and cisterns (*24, 54, 71*). By contrast, in high-income countries, most childhood drowning occurs in recreational settings. For younger children this is often a swimming pool and for older children a lake or river used for swimming. While approaches to prevention are transferable, specific prevention strategies and measures should be tailored for specific types of exposure.

In general, most children drown in or around the home. The younger the child, the closer to home the event is likely to occur. Baths are a very common location, though children mostly drown in them only when left unattended (*72*). For young children in high-income countries, the presence of a residential pool, particularly one that is inadequately fenced, is the strongest exposure factor (*51*), while in many low-income countries, the presence of open bodies of water or a well is strongly related to the risk of drowning. For instance, a study in a metropolitan area of Mexico found that children living in homes with a well experienced a seven-fold increased risk of drowning as compared with those in homes without a well (*54*). In Bangladesh, most young children aged 12–23 months who died from drowning did so in ditches and ponds, reflecting the fact that they were highly exposed to these water sources (*71*). A study of Australian farm injuries found that 78% of drownings in children under 5 years of age living on farms occurred in farm dams and irrigation channels (*73*).

Climate

Worldwide, large numbers of drowning deaths are associated with cataclysmic floods and ocean waves, which, in a single event, can leave thousands dead. Children accounted for about one third of those who died during the Indian Ocean *tsunami* in 2004 (*74*).

Holiday activities

A number of studies have found an increased risk of fatal drowning among both adults and children on holiday in their own country or abroad. In Australia, between 1992 and 1997, 4.7% of all non-boating drowning cases, 18% of surf and ocean drowning cases and 25% of scuba drowning cases were among foreigners (*75*). Another Australian study, covering the period mid-2001 to mid-2005, showed that almost 25% of drowning deaths were among foreign tourists, including children (*76*). It has been reported that many more children from the United Kingdom drown in swimming pools abroad than in swimming pools in their home country. This finding is presumably related both to the increased exposure to water when on holiday and exposure to a new situation (*77*).

Access to treatment and rehabilitation

Several studies have confirmed that most lives are saved by the immediate action of bystanders at the scene, either lay people or professional rescuers. Without such immediate first aid – including basic cardiopulmonary resuscitation – subsequent advanced and invasive life support techniques appear to be of little value in most cases (*78*).

Following the initial attempts at resuscitation, rapid deployment to an emergency department of a hospital is essential to prevent further neurological damage or death. The initial management of non-fatal drowning should involve continued resuscitation and treatment of respiratory failure, after which the child should be gradually rewarmed.

Outcome studies have shown that submersion for longer than 25 minutes, a continued need for cardiopulmonary resuscitation for more than 25 minutes, and lack of pulses on arrival at the emergency room are all predictors of severe long-term neurological consequences or death (*1, 79, 80*). However, the existence of case reports of children surviving neurologically intact after prolonged submersion in icy water suggests that more aggressive interventions can be helpful in these cases (*1*).

Interventions

Given the complexity of drowning events, strategies for prevention require a holistic approach, based on the particular pattern of drowning observed in a given location. Passive prevention strategies – such as improving safety design – that require no action or else only a single action on the part of the individual, are generally regarded as more effective than active strategies, such as adopting safer behaviours, requiring repeated actions. However, for many types of drowning there are a limited number of passive strategies – or even none at all.

Most drowning deaths could be prevented by a sustained effort to implement safety interventions. The task ahead is clear - to translate what is now known into action on the ground (UNICEF Bangladesh).

Engineering measures

Eliminating hazards

Eliminating a hazard – where this is possible – is the most effective prevention method, since it does not rely on barriers or other protective measures which may be ineffective. Buckets and baths, for example, should be left empty when not in use, as children could drown in them if they contained a liquid. Similarly, holes in the ground, dug for building purposes, should be drained of rainwater or filled in to prevent water collecting. Small containers, such as washing tubs, should be safely stored so that they will not fill with rainwater (*81*).

Passive strategies relating to the creation of infrastructure include the building of safe bridges and the installation of piped water systems, both of which have historically been factors in reducing drowning rates in developing countries. Having piped water to hand means that people can avoid open bodies of water to bathe or wash clothes in or to collect drinking water from. It also makes exposure to stored rainwater and wells less likely, both of which are potential hazards (*81*).

Providing safe venues for recreational swimming can also help prevent drowning. Natural bodies of water contain a number of associated hazards for swimmers. The depth of water in them may be unknown and there may be underwater obstacles, sudden and unseen changes of depth or deep holes. Strong currents and a low temperature of water can create further problems. The provision of suitably designed pools, whose depth is known at each point and in which obstacles and currents are absent, makes it possible for children to learn to swim in an environment with considerably fewer hazards.

Environmental measures

Pool fencing

Another passive intervention is the creation of an effective barrier between child and hazard (see Box 3.1). In high-income countries it has been found that surrounding private swimming pools and spas with safety barriers that prevent unsupervised young children entering significantly reduces their risk of drowning (*82–86*). A meta-analysis of three case–control studies showed a significantly decreased risk of drowning in a fenced pool, as compared to an unfenced one (*87*). Furthermore, the study found that a barrier isolating the pool from all other structures – a four-sided fence – was shown to be far more protective than perimeter fencing, a three-sided fence where the house or another structure forms the fourth side of the barrier (*87*).

Research in the United States and Australia has found that laws and regulations requiring pool fencing are insufficient if perimeter fencing is not accompanied by adequate enforcement to ensure the self-closing system of the gate and the latching system are functioning properly (*83, 88*).

Covering wells

In low-income and middle-income countries, creating barriers between young children and the bodies of water to which they are exposed can be an effective measure to prevent drowning. Covering wells or open barrels with grills, creating an embankment or fenced barrier near ponds and riverbanks, and building flood-control embankments, are all effective in preventing drowning (*54*) (see Box 3.1). Similarly, creating fencing around a dwelling where there is a hazard of open water outside the house can also provide protection.

BOX 3.1

Covering wells in Mexico

Wells and underground cisterns are important sources of household water. The former are common in rural areas, while the latter are used in some cities without a reliable community water source. A common characteristic of both is an opening large enough to allow access. This can create a major drowning risk for children, especially in developing countries. One study found that the presence of wells in homes increased the risk of drowning in the home by a factor of nearly seven, while cisterns increased the risk two-fold *(54)*.

Using accepted strategies as well as the experience of swimming pool fencing, a child's risk of drowning could be substantially reduced if the opening to these household water sources was closed by a locked hatch. This preventive strategy is familiar to the Mexican public, who have a popular saying, "close the well after the drowned child."

Because water must be drawn daily, wells and underground cisterns cannot be sealed the whole time. The most hazardous method of obtaining water would be through a hatch or lid large enough to admit a bucket – and therefore also large enough to let a small child pass through. A more effective preventive measure would be to draw water using a manual or electric pump. This would make it easier to obtain household water and would eliminate the risk of children drowning.

In Australia, farm safety researchers are investigating the feasibility of a "virtual fence". The technology for an alarm system signalling that a child under adult supervision has wandered beyond predetermined limits from the home already exists. The researchers are examining whether this technology can be applied effectively to increase child safety in low-income countries, especially in relation to the risk of drowning in bodies of water such as dams.

Legislation and standards

Pool fencing laws and their enforcement

In many high-income countries, legislation requiring isolation pool fencing for all swimming pools (including private ones) has been recommended and sometimes also enacted and enforced. Such legislation has proved effective in decreasing drowning rates, though not to the extent that had been anticipated (*86, 89, 90*). This may be due to a lack of knowledge of the law and its inadequate enforcement.

Personal flotation devices

Although not yet thoroughly evaluated, wearing a properly-fitted personal flotation device, such as a life jacket, is a promising strategy to prevent drowning (*91*). This is particularly the case with regard to swimmers who are unskilled or tired or who panic. If a young child wearing a properly-designed personal flotation device falls into the water, the device should keep the child afloat long enough to be rescued. Only certain types of personal flotation device will ensure that the child floats face-up. These devices should therefore be seen as short-term solutions and not as a substitute for supervision. The provision of personal flotation devices for all occupants of ferries and other vessels has the potential to save many lives (see Box 3.2).

Laws on alcohol

General minimum-age drinking laws and lowering the alcohol level do not appear to be associated with a reduction in drowning rates among adolescents (*96*). However, it is known that consuming alcohol before or during activities in bodies of water increases the risk of drowning. Adolescents should therefore be encouraged not to drink and swim. In addition, advertising that encourages alcohol use during boating and the sale of alcohol at water recreational facilities should be restricted.

BOX 3.2

Personal flotation devices and drowning

Lifejackets were developed to prevent drowning in emergencies at sea. In the water, they turn wearers to a position where the face points up, and with the head supported and the mouth out of the water. Buoyancy material is concentrated in front of the wearer, which makes the jacket bulky, uncomfortable and restrictive. Newer buoyancy devices are designed to keep the wearer afloat but do not meet the high performance requirements for lifejackets, with regard to buoyancy and keeping the face up. They are considered appropriate, though, for use by children, recreational boaters and water sports participants, who are undertaking activities in calm waters, close to the shore or close to help from rescuers.

The broader term "personal flotation device" is now used in many countries to cover all these new flotation devices as well as the lifejacket. Many governments now require all recreational vessels to carry one wearable personal flotation device, of a specified type, for each person on board. However, since drowning during recreational boating usually occurs suddenly or unexpectedly, lifejackets stored on board offer little protection unless they are actually worn. Various studies have shown that up to 50% of drownings resulting from boating-related incidents could have been prevented if the person had been wearing an appropriate personal flotation device *(92)*.

Two main strategies – education and, to a lesser extent, regulation – have been employed by governments to try to increase the wearing of personal flotation devices among recreational boaters, including water sports participants. Only two evaluations of educational campaigns on personal flotation devices have been published, both reporting modest effectiveness *(93, 94)*. Although the use of personal flotation devices among all boaters increased, the impact of the campaign on childhood drowning was undetermined.

Some countries have made the wearing of personal flotation devices mandatory. Preliminary data from an Australian study, which evaluates both the wearing rates and the effectiveness of regulations, shows promising results *(95)*.

The available evidence therefore suggests that the use of personal flotation devices is potentially a strong measure to prevent drowning among recreational boaters, including children, and that regulation is more effective than education in increasing the use of these devices and preventing drowning.

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Developing education and skills

Teaching swimming and improving skills

Most studies show that swimming instruction improves swimming ability, but no conclusive evidence exists that swimming ability confers protection against the risk of drowning. There are, however, indications that swimming instruction and the consequent increased ability at swimming, as well as greater survival skills, do provide some protection, even at relatively young ages.

Longitudinal studies of child drowning are hampered by the lack of data regarding the proportion of children who can swim and the level of swimming ability of those who drown. A study conducted in the United States (see Box 3.3), a recent study in rural China of child drowning (*46*) and research in Bangladesh (*7*) all suggest that swimming lessons may be protective.

Even in the face of this preliminary evidence, there should be caution in recommending swimming lessons as a protective strategy for young children. Several studies show children as young as 24 months can improve their skills, but their learning period is much longer than that of older children (*98*).

Concern has been voiced that mass training in swimming skills for children could lead to more children, especially young ones, being exposed to water and becoming overconfident in it. Ultimately, according to this view, drowning rates in children could increase rather than decrease (*99*). A study in Australia, however, suggested a link between swimming lessons and decreased drowning rates in children (*100*). However, this may have also been because more safe places for swimming were opened, including large numbers of public pools (see Box 3.4).

BOX 3.3

Teaching children to swim

One possible strategy to prevent drowning is to improve children's swimming skills through formal instruction. Few studies have examined the association between either swimming skills or swimming instruction and drowning risk. While it seems intuitive that more skilled swimmers would be less likely to drown, it is also the case that skilled swimmers drown. Among older children especially, it is possible that those who are comfortable in water or who perceive themselves to be good swimmers might seek out water-related activities. These activities might occur in more risky settings – such as in deeper water or at locations without lifeguards or other appropriate supervision.

Preliminary results of a study in the United States *(97)* found that past participation in formal swimming lessons offered a protective effect for drowning. In this study, the families of children who had drowned and the families of matched controls were asked about their child's past participation in formal swimming lessons. For children aged 1–4 years, interviews were conducted with 61 families of children who had drowned and the families of 134 matched controls. In the 5–19-year age group, interviews were conducted with 27 families of drowning cases and 79 matched controls.

For the younger age group, 3% of those who drowned had participated in formal swimming lessons, against 26% in the matched controls. This represents a 90% reduction in drowning risk among those who had swimming lessons. Among older children, 27% of the drowning cases had taken formal swimming lessons against 53% of the controls – an association that was not statistically significant.

In general, increased swimming skills also appear protective with respect to drowning risk. This is particularly true in children over 5 years of age, with several of the skills showing a protective effect in adjusted analyses, despite the small sample size. For example, in the older age group, drowning cases were less likely to be able to swim on the stomach for a distance of 5 metres. However, among those aged 5–19 years, many of those who drowned were relatively skilled swimmers. Of those who drowned in this group, 58% were reported to be able to swim continuously for at least a minute and 48% to be able to swim at least 15 metres.

This study had a number of limitations, including the relatively small sample sizes in both age groups and a reliance on reports, rather than on observation, of swimming skills. In addition, it is quite possible that parents who enroll young children in swimming lessons could differ from parents who do not do so. These differences are difficult to measure and could have an effect on a child's risk of drowning.

In spite of these shortcomings, these early results, together with a previous study in rural China *(46)* that also identified a protective association between swimming instruction and drowning risk, suggest that formal instruction in swimming ought to be a component of a strategy to prevent drowning. However, those designing prevention programmes, and those targeted by them, must be aware that even the most skilled swimmers can drown. Swimming lessons and the teaching of water survival skills should therefore be regarded as one important component of a multiple approach to prevention.

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More good intervention studies are needed to evaluate the effectiveness of swimming lessons in preventing drowning in young children, and to specify what sort of swimming and survival skills should be taught. Imparting knowledge and skills beyond the basic swimming strokes is certainly necessary. This includes teaching children to swim safely in open water, to identify hazards such as rocks, currents and dangerous weather conditions, and to recognize, avoid and – if necessary – escape from rip currents.

Supervision by lifeguards

Lifeguards (also known in Australia, New Zealand and South Africa as lifesavers) – both voluntary and paid – have provided protection at swimming pools and natural bodies of water in various parts of the world since the 19th century. Voluntary lifeguarding still exists, particularly around natural bodies of water. At the same time, paid lifeguards are increasingly being employed in public and commercial swimming venues.

There have been no published studies formally evaluating the effectiveness of lifeguarding as a primary prevention measure. Australian studies, based on rescue and resuscitation data from associations of lifeguards, do, however, point to some effectiveness (*101, 102*). Trained lifeguards on beaches and at public swimming pools are likely to decrease the risk of drowning by being models for safe behaviour, actively controlling the risk-taking actions of swimmers, monitoring water and weather conditions, and prohibiting or restricting swimming in the sea if behaviour or conditions pose a hazard. Lifeguards, furthermore, provide rescue and resuscitation to limit cases of drowning resulting in death or brain damage (*103*). For their work to be effective, though, they require ongoing training and need to adhere to high standards of performance, particularly as regards surveillance (*104*).

Supervision by parent or caregiver

Educating parents and caregivers about the risks for drowning is an important step for changing knowledge, beliefs and attitudes which in turn determine behaviour. People often underestimate the risk of drowning and are unaware of who is particularly at risk (*6*). A study of Americans of Vietnamese origin found that both parents and adolescents often attributed drowning to fate (*105*). Parents and caregivers need to understand that young children should never be left alone or with another young child in or around any body of water (see Box 3.5). They also need to learn basic life-saving and first-aid skills.

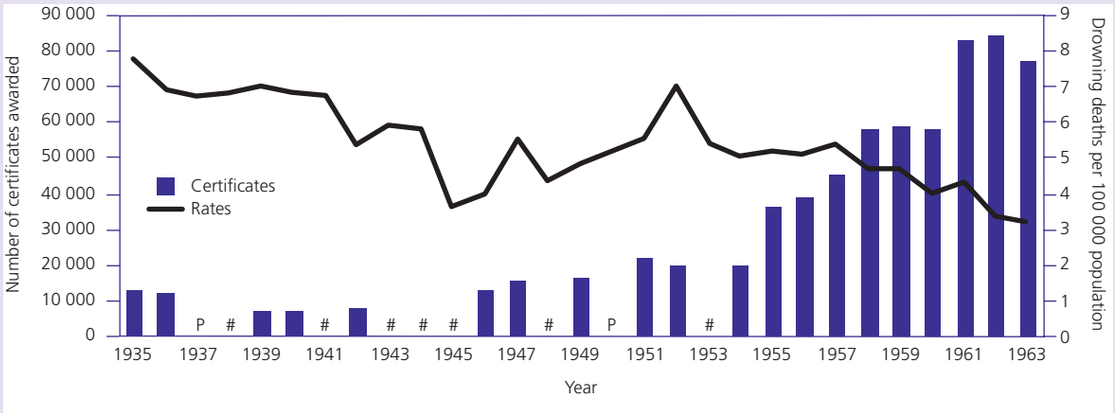
Numerous studies have shown that inadequate supervision is an important contributory factor for paediatric drowning of all types, especially drowning in the bath (*106*). However, the effectiveness of supervision as a drowning prevention measure has not been formally

BOX 3.4

A mass primary school swimming instruction campaign

From the 1950s onwards, a major collaborative swimming instruction campaign was implemented across the state of Victoria, Australia. The programme was named after a daily newspaper, *The Herald*, which had launched it and gave it publicity. Supported by the Education Department and the local government and championed by an ex-olympic swimmer, the campaign also coincided with the Olympic Games held in Melbourne in 1956.

The campaign was aimed at the later years of primary school children. These children received a "Herald Certificate" when they swam the target distance of 23 metres, and the annual award rates were published by the newspaper. By the summer of 1962–63, over a million children had participated in the *Herald* campaign. All children aged 10–12 years were covered by this programme, which was associated with a reduction in the drowning rate. This mass swimming campaign, together with an increase in the number of safe places to swim and other drowning prevention strategies, resulted in a significant reduction in the drowning rate (see accompanying figure).



BOX 3.5

Adult supervision and swimming training for very young children

In New Zealand, children under five years of age have the highest death rate from drowning of any age group in the country. In an attempt to prevent such deaths, a number of organizations have promoted swimming lessons for very young children, despite a lack of evidence that swimming instruction in this age group is effective in teaching protective skills. Some experts have warned that swimming lessons at this age may actually be harmful, making young children less fearful of water and giving parents a false sense of security. A study to examine the beliefs of adults about the benefit of swimming instruction was conducted, with 555 parents who had enrolled their preschool children in swimming lessons, together with a control group of 327 parents of similar children who had not *(107)*. The study found that parents believed that children as young as two years could learn to swim, and that a sizable proportion thought that swimming classes were the best way to prevent small children from drowning. A third of parents considered it better to develop the swimming ability of their children than to rely on adult supervision in order to prevent drowning.

The study brought out parents' misconceptions over their young children's ability to be safe. Parents often place their children in situations where there is a mismatch between the child's skills on the one hand, and the demands of the tasks required for safety on the other. This has been shown not only for drowning, but also for pedestrian safety, driving skills and safety with firearms. Such misconceptions need be combatted with a range of educational, regulatory and other interventions so as to reduce the risk of inadvertent injury to children.

evaluated. What constitutes adequate adult supervision for bathing and water safety has only recently been studied. Those who supervise children in and around water should receive appropriate training in rescue and resuscitation skills.

Infants and other children who lack mobility require continuous supervision on the site while in the bath. The age up to which children need such supervision has not been determined but is likely to extend to at least five years. Beyond this age, reported drownings in a bath are almost always related to seizures (*62*). For children and adolescents with epilepsy, being in a bath poses the highest risk for unintentional death. Children with epilepsy should therefore always use a shower rather than a bath and adhere strictly to other seizure control measures (*62*).

In some communities it is common to rely on other children of the same age or older to protect a young child. In the case of drowning, such a form of care appears to provide insufficient protection. A historical review of drowning in Australia found that throughout the 19th and 20th centuries many child drowning deaths occurred in the company of other children (*81*). Because drowning happens rapidly, companions are often unable to rescue the drowning child and may themselves drown in the process.

Interventions for adolescents

Adolescent drowning usually occurs in open water while swimming, boating or undertaking other leisure activities. Those who drown have generally been swimming with one or more friends of a similar age who do not recognize they are in trouble or cannot rescue them. Adults are usually absent, and there may be peer pressure to indulge in risk behaviours, such as consuming alcohol. With alcohol consumption, the risk of drowning increases as blood alcohol concentration levels rise. Measures to prevent the use of alcohol and recreational drugs around water activities are therefore likely to reduce the rate of adolescent drownings (*108, 109*).

From early adolescence onwards, preventive interventions for drowning should increase a person's cognitive skills around water. These skills include:

- better recognition of hazards;
- recognition of personal limits, including knowledge of one's swimming ability;
- the ability to resist peer pressure to take part in activities for which skills are lacking.

Such interventions, though, have not been properly developed or tested. For children and adolescents, a particular problem is to provide safe sites for swimming that are also attractive. To this end, trained and equipped lifeguards need to be present at places and at times that adolescents are most likely to congregate. In rural areas, safe settings for swimming need to be made available. Otherwise, children and adolescents are likely to gather at unsafe places such as irrigation ditches, quarries and other open water sites.

Managing drowning

Drowning injuries arise because a person cannot adequately breathe and obtain oxygen. Even if a person is quickly retrieved from the water while drowning, they may have stopped breathing, and suffer brain damage as a result of a lack of oxygen. A secondary prevention strategy, therefore, for all age groups, is training in resuscitation techniques. The strongest predictor of outcome following drowning is the mental status of the person being rescued (*110*).

Support from bystanders

Studies have shown that children who receive immediate resuscitation from bystanders – before the arrival of medical personnel – have improved outcomes (*111, 112*). Attempts by bystanders to provide "mouth-to-mouth" resuscitation to the child may stimulate the return of the child's spontaneous breathing. If the child does not begin to breathe, providing such resuscitation is critical for survival. Advanced life support provided by medical personnel may save a child who has deteriorated to a state of cardiac arrest. However, even in high-income countries

with local paediatric intensive care facilities, the window of opportunity for intervention is at the scene of the drowning (*113, 114*).

Psychosocial support

Coping with a sudden unexpected death, such as occurs with drowning, is always difficult. When the person in question is a child, the loss is generally even more devastating and one over which the parents frequently experience feelings of guilt. Childhood death is also stressful for health care providers. There needs to be greater support for families in which a childhood drowning has occurred, as well as for the health care providers. Greater attention should also be devoted to the long-term care of children who have become neurologically damaged through drowning (*78*).

Adapting interventions

To maximize their effectiveness, prevention strategies and measures against drowning should be appropriate to the child's developmental stage. While a barrier, for example, might be effective in preventing drowning in young children, this measure is not in general likely to keep older children and adolescents from accessing water. The cultural acceptability to children and parents of possible interventions also needs to be borne in mind.

Affordability and availability are further factors that may determine whether interventions are implemented. Fencing works well for swimming pools, for instance, but it may not be the solution in regions where canals and irrigation ditches are ubiquitous.

As another examples, items such as personal flotation devices may not be locally available. Measures to overcome this obstacle include the setting up of local loan schemes for such devices.

Potentially harmful interventions

Baby bath seats and flexible solar pool covers are not designed to prevent drowning, though they are sometimes used for that purpose. Several small studies have documented drowning among infants who were left unattended in a baby bath seat (*115, 116*). While in most cases it was not the bath seat itself that was unsafe, its use tended to make parents feel more comfortable about leaving their young child unattended. Similarly, flexible solar pool covers do not prevent drowning from occurring. There have been cases where unsupervised children drowned, having become trapped in them or hidden from view (*117*). More rigid, heavier devices may offer protection, though these have not been tested for effectiveness and are considerably more expensive, although they are sometimes used on public swimming pools.

Further research on interventions

For all interventions to prevent drowning, accurate and comprehensive data are vital for evaluating their effectiveness. Many interventions still require rigorous evaluation. Above all, the debate around whether children under the age of five years should be taught to swim needs to be resolved, so that an unequivocal message can be given to parents. Research is also needed as to why pool fencing laws do not live up to expectations, including an examination of both the knowledge of users as well as their attitude to newer fencing. For young children, close supervision is a vital strategy for prevention. Such supervision includes safe play areas for children which have been proposed but not evaluated (*118*). What qualifies as "adequate" supervision, though, needs defining and evaluating.

Conclusions and recommendations

Drowning is a public health issue calling for worldwide attention. Recent community-based surveys indicate that the problem of drowning is likely to be much greater than present global estimates would suggest. This relatively neglected injury problem should be given a much higher priority by policy-makers and donors.

In 1997, drowning was described as "the final frontier of injury prevention" (*119*), because of the scarcity of evidence for the effectiveness of intervention strategies. Since that time, though, a certain amount of progress has been made. This chapter has described the many effective and promising interventions now available to reduce childhood drowning (see Table 3.4). More scientific investigation, though, is still required to identify significant risk and protective factors in drowning.

Recommendations

- *An agenda to address drowning, with targets* appropriate to the local situation, should be set up by every country. Because of the high rates of drowning fatalities, the main focus needs to be on *primary prevention strategies*.
- *Partnerships* between governments, communities, industry, private sector bodies and public health agencies should be created to address drowning. While the type of strategies to prevent drowning and treat children and adolescents will vary greatly between countries and regions, cooperative efforts at every level – including at the global level – are essential.
- To enable countries to compare data and share experiences and intervention strategies more effectively (*120*), the following need to be done:
  - the *collection of consistent epidemiologic data*;
  - the use of *standard definitions*;
  - the use of *coding schemes*.
- *Further research to evaluate protective factors* is urgently called for, using large intervention trials, examining the effect of measures such as providing instruction in swimming and survival skills.
- The design and evaluation of *interventions in specific settings* needs ongoing research.

TABLE 3.4

Evidence for key strategies to prevent drowning among children

Strategy	Effective	Promising	Insufficient evidence	Ineffective	Potentially harmful
Removing (or covering) water hazards	■				
Requiring isolation fencing (4-sided) around swimming pools	■				
Wearing personal flotation devices	■				
Ensuring immediate resuscitation	■				
Ensuring the presence of lifeguards at swimming areas		■			
Conducting targeted awareness-raising on drowning		■			
Teaching children older than 5 years to swim			■		
Introducing laws on pool fencing			■		
Introducing a law on the use of personal flotation devices			■		
Promoting drowning prevention through doctors			■		
Restricting access to areas unsafe for swimming			■		
Teaching children younger than 5 years to swim			■		
Introducing laws on blood alcohol content for swimmers			■		
Conducting prevention campaigns, such as on advertising hoardings, for drowning				■	
Promoting solar pool covers[a]					■
Using baby bath seats[a]					■

[a] These are not primarily designed as drowning prevention interventions.

Source: references *121, 122*.

- *Proven interventions* should be implemented where their relevance has been demonstrated. These include:
  - the elimination of water hazards;
  - the creation of barriers between children and hazards;
  - the use by children of personal flotation devices.
- *Immediate resuscitation*, prior to the arrival of paramedical personnel, should be promoted everywhere. Such resuscitation significantly increases the likelihood of a good outcome – irrespective of age, gender, duration of submersion or the presence of hypothermia.

"Considering that drowing is the second leading cause of unintentional injury death worldwide and the single leading cause of child death (including disease) in some countries, the focus this critical report brings to the problem and viable preventive measures is immensely valuable. Now comes the time for action." Alan Whelpton, World President, International Wife Saving Federation.

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BURNS

VUSI'S STORY

Five years ago, when he was 13 years old, Vusi suffered serious burns. He woke up one night to find his blanket and bedroom ablaze from a candle that had fallen over. The flames injured his face, hands and feet.

After many months in hospital, he left wearing a brown elasticized pressure garment around his face and hands so that his scars would not become thick and raised, as often happens.

From the start, Vusi was very sensitive about his appearance. People on the streets and at school used to tease him about the mask-like pressure garment, comparing him to a masked television entertainer. The long hospital stay and the psychological stress led to problems at school and his education was delayed. Despite all he went through, though, Vusi has become a charming, friendly person with an engaging smile. He loves music and voluntarily spends time with blind children and others with disabilities, encouraging them to exercise more.

Africa's first burns charity, "Children of Fire", has, for the past twelve years, been helping severely burned children to obtain complex surgery, therapy and education. They now also work on community safety, teaching those at risk how to prevent fire burns, as well as imparting first aid and fire-fighting skills. The organization also helps inventors of safer paraffin or biofuel stoves to publicize their inventions more widely, and in a similar way promotes the use of safer candlesticks.

In June 2007, 15 teenaged burns survivors, along with other young volunteers, climbed Mount Kilimanjaro in a campaign to raise awareness of burn injuries and how to prevent them, and to increase tolerance of disability and disfigurement. Vusi was one of those who climbed to above 5000 metres and 12 others reached the summit.

Adapted from the Children of Fire web site (http://www.firechildren.org, accessed 9 June 2008).

Chapter 4
Burns

Introduction

Children are naturally curious. As soon as they are mobile, they begin to explore their surroundings and play with new objects. In this way, they acquire the skills they need to survive in the world. At the same time, though, they come into contact with objects that can cause severe injuries. Playing with fire or touching hot objects can result in burns. This is a debilitating condition accompanied by intense pain and often by longer-term illness that creates suffering not only for the child but for the wider family and community. Fortunately, the prevention, acute care and rehabilitation of burns have improved greatly over the past few decades. There is now ample evidence that a number of measures are effective in preventing burns. These include the introduction and enforcement of items such as smoke alarms, residential sprinklers and fire-safe lighters, and laws regulating the temperature of hot-water taps. Nonetheless, considerable disparities exist between countries in the extent of their prevention, care and rehabilitation of burns.

This chapter describes what is currently known about childhood burns and how to prevent and manage them. In doing so, it summarizes the epidemiology of burns in children and the risk factors and discusses in detail both proven and promising interventions. The chapter concludes with a set of recommended interventions and a description of areas where further research is required.

For the purpose of this chapter, a burn is defined as an injury to the skin or other organic tissue caused by thermal trauma. It occurs when some or all of the cells in the skin or other tissues are destroyed by hot liquids (scalds), hot solids (contact burns), or flames (flame burns). Injuries to the skin or other organic tissues due to radiation, radioactivity, electricity, friction or contact with chemicals are also considered as burns (*1*).

Burns may be distinguished and classified by their mechanism or cause, the degree or depth of the burn, the area of body surface that is burned, the region or part of the body affected, as well as the extent. Box 4.1 summarizes three of the most commonly used classifications.

BOX 4.1

Classification of burns

There are several ways of classifying burns. The following are three commonly used typologies, based respectively on the cause, extent and severity of the burn.

Classification by mechanism or cause

Causally, burns may be classified as thermal or inhalational.

- *Thermal burns* involve the skin and may present as:
  - scalds – caused by hot liquid or steam;
  - contact burns – caused by hot solids or items such as hot pressing irons and cooking utensils, as well as lighted cigarettes;
  - flame burns – caused by flames or incandescent fires, such as those started by lighted cigarettes, candles, lamps or stoves;
  - chemical burns – caused by exposure to reactive chemical substances such as strong acids or alkalis;
  - electrical burns – caused by an electrical current passing from an electrical outlet, cord or appliance through the body.
- *Inhalational burns* are the result of breathing in superheated gases, steam, hot liquids or noxious products of incomplete combustion. They cause thermal or chemical injury to the airways and lungs *(2)* and accompany a skin burn in approximately 20% to 35% of cases. Inhalational burns are the most common cause of death among people suffering fire-related burn *(3)*.

Classification by the degree and depth of a burn

Burns may also be classified by depth or thickness:

- *First-degree or superficial burns* are defined as burns to the epidermis that result in a simple inflammatory response. They are typically caused by exposure of the unprotected skin to solar radiation (sunburn) or to brief contact with hot substances, liquids or flash flames (scalds). First-degree burns heal within a week with no permanent changes in skin colour, texture, or thickness.
- *Second-degree or partial-thickness burns* result when damage to the skin extends beneath the epidermis into the dermis. The damage does not, however, lead to the destruction of all elements of the skin.
  - Superficial second-degree burns are those that take less than three weeks to heal.
  - Deep second-degree burns take more than three weeks to close and are likely to form hypertrophic scars.
- *Third-degree or full-thickness burns* are those where there is damage to all epidermal elements – including epidermis, dermis, subcutaneous tissue layer and deep hair follicles. As a result of the extensive destruction of the skin layers, third-degree burn wounds cannot regenerate themselves without grafting.

In adults, a full-thickness burn will occur within 60 seconds if the skin is exposed to hot water at a temperature of 53° C *(4)*. If, though, the temperature is increased to 61° C, then only 5 seconds are needed for such a burn. In children, burns occur in around a quarter to a half of the time needed for an adult to burn.

Classification by extent of burn

The extent of burn, clinically referred to as the total body surface area burned, is defined as the proportion of the body burned *(5)*. Several methods are used to determine this measurement, the most common being the so-called "rule of nines". This method assigns 9% to the head and neck region, 9% to each arm (including the hand), 18% to each leg (including the foot) and 18% to each side of the trunk (back, chest and abdomen). The "rule of nines" is used for adults and children older than 10 years, while the Lund and Browder Chart is used for children younger than 10 years *(6)*. The calculation assumes that the size of a child's palm is roughly 1% of the total body surface area *(7)*.

Epidemiology of burns

According to the WHO Global Burden of Disease estimates for 2004, just over 310 000 people died as a result of fire-related burns, of whom 30% were under the age of 20 years (see Statistical Annex, Table A.1). Fire-related burns are the 11th leading cause of death for children between the ages of 1 and 9 years. Overall, children are at high risk for death from burns, with a global rate of 3.9 deaths per 100 000 population. Among all people globally, infants have the highest death rates from burns. The rate then slowly declines with age, but increases again in elderly adults.

The long-term consequences and the disability that can result from burns place a considerable strain on individuals and their families, as well as on health-care facilities. According to WHO data, approximately 10% of all unintentional injury deaths are due to fire-related burns (see Statistical Annex Table A.1). In addition, fire-related burns are among the leading causes of disability-adjusted life years (DALYs) lost in low-income and middle-income countries (see Statistical Annex A.2).

Mortality

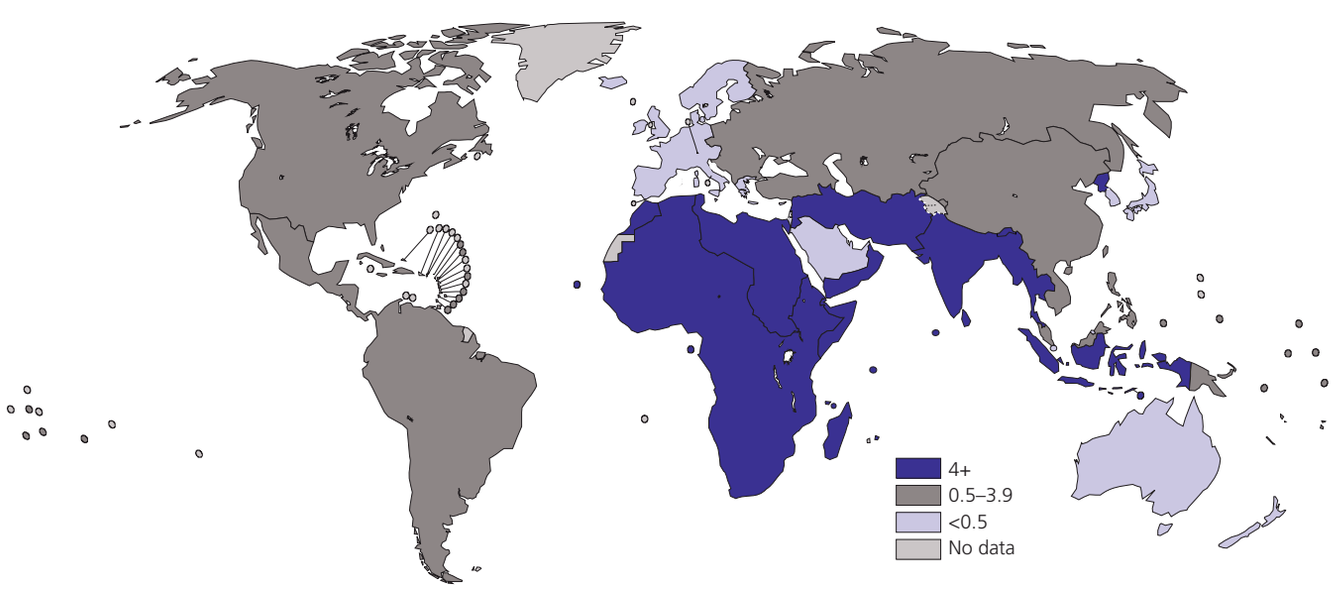
Globally, nearly 96 000 children under the age of 20 years were estimated to have been fatally injured as a result of a fire-related burn in 2004. The death rate in low-income and middle-income countries was eleven times higher than that in high-income countries, 4.3 per 100 000 as against 0.4 per 100 000 (see Statistical Annex, Table A.1). However, as can be seen in Figure 4.1, burn-related deaths show great regional variability. Most of the deaths occur in poorer regions of the world – among the WHO regions of Africa and South-East Asia, and the low-income and middle-income countries of the Eastern Mediterranean Region. The death rates in the Americas and the high-income countries of the Europe and the Western Pacific regions are among the lowest in the world.

Every year 70 Member States – mainly middle-income and high-income countries –submit to WHO mortality data that include the fourth digit of the International Classification of Disease codes, which allows disaggregation into subtypes of burns. Analysis of these data show that, in 2002, fire-related burns made up 93.0% of all burn deaths, scalds contributed 5.4% and the rest, 1.6%, were as a result of contact, chemical or electrical burns (*8*).

Studies from high-income countries suggest that smoke inhalation is the strongest determinant of mortality from burns, mostly from house fires or other conflagrations. For children over three years of age, smoke inhalation is strongly associated with mortality, despite improvements in the care of burns (*9*).

FIGURE 4.1

Mortality rates due to fire-related burns per 100 000 children[a] by WHO region and country income level, 2004



Africa	Americas		South-East Asia	Europe		Eastern Mediterranean		Western Pacific	
LMIC	HIC	LMIC	LMIC	HIC	LMIC	HIC	LMIC	HIC	LMIC
8.7	0.7	0.6	6.1	0.2	1.1	0.4	4.7	0.3	0.6

[a] These data refer to those under 20 years of age.

HIC = High-income countries; LMIC = low-income and middle-income countries.

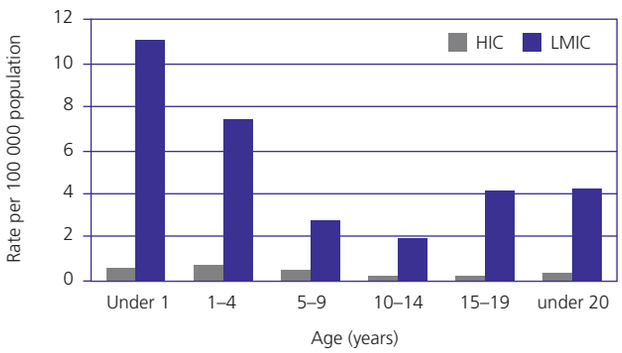
Source: WHO (2008), Global Burden of Disease: 2004 update.

Age

Figure 4.2 shows child death rates from burns by age group. Infants have the highest rates, while those aged between 10 and 14 years have the lowest rates. The death rate climbs again in the 15–19-year age range, possibly as a result of greater exposure, experimentation and risk-taking, as well as the fact that many in that group are beginning employment.

FIGURE 4.2

Fatal fire-related burn rates per 100 000 children by age and country income level, World, 2004



HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

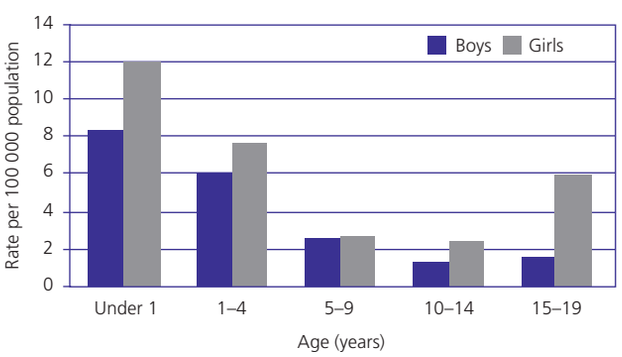
Gender

Burns are the only type of unintentional injury where females have a higher rate of injury than males. The fire-related death rate for girls is 4.9 per 100 000 population, as against 3.0 per 100 000 for boys. The difference is particularly pronounced in infants and also in adolescents between the ages of 15 and 19 years (see Figure 4.3).

The greatest gender discrepancies are found in the WHO South-East Asia Region and in the low-income and middle-income countries of the Eastern Mediterranean Region. In these regions, girls in the 15–19-year age bracket have death rates that are substantially higher than rates for the same age group in any other region (see Statistical Annex, Table A.1).

FIGURE 4.3

Fatal fire-related burn rates per 100 000 children by age and sex, World, 2004



Source: WHO (2008), Global Burden of Disease: 2004 update.

Morbidity

Global data on non-fatal outcomes from burns is not readily available. However, the WHO Global Burden of Disease project for 2004 makes it clear that burns are an important contributor to the overall disease toll in children in the low-income and middle-income countries of the African, South-East Asia and the Eastern Mediterranean regions (see Statistical Annex, Table A.2).

While burns from fire contribute to the majority of burn-related deaths in children, scalds and contact burns are an important factor in overall morbidity from burns and a significant cause of disability. Chemical and electrical burns among children, though, are relatively rare (*10–12*).

Age

In high-income countries, children under the age of five years old are at the highest risk of hospitalization from burns, although 15–19-year-olds, as already stated, are also a group at high risk. Nearly 75% of burns in young children are from hot liquid, hot tap water or steam. Infants under the age of one year are still at significant risk for burns, even in developed countries. The burns they suffer are most commonly the result of scalds from cups containing hot drinks or contact burns from radiators or hot-water pipes (*13*).

The following give an indication of the situation in some high-income countries:

- In Canada, in a single year, there were over 6000 visits to emergency departments in the province of Ontario (whose population is about 12 million) due to burns (*14*). Almost half the cases of burns are among children under five years of age (*15*).
- In Finland, an 11-year study found that scalds were responsible for 42.2% of children being admitted to two paediatric burns units. Among children under three years of age, 100% of burns were the result of hot water. In the 11–16-year group, 50% of burns were due to electricity, with the other 50% resulting from fire and flames (*16*).
- In Kuwait, the incidence of burns in children under 15 years of age was 17.5 per 100 000 population. Scalds (67%), followed by flames (23%), were the leading causes of burns (*17*).
- In the United States, one of the leading causes of injury from scalding in children is hot soup, particularly prepackaged instant soup (*18*).

In low-income and middle-income countries, children under the age of five years have been shown to have a disproportionately higher rate of burns than is the case in high-income countries. In Kenya, for example, 48.6% of children presenting to the Kenyatta National Hospital were under the age of five years. Although scalds were the most common type of burn, those caused by open flames were also prominent (*19*). Other examples from low-income

and middle-income countries show rather different age patterns and leading causes.

- In Shandong Province, China, a 5-year review of data from the burns unit revealed that children under the age of 10 years were admitted in the greatest numbers, followed by adults aged between 20 and 30 years. Scalds and fire-related burns were seen in roughly similar numbers (*20*).
- Burns from boiling liquids, most frequently water boiled for bathing, were among the leading causes of injuries to children under the age of 10 years in Cuernavaca, Mexico (*21*).
- In Maiduguri, north-east Nigeria, the commonest cause of burns was scalds (64.4%). Children under the age of three years were disproportionately represented (*22*).
- In Brazil, Côte d'Ivoire and India, infants account for nearly half of all childhood burns (*23–25*).
- In Fars Province in the Islamic Republic of Iran, the annual hospitalization rate for children under 15 years was 11.8 per 100 000 population. Scalds accounted for 46.2% of the burns, whereas flames accounted for 42.8%. Most burns occurred at home (*26*).

Similar results have been found in a recent study in four low-income countries. In this study, 53% of burns in children under 12 years of age were the result of a hot liquid, followed by fire and flame in 19% of cases and electricity in 14% of cases (see Statistical Annex, Table C.1).

Infants in Africa under one year of age have an annual incidence of fire-related burns of 35 per 100 000 – more than three times the world average for this age group (*27*).

Gender

The gender distribution of non-fatal burns differs between countries – a fact that may be related to cultural practices, particularly with regard to cooking. Some African and Asian countries – including Angola, Bangladesh, China, Côte d'Ivoire, Kenya and Nigeria – report a higher number of cases among males (*19, 20, 22, 24, 28, 29*). Others, such as Egypt and India, have a greater proportion among girls, particularly teenage girls (*30–32*).

The increasing proportion of burn injuries recorded in girls as they grow older might be explained by the changing activities of the two genders. While girls are increasingly involved in the kitchen, helping their mothers – and therefore more exposed to fire, and hot liquids and other substances – boys tend to stay more outdoors (see Box 4.2). In some cultures, "bride burning" is still practised and may be linked to a higher incidence of burns in adolescent females (*33*).

BOX 4.2

Burns to young working females in work and home settings

Burns are the leading cause of deaths from injury in many developing countries. Work-related burn injuries are relatively rare in children. Nonetheless, they are an important public health problem for young people employed in the catering industry and children working in residential kitchens. Work-related childhood burn injuries – in whatever setting – often go unreported, especially in developing countries, either because safety regulations are not being enforced, or because of a lack of regulation and supervision. Three types of workplaces are typically involved in employment-related burn injuries in children.

Catering and restaurant industry: The most common sources of burn injuries in restaurants and kitchens are cooking oils, hot water, steam and heating equipment. A study in the state of Washington, United States for the period 1989–1993, found that 2076 workers under 18 years of age suffered burn injuries, representing 7.6% of all work-related burn injuries. The most common sector in which they occurred was the food services industry. Young people working in fast-food outlets and restaurants made up 62% of these cases – as against only 32% of burn injuries in 125 other occupations combined (34). Similar findings for the state were also found for the period 1994–1998 *(35)*.

Other industrial settings, including metal industries: Children have the lowest rates of burns in large-scale industrial settings, presumably because they are generally unsuitable for this work and therefore have little exposure to its risks. Where they are involved and suffer burns, though, their burns are on the whole more severe than in other settings. In both industrial settings and in food services, males are more affected than females by burns.

House kitchens: Unlike the situation in other workplace settings, employment-related injuries in house kitchens principally involve girls. Girls working as house maids are generally responsible for cooking as well as other household tasks. They often work without contracts and may be deprived of legal support. Due to their young age, they are on average less skilful and more prone to burns than adults. In addition, their work conditions are frequently unsafe. Some young females are employed in households that are not their own, while others are obliged to work in their home as family members. The flammable and loose clothing often worn by young women in developing countries further increases the risk of burn injuries *(36)*.

In the Islamic Republic of Iran, burn injuries are the most common unintentional home-related injury *(37)*. Iranian injury registry databases show that during the period 1999–2001, 58% of all reported burn injuries were in children. In the Ardabil province of Iran, a recent study found that 65% of children suffering burns in the kitchen were girls, and that girls aged 16–17 years were three times as likely to be burned in the kitchen as were boys. The study also found that children younger than 12 years were having to help in cooking-related work in kitchens, with an average starting age of 8 years (see Table).

Children helping in household kitchen jobs, Ardabil province, Islamic Republic of Iran, 2006

Kitchen jobs	Proportion of children helping in kitchen (%)	Mean age of starting to help in kitchen (years)
Cooking	21.2	8.7
Preparing tea	37.2	8.0
Carrying hot food	37.5	7.9
Lighting the oven	24.0	–

Location

Most studies suggest that burns in children occur most frequently in the home, or else – among older children – in the workplace. A study in four low-income countries found that 65% of childhood burns had occurred in and around the home (Statistical Annex, Table C.1). The kitchen is usually the most common part of the house. In this room, children may upset receptacles with hot liquids, be injured by exploding stoves, stand on hot coals or be splashed with hot cooking oil.

Most burns occur in urban areas. Those burns that take place in rural areas with inadequate prehospital care, though, can lead to greater volumes of illness and disabilities.

Nature and severity of burns

Few empirical studies have described burn injuries by the body part affected. Among those that have, though, the most common sites are reported to be the following:

- from *scalds*: the trunk and upper extremities (*24, 38*);
- from *flame-related burns*: the lower extremities (*38, 39*);
- from *contact burns*: the hands (*40*);
- from *electrical burns*: there may be little external evidence of the burn but extensive internal damage. Small children who bite or suck on extension cords can burn their mouth and lips. Such burns may cause cosmetic deformities and impair growth of the teeth, mandibles and maxilla (*41*).
- from *chemical burns*: the site depends on whether the chemical is ingested, splashed or inhaled.

The total surface area of the body that is affected depends on the cause of burn, the mechanism of injury and the age of the child. In general, scalds and contact burns are less severe than fire-related burns. Lung damage, as a result of inhalation injuries, is the most frequent cause of death and is largely unpreventable (*42*).

Consequences of non-fatal burns

The study already mentioned that was conducted in four low-income countries found that the average injury severity score for children who had been burned was 5. In addition, 49% of affected children suffered some form of disability after a burn, with 8% being left with a permanent physical disability (see Table 1.5 in Chapter 1). There were similar results in Bangladesh, where a community-based survey revealed an annual disability rate of 5.7 per 100 000 children as a result of burns (*29*).

Burns can result in significant long-term consequences which – in the absence of a comprehensive and coordinated rehabilitation programme – can leave children scarred, physically and psychologically, for the rest of their lives. Most rehabilitation programmes seek to prevent long-term problems – such as scarring, contractures and other physical problems that limit functioning. However, attention should also be paid to managing pain as well as psychological issues such as anxiety, post-traumatic stress, phobias and isolation (*43, 44*).

The most common physical long-term consequences following a burn include hypertrophic scarring, extensive contractures, the formation of keloids and the need to amputate an extremity (*43*). Hypertrophic scarring in particular has been found to be one of the most significant long-term consequences of childhood burns, occurring in almost half of severe cases (*45*). Keloid formation is relatively more common among children of African descent (*46*).

> "My worst experience took place on a crowded bus. Other passengers kept looking at me so I took my jacket off and covered my head. I just wanted to be invisible and I wanted them all to disappear too." (Michael, aged 17, Changing Faces – a United Kingdom non-governmental organization for people with disfigurements)

The outcome following a burn depends on a number of interrelated factors. These include:

- the child's age;
- the body part affected;
- the proportion of body surface area burned;
- the length of time from injury to care;
- the type of care applied – such as dressings or debridement (the removal of damaged tissue from a wound);
- post-burn complications.

Burns to the face resulting in gross disfiguration can lead to poor self-esteem in children and adolescents (*47*). Children suffering burns when they are young, though, appear to be very resilient, adapting to their disfiguration with greater ease than those similarly affected during adolescence. A recent study from India showed that only adolescents in the study required psychosocial rehabilitation (*48*).

As one of the factors in the child's long-term social adjustment is that of self-esteem (*49*), social support networks may help the process. This is the case not only for the child, but also for parents, and in particular mothers, who often experience post-traumatic stress disorder after their child has suffered a large burn (*50, 51*). Nongovernmental organizations can play an important role in providing such support. So can "burn camps" for children, that were first set up in 1983 (*52*). Siblings of a child who has suffered burns should also be taken into consideration, as overprotecting the child can have an adverse behavioural impact on other children in the family (*53*).

Impact on families and communities

Evaluating the cost of burns and their treatment is difficult. It is certain, though, that burns create a heavy economic

load on health-care services. A study of hospitalizations in Bangkok, for example, found that the cost of burn injuries was not sufficiently reimbursed to the hospitals. As a result, the hospitals had to divert resources from other areas of care (*54*).

The cost of treating burns is dependent on the type and severity of the burn. In the United Kingdom, a recent study found the average cost of an uncomplicated minor paediatric scald to be £1850 (US$ 3618) (*55*). Another study from the United States found that the cost of hospitalizations from burns ranged from US$ 1187 for scalds to US$ 4102 for those resulting from fires (*56*).

In addition there are also costs to the families of children associated with hospitalization, the need for long-term rehabilitation, lost school days and education, possible future unemployment, social rejection and other psychosocial issues (*51, 57*).

The potential to reduce individual and societal costs by carrying out effective burn prevention interventions is huge. A recent study in Ontario, Canada (*58*), for instance, found that – through a combination of educational and legislative measures – preventing scald burns could save 531 Canadian dollars (US$ 507) per scald.

Limitations of data

There are wide differences between countries in data on childhood burns – as regards their availability, quality and reliability. The WHO Global Burden of Disease project data used in this chapter relies only on fire-related burns. Although these account for nearly 97% of fatal burns in children, the data still underestimate the total number of burns cases. This could be rectified if more countries submitted data that included the 4th digit of the ICD coding.

While there is no global morbidity database, there now exist many studies from both high-income and low-income countries on the epidemiology and risk factors for burns. Using these hospital-based studies researchers have tried to estimate the global extent of non-fatal burns. However, these attempts have been hampered by the lack of population-based information and also by the differing definitions of the age range of childhood (*59*).

Risk factors

Various studies, using descriptive and case-control designs, have found a range of risk factors for childhood burns. However, because of the way in which burns are coded in many countries, it is often impossible to distinguish between the different mechanisms that lead to burns. For example, the risk factors for burns caused by chemical agents, and the population most frequently affected by such burns, are both very different from the risk factors for and populations affected by scalds from boiling fluids. Thus, while the existing data identify children and young people as a high-risk population for burns, information on mechanisms and causal factors is largely missing. This section makes use of the Haddon matrix (*60*) to highlight the child, agent and environmental risk factors. Some risk factors are applicable, of course, only to certain types of burns (see Table 4.1).

TABLE 4.1

Haddon Matrix applied to the risk factors for fire-related burns among children

Phases	Factors			
	Child	Agent	Physical environment	Socioeconomic environment
Pre-event	Developmental issues, including experimentation; gender; vulnerability – including disabled children, refugees, street children; lack of supervision; parents smoking in the home or in bed; lack of knowledge about risks of fire in the home.	Storage of flammable substances in the house; combustibles, matches or lighters accessible to children; unsafe stoves or lamps; fireworks.	Housing in slums or congested areas; overcrowded households; no separation between cooking area and other areas; absence of flame-retardant household materials.	Poverty; unemployment, illiteracy among parents; sibling who died of burns; lack of fire-related building codes and their enforcement; lack of policies or laws on smoke alarms, sprinkler systems, access to hydrants; lack of policies or laws on flammability standards.
Event	Unmaintained smoke alarms and sprinkler systems; child not wearing flame-retardant clothing; poor knowledge about evacuation procedures.	Lack of sprinkler systems; lack of fire hydrants or other access to a supply of water.	Lack of functioning smoke alarms; lack of clear and easily accessible escape routes; lack of access to telephone to call for help.	Poor access to information and resources to minimize risk; inadequate communications infrastructure for calling emergency health services.
Post-event	Inaccessible first-aid kits; lack of knowledge by caregivers and community about what to do immediately after a burn.	Flammability of household materials and children's clothing; toxicity of smoke and burning household materials.	Poor emergency or fire department response time; poor rescue and treatment skills; lack of access to water; inability to transport to medical care promptly.	Inadequate burns care; inadequate access to burn centres and rehabilitation services; insufficient community support for those who have suffered burns.

Child-related factors

Age and development

Burns in very young children often occur from a mixture of curiosity and awkwardness. In children under the age of four years, the level of motor development does not match the child's cognitive and intellectual development and injuries can thus occur more easily (*61*).

Infants under the age of one year are in a particular category, as their mobility starts to develop and they reach out to touch objects (*13*). Consequently, burns to the palms of the hands are particularly common, as a result of touching heaters or hot-water pipes. Because a child has thinner skin on the palms and slower withdrawal reflexes, such contact burns may be deep and thus require prolonged and careful therapy during the healing phase to prevent flexure contractures of the hand (*40*).

Scald burns are the most frequent type of burn among children under the age of six years – an observation that appears to cut across geographic and economic groups. Typical scald burns occur when a child pulls down a container of hot fluid, such as a cup of coffee, onto his or her face, upper extremities and trunk. These are typically superficial second-degree burns. Apart from the pain they cause the child and the distress for the parents, these burns will typically heal within weeks, leaving little or no permanent damage.

As children grow older, they become less likely to be injured by common household objects and more interested in the world outside. There is then an increased likelihood that they will be involved in serious fires. In particular, boys older than 6 or 8 years of age often become curious about fire, leading to experimentation with matches, lighters or fireworks. In some cases, younger siblings are injured while watching the experimentation of an older brother or sister (*62*).

Gender

As already mentioned, burns are the only type of fatal injury that occurs more frequently among girls than boys in three WHO regions (see Table 4.2). For non-fatal burns, the pattern is not quite as clear, and in some settings boys may be at a greater risk of burns than girls, perhaps as a result of the more inquisitive nature of boys and their greater risk-taking behaviours (*63, 64*).

Local customs of using open fires for cooking and heating, together with the wearing of loose-fitting clothing, particularly among teenage girls in the South-East Asia and Eastern Mediterranean regions (*30*), are associated with an increased rate of burns among young women (*1*).

Vulnerability

Some children are more vulnerable to burns than others. Disabled children have a significantly higher incidence of burn injuries than non-disabled children (*65*). Although not specific to children, those who suffer from uncontrolled epilepsy appear to be at greater risk for burn injuries. Such injuries are often severe enough to require admission to hospital (*66*).

Other vulnerable groups – such as children of asylum seekers (*67*), those living in high-income countries but born to foreign parents (*68*), as well as children in rural areas distant from medical care – have higher incidences of burns and of their consequences (*69*).

Among street children, there have been numerous journalistic reports, though few scientific studies, on how they may be burned while sleeping in derelict buildings, underground sewers or close to open fires. Apart from the danger from flames, the inhalation of hydrocarbons or the sniffing of glue among street children can lead to burns of the trachea (*70*).

Studies have also found that the children of parents who smoke while in bed are at higher risk of burns than those who do not have parents who smoke (*71*).

Poverty

Mortality and morbidity from burns are strongly associated with poverty. In addition to the markedly higher incidence of burns among children in low-income and middle-income countries, there are also differences by socioeconomic class *within* high-income countries, with studies from Sweden and the United Kingdom showing an increased risk of burns among poorer children (*72, 73*). In Sweden, the relative risk of being hospitalized for a burn was 2.3 times higher for children in the poorest socioeconomic group than among those in the most prosperous group. Furthermore, within

TABLE 4.2

Fatal fire-related burn rates per 100 000 children[a] by sex, WHO region and country income level, World, 2004

	Africa	Americas		South- East Asia	Europe		Eastern Mediterranean		Western Pacific	
	LMIC	HIC	LMIC	LMIC	HIC	LMIC	HIC	LMIC	HIC	LMIC
Boys	8.9	0.7	0.7	3.3	0.2	1.3	0.6	3.6	0.3	0.4
Girls	8.5	0.6	0.6	9.1	0.2	1.0	0.1	5.8	0.3	0.8

[a] These data refer to those under 20 years of age.

HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

the poorest group, the risk for burns was greater than for any other childhood injury (*73*). In Australia, too, the risk of fire-related burns and scalds requiring a hospital stay was found by one study to increase as income decreases (*74*). This finding was confirmed by a systematic review of the risk factors for injury in a house fire. The review found that those in the lowest quintile of income were 2.4 times more likely to die in a house fire than those in the highest two income quintiles (*71*).

Agent factors

Unsafe equipment

Heat, light sources and cooking equipment – especially those relying on fossil fuels – all carry inherent risks (*75*). In particular, heating or cooking on open fires that are not enclosed or that stand at ground level pose significant dangers to children. There are similar dangers in the use of small kerosene stoves or lanterns, candles for lighting, and other volatile or highly flammable fuels within the house (*75–78*). Easy access for children to cooking appliances or pots with boiling liquids is a further risk factor for burns (*76, 79, 80*).

Unsafe electrical appliances, plugs, wires and other connections all increase the risk of electrical burns for children (*21, 80*).

Flammable substances

Flammable substances such as kerosene and paraffin should not be stored in the house. However, for practical reasons, they are not usually stored in this way. Apart from the obvious danger of fire, they are also a poisoning risk for small children, being frequently kept in containers lacking child-resistant closures (see Chapter 6).

Fireworks

Many countries celebrate religious or national festivals by setting off fireworks and many burn injuries regularly occur around these holidays (*75, 81, 82*). Fireworks pose a significant risk for children, particularly adolescent boys. In Greece, 70% of firework burn injuries recorded by the country's injury surveillance system involved boys aged 10 to 14 years, usually as a result of setting off the fireworks themselves. Girls who were injured by fireworks were usually bystanders (*81*). In Australia, 50% of those injured by fireworks were boys under 18 years of age (*83*).

Fireworks have been banned in many high-income countries unless they are safely set off by professionals as part of a public display. In most low-income and middle-income countries, there are no laws restricting the use of fireworks. However, in some countries that ban the private use of fireworks, injuries from them nevertheless occur, usually in adolescent males (*62, 83, 84*). In the state of Minnesota in the United States, after a law banning private fireworks had been repealed, there was an increase in the number of children suffering burns (*85*).

Environmental factors

Cooking and living areas

The overwhelming majority of childhood burns occur in the home, and in particular in the kitchen. It has been suggested that the location within the home of the heating equipment and the structure of the kitchen may present significant risks to children (*86*). In South Africa, for example, many homes consist of one or two main rooms, that are divided by temporary internal divisions made of curtains or cardboard. These rooms are utilized for functions such as sleeping, washing, cooking and eating, depending on the time of day and the requirements of the family (*86, 87*), or else as a work space (*88*). This type of domestic arrangement may greatly increase the exposure of a child to domestic equipment and sources of heat (*89, 90*).

Socioeconomic environment

A number of case-control and descriptive studies conducted in different parts of the world have identified several socioeconomic factors that increase the risk of childhood burns (*74, 75, 77, 79, 91–93*). These factors include:

- a low rate of literacy within the family;
- living in overcrowded dwellings or with cluttered areas in the home;
- a failure of proper supervision of children;
- a history of burns among siblings;
- the absence of laws and regulations relating to building codes, smoke detectors and flammable clothing.

Time of incident

Two peak times of the day have been reported for incidents involving burns – the late morning, when domestic tasks are being done, and around the time for the evening meal (*29, 94*). There have also been peaks noted, in some regions of the world, by season of the year. In tropical climates, where heating, even in winter, is not generally required, there is a fairly even distribution of cases of burns throughout the year (*28, 38*). In places where the winters are cold, though, an increased incidence of burns tends to be recorded during winter (*94–97*). The association, in many countries, of incidence of burns with public or religious holidays has already been noted.

Lack of access to water

Inadequate access to a good supply of water – in the form of a tap, hosepipe or sprinkler system – to douse flames or stop the flames spreading, is a strong risk factor (*74*). Similarly, a lack of smoke detectors or the presence of non-functioning smoke detectors appears to be related, in some developed countries, to an increased risk for childhood burns (*98*).

Protective factors

Several protective factors have been shown to reduce the risk of burns or to minimize their consequences (*74, 75, 77, 99*), including:

– literacy, particularly among mothers;
– knowledge of the risk of burns and of health-care services;
– ownership of the house;
– having living rooms separate from the kitchen;
– the use of fire-retardant fabrics for clothes;
– the installation of smoke detectors and water sprinklers;
– appropriate first-aid and emergency response systems;
– the existence of good quality health-care services.

Interventions

This section summarizes some of the interventions to prevent various types of burn injuries among children. The main protective factors for burns are briefly listed, and three broad approaches for prevention are described, namely:
– engineering, design and environmental measures;
– the introduction of legislation and standards;
– educational measures.

A fourth, and effective, approach consists of a combination of the three earlier ones. The management of burns, in particular first aid, and the value of dedicated trauma centres and of proper rehabilitation are discussed in a separate section.

Engineering measures

Safer lamps and stoves

In many low-income and middle-income countries, the lamps and stoves for lighting and heating use fossil fuels. These lamps and stoves are commonly linked to childhood burns. Developing safe stoves and moving them out of doors and off the ground would not only reduce the number of burns sustained by children but also reduce their exposure to indoor fumes. A trial in rural Guatemala of an improved wooden stove produced a decrease in both acute lower respiratory infections and fire-related burns. Rigorous evaluation of this trial is still in progress (*100*).

In Sri Lanka, an intervention using safe lamps for lighting is being implemented (see Box 4.3). Although this project too is awaiting evaluation, the initial results appear promising.

BOX 4.3

Cheap and safe alternatives to traditional paraffin lamps

Paraffin oil (also known as kerosene) is a flammable fuel, used widely in some countries for lamps. According to the World Bank Global Data Monitoring Information System[1], only 29% of households in sub-Saharan Africa are electrified, while in most countries in South Asia two out of three houses have electricity. While there are efforts in all these countries to provide more homes with electricity, progress is often slow. The global use of paraffin is therefore likely to continue for many years. At the same time, there is an urgent need for cheap and safe paraffin lamps.

A properly designed paraffin lamp it is not by itself unsafe for use in the home, even though it carries a flame. Like the kitchen knife, it is safe if well-designed and used with the proper basic safeguards. Unfortunately, paraffin lamps designed with safety in mind are relatively expensive. Around the world, millions of families use makeshift paraffin lamps that are very cheap – but unsafe. Poverty is the main factor here, though ignorance of the fact that their lamps pose a serious danger also plays a part.

In Mozambique, people use a lamp known as a *xiphefo*, consisting of a tall bottle with a wick-carrier placed on its top. In Sri Lanka, some lamps are made out of discarded medicine bottles, while others are burnt-out light bulbs fitted with a wire frame and metal base. Both types are light in weight and could easily topple, igniting the clothes of a child sitting or sleeping nearby.

People in these places have been accustomed to their traditional lamps from childhood. Marketing a safe alternative that is radically different would be difficult to accomplish. A strong promotional campaign on safety is therefore needed. People should be told how to use paraffin lamps safely, and, among other things:
– not to add paraffin to burning lamps;
– not to place lamps at the edge of a table or other raised surface;
– not to hang the lamps on walls;
– not to use containers for paraffin that previously contained petrol.

The unsafe, makeshift lamps that are used by poor people cost very little. Therefore any alternative that is proposed has to be as cheap as possible.

There are two options. The first is the use of a safer oil, in place of the paraffin in the existing lamps. Vegetable oils such as those of coconut, sesame, neem and mustard are safe, but their disadvantage is that they do not rise in the wick-carrier.

The second option is for a lamp that is safe, even with paraffin. Such a lamp is, in fact, currently being marketed in Sri Lanka to good effect. Its principal features are:
· It is short and heavy, so that it does not easily tip over.
· It has two flat sides, so that even if it tipped over, it would not roll.
· It has a screw-on metal lid, to prevent oil spilling if it tips over.
· Its design is simple and it can be mass-produced at low cost.
· It has a near-globular shape and is made of thick glass, so that it does not crack if it falls.
· There are no delicate or moving parts, so that it can be used for several years.

The use of such a lamp, with appropriate basic care being exercised, could prevent the many paraffin burns that occur around the world each year, though its efficacy has yet to be subjected to rigorous evaluation.

[1] Available at web site: http://ddp-ext.worldbank.org/ext/GMIS/gdmis.do?siteId=1&menuId=IDA14RMS10

Families in many developing countries will continue to use fossil fuels for heating and cooking, until such time as the cost of electricity and of essential electrical appliances becomes affordable (*101*).

Smoke alarms

Evidence for the effectiveness of interventions exists most markedly in the case of smoke detectors, which have been found to reduce the risk of deaths by over 70% (*102*). The problem, though, is to make sure that all homes have working smoke alarms on all levels of the residence, including in the sleeping areas. People often remove the batteries from their smoke detectors to avoid the nuisance of false alarms, or else do not check the batteries regularly. For optimum protection, most smoke detectors require that they be tested monthly and that their battery be changed twice a year. However, there are new devices, which – while more expensive – make use of a 10-year battery. Fully integrated, hard-wired smoke alarms often now come with the new types of residential construction, at least in some developed countries.

A systematic review of controlled trials of interventions promoting smoke alarms found that approaches that used only education produced only modest benefits. Programmes that provided and installed smoke alarms appeared to reduce fire-related injuries (*103*). However, programmes that combined legislation on smoke alarms with installation and education seemed to result in the greatest benefit (*104*).

A study in the United States (*105*) evaluated the cost-effectiveness of smoke detectors and found the ratio of the cost of detectors to the saving in health-care costs to be 1:26.

Residential sprinklers

Fire sprinkler systems have been proved to be effective (*106*) and can now be found widely in public and commercial property in many countries. Home sprinkler systems, on the other hand, are recommended but not widely used, though in some countries governments require them to be installed in the construction of new homes.

Fire-retardant household materials

Modifying products associated with fire-related burns is a promising approach. Following the introduction in Australia of fire-retardant material for children's bedclothes in 1979, the annual number of burns related to clothing dropped from around 300 to 30 (*107*). In the United States, children's bedclothes are regulated by the United States Product Safety Commission. Certain types and sizes of clothes need to pass a flammability test or else be tight-fitting, so as to reduce the risk of burns (*108*). In addition, many countries require that bedding, mattresses and upholstered furniture be fire-retardant.

Environmental measures

Promising environment modifications that may reduce the incidence of burns include, among others:

- introducing new or stricter building codes and standards;
- modifying or improving construction materials;
- improving heating and lighting equipment in homes;
- raising cooking facilities off the ground;
- separating cooking areas from living areas.

Unfortunately, although promising, such prevention measures have not been well evaluated, particularly in low-income and middle-income countries.

A Cochrane review of interventions that altered the home environment to reduce all types of injury, including burns, concluded that there is still insufficient evidence to determine their effectiveness (*109*).

Laws and regulations

Laws and regulations are one of the most efficient ways to get people to adopt safe behaviours. In addition to legislation enforcing smoke detectors, which has proven effective in many high-income countries, three other measures appear to be effective – laws on the temperature of hot-water taps, banning fireworks and standards for child-resistant lighters.

Temperature of hot-water taps

Interventions to prevent scald burns focus primarily on education together with laws and their enforcement regulating the temperature of hot water from household taps (*110*). In the United States, the control of hot-water temperature in taps in the state of Washington reduced the number of domestic hot-water scalds by combining an educational programme with laws cutting the temperature in preset water heaters from 60°C to 49°C (*111, 112*). As a result, 84% of homes changed to lower temperature. Other educational interventions in Norway (*113*) and New Zealand (*114*) aimed at reducing the hot-water temperature were also successful in reducing burns. A Canadian study evaluated the effectiveness of a combined educational and legislative approach to reduce thermostat settings and found a 56% reduction in scald burns (*58*).

Child-resistant lighters

A survey in the United States in 1985 showed that children playing with lighters were the cause of residential fires resulting in 170 deaths and 1150 injuries annually in the country (*115*). As a result, the United States Consumer Product Safety Commission developed a standard for cigarette lighters that applied to all products manufactured or imported into the country. A study after this standard was introduced found that fires, deaths and injuries caused by young children playing with lighters had been reduced by as much as 58%, saving over half a billion US dollars in

societal costs in 1998 alone (*116*). Other countries followed the United States example. In 2007, the European Union introduced laws requiring manufacturers and importers to comply with the European standard for child-resistant lighters (*117*). Although child-resistant lighters are not a substitute for parental supervision, considerable savings to the health sector and society could be made if all countries adopted similar standards.

Banning of fireworks

Many high-income countries have banned firework purchase or ownership by children. A recent review in the United Kingdom revealed that since the introduction of the Fireworks Act in 2003 and the Fireworks regulation in 2004 which limited the sale of fireworks to the three weeks surrounding Bonfire Night, and banned the sale or possession of fireworks by under 18 year olds, more than 80% of children's firework injuries were seen in the three weeks surrounding Bonfire Night. They concluded that the law had a definite impact on reducing non-Bonfire related firework injuries, but that stricter enforcement was required (*118*).

Educational approaches

Increased knowledge about burns among young children has been shown to result from educational programmes in schools and communities (*119*). It is unclear, though, whether these programmes have any effect in reducing the incidence of burns, as they lack a rigorous evaluation of the long-term outcomes of burn injuries (*120*).

Community programmes to ensure good supervision of children, particularly those with disabilities, to educate parents about burns and to advise against the storage of flammable substances in the home, have all been proposed as primary prevention strategies for burns (*92*). A programme in Bangladesh involves children being placed in nurseries for a number of hours each day. The purpose is to give the mothers free time for their domestic tasks, so that they can be more attentive when the children return home. The programme has yet to be evaluated for its effectiveness in preventing burns or drowning.

Educating parents about the use of safety equipment has been shown to result in increased knowledge, but again it has not been possible so far to demonstrate that as a result there is better use of such equipment (*121, 122*). The effectiveness of home visitation programmes is similarly uncertain. In general, educational programmes appear more successful when coupled with increasing access to safety products or with changes in the law.

Combined strategies

Strategies which combine legislation and standards, product modification and education appear to have the most far-reaching effects in reducing the incidence of burns (see Box 4.4).

BOX 4.4

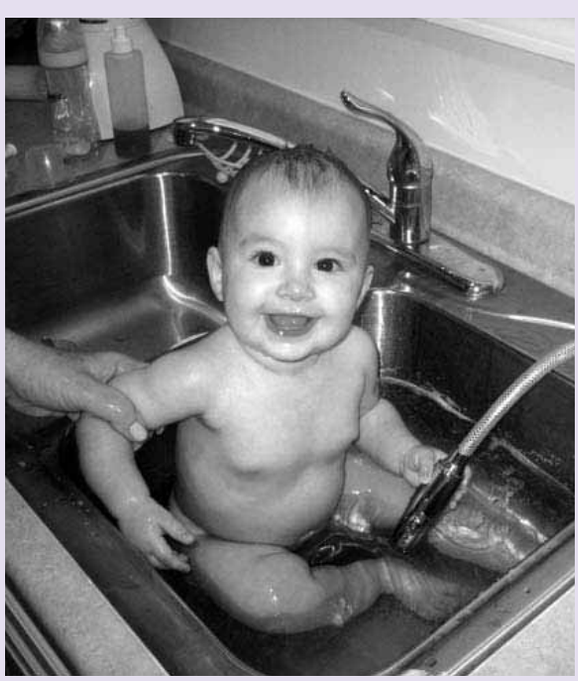
"Hot water burns like fire"

In 1992, the Australian state of New South Wales launched the country's first state-wide prevention campaign for scalds in children, entitled "Hot Water Burns Like Fire". This followed a report on injuries in emergency departments that showed scalds as the fourth-leading cause of hospitalization among young children. The main agents of scalds identified were: hot tap water, hot beverages, kettles and saucepans. As a result of this campaign, the whole of Australia now has laws mandating a maximum temperature of 50° C for hot water taps in bathrooms – for new installations fitted and old ones that are replaced.

The first phase of the campaign aimed to raise awareness about the causes of scalds to children, the most serious and preventable one being hot tap water. This phase involved community heath-care staff, health promotion personnel, retailers, plumbers and the members of the hot-water heating industry.

The second phase, beginning in 1994, focused on how to modify temperatures of hot-water taps in bathrooms. Following meetings involving experts in infection control and manufacturers of hot-water heating, an amendment to the national standards on hot water delivery for personal purposes was introduced. Each state was then obliged to change its plumbing code so that the delivery of hot water in homes was capped at 50° C. This involved the use of a temperature testing card and a brochure with instructions on how to test and modify the temperature.

Between 1989 and 1996, the rate of hospitalizations for scalds involving young children aged 0–4 years fell by 13%. In the same period, the duration length of hospital stay dropped by 18%. The combined effect of the reduced number and severity of cases resulted in a net 27% fall in the total number of hospital beds utilized. Rates for the most serious scalds (involving a stay of 10 days or more) showed the greatest decline – a reduction of 30% for the two years following the second stage of the campaign. In all, there was an annual saving to the health care system of between 3.8 and 6.5 million Australian dollars, based on an average cost of treating a serious scald.



Managing burns

Access to treatment and rehabilitation

Although the care of burns depends largely on the availability of financial and human resources, many countries still manage to deliver good quality care despite limited health budgets. A number of cheaper options for burns management are currently being evaluated. These include:

- open, as against closed techniques to manage wounds (*123*);
- less costly grafting techniques (*124*).

In addition, practical guides for managing paediatric burns are being promoted in developing countries (*125*).

In many places the cost of treatment is high and only those who are well-off can afford to take their children to hospital (*38*). This can result in delayed healing, contractures and superimposed infections.

Families frequently resort to using traditional methods of healing before attempting to access modern medicine, because of the difficulty of accessing such health care (*27, 126*).

First aid for burns

Following a burn, the child should be stabilized before being transported to hospital. This is usually done by family, bystanders or first responders and should follow the basic rules of what should and should not be done in these circumstances (see Table 4.3). The overall aim must be to cool the burn, prevent ongoing burning and prevent contamination.

There are many studies assessing the first aid of burns in high-income countries, and from these, examples of good practices – such as to "cool the burn" – are drawn. Cooling the burn surface is one of the oldest methods of treatment (*127*). However, only a handful of studies have examined burn interventions in low-income and middle-income countries. A survey in India found that only 22.8% of patients had received appropriate first aid for their burns. The remainder had either received no first aid or else inappropriate treatment – such as raw eggs, toothpaste, mashed potato or oil being rubbed into the burn (*32*). In Viet Nam, a study compared children who had received immediate cooling with water after a burn with those who had not. It turned out that those who had received proper first aid needed 32% less subsequent grafting (*128*). Education on the effect of immediate application of cool (not ice cold) water to burns should be promoted widely as an effective first-aid treatment.

Acute management of burns

Medical care for burns has markedly improved survival. In the United States in 1940, 50% of children with burns involving 30% or more of their total body surface died. In 2000, a study in the same country found no deaths in children with burns involving as much as 59% of body surface area (*129*). In Pakistan, on the other hand, burns of over 40% in children are still often fatal (see Box 4.5).

Once a child suffering burns has been transported to an acute care facility, assessment and stabilization initially focus on a survey of airway, breathing and circulation. There should also be a careful examination of the child from head to toe, looking for other signs of trauma. Children with second-degree burns usually present with intense pain and typically hold the affected limbs immobile in a position of comfort. The site of the burn should immediately be assessed to determine its severity. Pain management in such cases is essential.

For reasons that are not yet understood, when the size of a burn exceeds 15% to 20% of body surface area of the affected child, the inflammatory response extends beyond the local site of injury. Blood pressure becomes dangerously low, and if fluids are not given fast enough, the child will go into shock and die. If the child does survive the first 48 hours, there is still a risk of death from infectious complications, since the barrier to bacteria is broken and the immune system suppressed.

The overall aim of managing burn wounds is to close the wound as quickly as possible, either by allowing the

TABLE 4.3

First aid for burns

What not to do	What to do
· Do not commence first aid before ensuring your own safety (switch off electrical current, wear gloves for chemicals, etc.). · Do not apply paste, oil, kumkum (a paste made from turmeric) – or raw cotton to the burned area. · Do not apply ice. · Do not open the blisters with a needle or pin. · Do not apply any material directly to the wound as it might become infected. · Avoid application of topical medication until the patient has been placed under appropriate medical care.	· Stop the burning process by removing clothing and irrigating the wounds. · Apply cold water or allow the burnt area to remain in contact with cold water for some time. · In flame injuries, extinguish the flames by allowing the patient to roll on the ground, or by applying a blanket, or using water or other fire-extinguishing liquids. · In chemical burns, remove or dilute the chemical agent by copiously irrigating the wound with water. · Obtain medical care.

Source: reference *1*.

BOX 4.5

Managing burns in Pakistan

Burns are one of the most neglected areas of health care in developing countries. These countries have 90% of global burn injuries, with 70% of these injuries occuring in children. While there have been major improvements in burn care in many high-income countries, making it quite possible for patients with burns of more than 90% of body surface area to survive, in countries such as Pakistan, burns of over 40% are frequently fatal. Even minor burns can lead to significant illness as a result of recurrent wound infections, delayed wound healing and the formation of contractures.

There are various reasons for this poor outcome. Access to care may be impeded by difficult terrain, as well as by a lack of pre-hospital services and inefficient chains of referral. Even if the patient manages to reach a health-care facility, initial resuscitation procedures are frequently inadequate. Appropriate airway management, mechanical ventilation and aggressive fluid resuscitation are often not provided in the first few hours.

Burn care has become highly specialized and is performed at dedicated centres. These specialized institutions not only provide comprehensive clinical care but also serve as important research centres. In several developed countries, burn centres have existed for more than 60 years. Today, the United States has 70 burn centres. In Pakistan, there are only eight specialized burns units for a population of 150 million people. Their standards of care vary considerably, depending on the workload, the availability of funding and the quality of management. There are no nationally-agreed standards or ways in which to enforce standards. In the whole of Pakistan, there are currently only 15 to 20 surgeons who are burn care specialists.

The ability of health-care specialists to manage sepsis and inhalational injury often defines the eventual outcome in patients with burns. Managing sepsis requires meticulous aseptic wound treatment and surgical debridement, and the early recognition and aggressive treatment of sepsis and septic shock, as well as nutritional support. Similarly, inhalational injury often requires long periods of mechanical ventilation under the supervision of an experienced critical care worker.

Burn care is also expensive. In Karachi, the daily average cost of treating a patient with a major burn of 25% or more of body surface area is around US$120, and a hospital stay can last as long as 8 to 10 weeks. The economics of burn care discourages the creation of burns centres in the private sector and fails to attract committed staff.

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skin to heal by secondary intention (allowing the wound to heal over on its own) or through surgical closure (grafting). The management of small, deep second-degree burns has evolved into an efficient and effective plan of treatment that nowadays produces highly satisfactory cosmetic and functional results with minimal morbidity. The treatment plan has two components: excising the burn wound before suppuration occurs; and covering the excised wound with synthetic or biological wound coverings. However, large, deep second-degree or third-degree burns, particularly in children, continue to pose a significant problem for the burn surgeon.

The surgical approach to early excision and grafting of burn wounds involves trained personnel and safe and effective resources. As removing the burn wound is a procedure associated with a high volume of blood loss, the operation cannot be performed unless there are facilities in the hospital to provide blood for transfusions. The management of children around the time of such an operation is very complicated and requires collaboration with experienced anaesthesiologists (*125*). The post-operative care of the grafted wounds and the areas from which skin has been taken for the grafts calls for a team of trained nurses and occupational and physical therapists. For these reasons, early excision and grafting may not be an appropriate course to be taken in some low-income countries.

Sadly, the usual fate of a child with an extensive third-degree burn in a low-income country is death. The risk of mortality from burns covering over 30% of total body surface area is roughly 50%. The risk of burns covering more than 50% of total body surface area is nearly 100% (*56*). For those children who survive such severe burns, most are left with unsightly scarring, resulting in both physical and psychological disability.

Dedicated trauma centres

Not all children require treatment from a dedicated trauma centre. A large number of countries now have such centres and criteria exist for deciding which patients are transferred to them. The American College of Surgeons and the American Burn Association recommend that children with the following conditions should be treated in a burns centre (*130*):

- partial thickness (second-degree) burns greater than 10% of the total surface area of the body;
- burns involving the face, hands, feet, genitalia, perineum or major joints;
- full-thickness (third-degree) burns;

– electrical burns, including injuries from lightning;
– chemical burns;
– injuries from inhaling smoke;
– pre-existing medical disorders that could complicate the management of burns, prolong recovery or affect survival;
– accompanying trauma, where the burn injury poses the greater risk of morbidity or mortality.

While it is well established that trauma systems prevent unnecessary deaths in patients with blunt or penetrating injuries (*131*), there are few data to sustain this argument in the care of burn patients (*132*). Nonetheless, expert opinion supports the claim that patients with serious burns will have better outcomes and with less costly management if they are in a dedicated burn centre (*133*).

Rehabilitation facilities

Children who sustain burns deserve the best rehabilitation facilities available, so that they are able to return to productive and meaningful roles within their community. The requirements for rehabilitation should be discussed during the acute phase and should involve not only physical but also psychological therapy (see Box 4.6). Inadequate rehabilitation can result in physical and psychological damage with a serious lifelong effect.

BOX 4.6

Rehabilitation for paediatric burn survivors in South Africa

Burn injuries are tragic, largely preventable and frequently have lifelong consequences for the young patient. In South Africa these injuries are on the increase. This is due to factors such as poverty, illiteracy, a lack of resources, urban migration and the consequent rising number of makeshift housing settlements.

New developments and improvements in burn care generally have led to increased survival rates and a fall in the death rate. However, paediatric burn survivors need more than excellence in wound care, surgery and nursing. They also require in-depth rehabilitation, consisting not only of physiotherapy and occupational therapy, but also of emotional support and reintegration into the community.

An estimated 90% of children who have survived burns are not followed up. Once a child is discharged from hospital, the parents often do not recognize that follow-up rehabilitation or long-term reconstructive surgery may be needed. For those who do receive rehabilitation services, the emphasis is largely on physical rehabilitation, rather than emotional support and community reintegration. South Africa has an acute shortage of appropriately-trained professionals to provide for the complex rehabilitation needs of burn survivors.

At Cape Town's Red Cross Hospital burns unit, up to 96% of children admitted are from disadvantaged communities. A study at this hospital in the late 1970s found that up to 70% of severely burned children either attempted or actually committed suicide. In 2002, health professionals at the hospital set up a three-tiered pilot rehabilitation project for burned children and their families.

The first phase of rehabilitation starts as soon as possible during the admission stage. At this point individual physiotherapy, occupational therapy and the management of pain is arranged. A community worker will also become involved, responsible for parental support during this first phase and for long-term follow-up of disfigured children during the final phase of rehabilitation. The Red Cross Hospital is unique in including touch therapies – such as reflexology and aromatherapy – in the management of burns, along with more traditional treatments such as music and art therapy. This holistic approach thus attempts to deal with stress and anxiety, as well as with the general emotional well-being of the child.

The second phase is on an out-patient basis and continues what was started in the first phase. The previous therapies are again offered, along with such things as children's yoga and creative play. The use of the African drum (jembe) has been found to be particularly successful in music therapy.

The third and final phase of rehabilitation focuses mainly on community and school reintegration. Information is disseminated through the mass media on the situation of disfigured children and their needs. Teachers from 63 township schools have received training around the prevention of burns and the reintegration into the education system of children disfigured by burn injuries. Continuous education for children is the single most important outcome of their successful rehabilitation. Disfigured children are often reluctant to return to school for fear of being ostracized. If they stay uneducated they are more likely to be unemployable. In South Africa, this could lead to the child's ending up on the streets or in prison.

Through this programme, the Red Cross Hospital aims to provide for the emotional needs of children who have suffered burns and help them become fully reintegrated into society. For financial reasons, only the first phase of the three-phase programme is being offered at present. Community reintegration of burned children can be achieved, even in the developing world. However, this requires dedicated, trained staff and the substantial financial resources which are sadly lacking.

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Adapting interventions

The extent to which interventions that work in one socioeconomic setting can be effectively transferred to another depends on several factors. The advantage of transferring an established intervention – if that is possible – is that resources are conserved. A decision, though, to implement a particular intervention measure in a particular place should always be based on solid scientific evidence, considerations of cost, cultural appropriateness and sustainability (*134*).

Potentially harmful interventions

First-aid treatment for burn injuries is best accomplished with cool water (*127, 135*). Traditional treatments, though, continue to be practised. These include putting butter or oil on sunburn, and ice, aloe, sugar water, toothpaste or other household products on a second-degree burn. All these traditional practices can be harmful, as they can cause the skin to slough away, leaving the tender lower layers susceptible to infection. Although some agents – such as honey or commercially available cold packs – may indeed have some beneficial effects, they are better avoided. Instead, people should be advised to use only cool, clean water.

Evaluating interventions

A number of evaluation studies have been conducted in high-income countries. These include an economic analysis of 1990 that found that three quarters of childhood fire-related deaths in the home could be prevented if there were working smoke alarms, sprinkler systems, anti-scald devices, slow-burning cigarettes and childproof lighters (*136*).

There are no systematic evaluations, though, of burn prevention strategies in low-income and middle-income countries. Nevertheless, a number of interventions appear promising. Among them are: separating cooking areas from living areas; eliminating the storage of flammable substances in the house; placing cooking surfaces higher than ground level; introducing smoke alarms; making first aid available; and increasing awareness about burns and their prevention (*137*). At the same time, others, such as community-based interventions and campaigns (*138*) and home visitation programmes for at-risk families *(139)*, have insufficient evidence for them to be promoted as good practices.

Further research in these areas is needed so that model intervention programmes can be developed for implementation in countries that share a similar pattern of childhood burns.

Conclusions and recommendations

There is overwhelming evidence that childhood burns are largely environmentally conditioned and preventable (*93*). It would therefore seem natural that the prevention of burns should focus on a mixture of environmental modifications, parental education and product safety (see Table 4.4).

Special attention needs to be paid to the kitchen, the scene of the majority of burns. Programmes are needed to ensure proper supervision of children and their general well-being, particularly of those with disabilities. Parents should receive better information about all types of burns. There must be much greater awareness everywhere about the dangers of storing flammable substances in the home.

Recommendations

A range of measures to prevent burns have been discussed in this chapter. Many of these still require rigorous evaluation, particularly in low-income and middle-income countries.

- Those prevention interventions that have proved effective include:
  - laws and enforcement for the installation of smoke alarms;
  - child-resistant lighter standards;
  - laws to regulate hot-water temperature.
- A number of other prevention interventions are considered highly promising. These include:
  - the use of safe lamps;
  - the separation of cooking areas from living areas;
  - the development of safer stoves.
- As regards measures taken after the event, two fire related measures are strongly recommended:
  - smoke alarms;
  - residential sprinkler system.
- The management of burns, from first aid to rehabilitation, is an essential component of secondary and tertiary prevention strategies. Children who suffer burns require the best care available so as to minimize the potentially serious physical and psychological long-term consequences of this type of injury.
- Educational programmes convey knowledge to children and parents. They are useful for creating a climate in which campaigns for changes in behaviour and in products will be supported. For prevention purposes, educational programmes are often combined with programmes involving legislation and standards and product modifications. Education and counselling *on their own*, though, whether at the individual level or within schools, appear to be ineffective in reducing the incidence of burns.

"Thermal burns are a common cause of accidental death in children worldwide. Despite various methods of prevention and care, such injuries are on the rise. Only through a deeper understanding of the underlying causes can we develop truly viable alternative solutions. If the proposals outlined in this report are implemented correctly, they can bring about the necessary changes." Mehmet Haberal, President, International Society for Burn Injuries.

TABLE 4.4

Key strategies to prevent burns among children

Strategy	Effective	Promising	Insufficient evidence	Ineffective	Harmful
Setting (and enforcing) laws on smoke alarms	■				
Developing a standard for child-resistant lighters	■				
Setting (and enforcing) laws on hot-water tap temperature and educating the public	■				
Treating patients at dedicated burns centres	■				
Separating cooking areas from living areas		■			
Developing standards and codes for fire-retardant garments		■			
Banning the manufacture and sale of fireworks		■			
Promoting the use of safe lamps and stoves		■			
Providing first-aid for scalds – "cool the burn"		■			
Conducting home visitation programmes for at-risk families			■		
Installing residential sprinklers			■		
Distributing smoke alarms on their own (without accompanying laws)			■		
Conducting community-based campaigns and interventions			■		
Storing flammable substances correctly			■		
Modifying the environment, e.g. home alterations			■		
Conducting school-based burns prevention programmes			■		
Using traditional remedies on burns					■

Source: references *120, 137, 138*.

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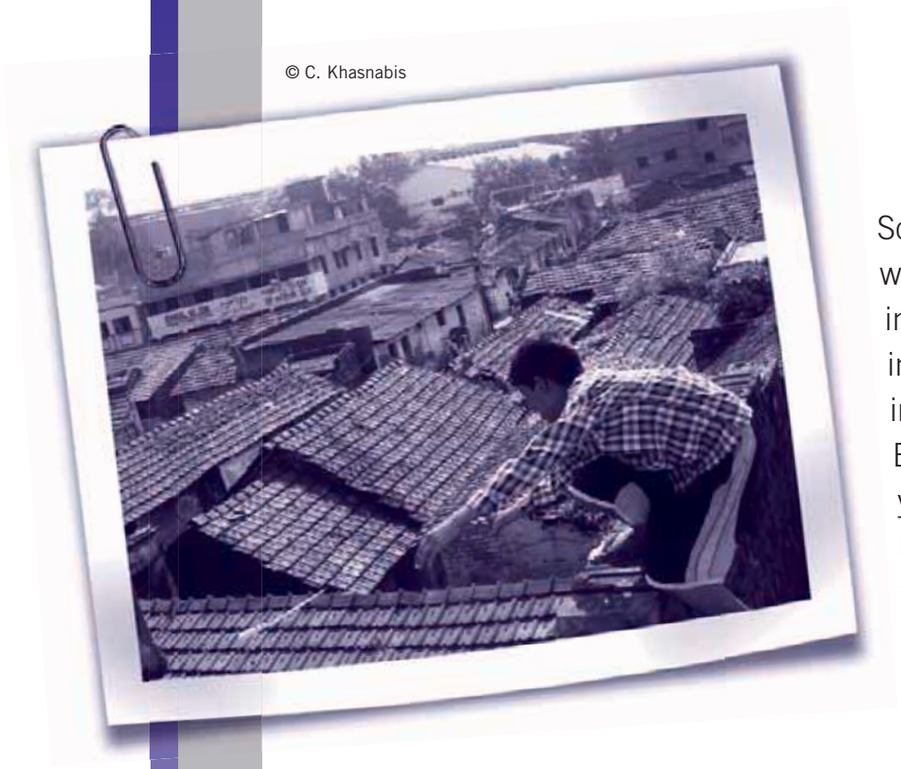
FALLS

SOHEL'S STORY



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Sohel, a boy of 14 years, was the main breadwinner in his family of four. He lived in the village of Krishnapur, in Narsingdi district in Bangladesh. At the age of 7 years, Sohel lost his father, Fazlur, who had slipped in the bathroom and suffered a severe head injury.

The father left behind a small plot of land and a poor dwelling. The mother, Jharna, a 38-year-old widow, did household work for neighbours to earn a minute income. As a result of their circumstances, Sohel dropped out of school when he was in the seventh grade, and began to cultivate their small piece of land. He grew rice and other crops, which mostly went for their own consumption. Sohel and his friends used to go to the river to fish, to earn a bit of extra money for their daily living.

It was the rainy season, in July 2004. One afternoon Sohel went out to the river to fish with his two friends. After failing for two hours to catch anything, they returned despondently to the village. There was an old mosque there, on which the villagers had started some renovation work. Keen to see what had been done and inquisitive by nature, Sohel climbed onto the roof of the mosque. No construction workers or anyone else were around at the time. Sohel's friends wouldn't follow him and pleaded with him not to climb. Sohel ignored them and walked around the roof, moving towards the edge.

The roof, littered with construction materials, was very wet. Suddenly Sohel stumbled over some materials, lost control and fell from the roof. His head, which was badly injured, bled profusely, his right hand was broken and he lost consciousness. Some nearby people, alerted by the cries of his friends, took him to the nearest health centre, 15 kilometres from the village. So severe were his injuries that the paramedic could not help him. Within half an hour, he was dead.

Sohel's tragic case is not unique in Bangladesh. The Bangladesh Health and Injury Survey showed that each year more than a thousand children under 18 years of age die in the country as a result of unintentional falls. Each year five thousand children are injured from rooftop falls alone. Over 5% of these become permanently disabled while the others suffer from varying degrees of illness. More than half the childhood injuries are among 10–14-year-olds, with more boys than girls suffering *(1)*.

To stop more children like Sohel needlessly dying from what are preventable injuries, action must be taken now.

Chapter 5
Falls

Introduction

Falling is a normal part of the way a child develops – learning to walk, climb, run, jump and explore the physical environment. Fortunately, most falls are of little consequence and most children fall many times in their lives without incurring damage, other than a few cuts and bruises. All the same, some falls are beyond both the resilience of the human body and the capacity of the contact surface to absorb the energy transferred. Falls are thus an important cause of childhood injuries, including those resulting in permanent disability or death. Falls of this degree of seriousness are not randomly distributed, either globally or within single countries. To understand why this should be one needs to examine the built environment and the social conditions in which children live.

This chapter focuses on the main ideas underlying the prevention of unintentional falls in childhood, using a public health approach. The extent and characteristics of the problem are first identified and after that the types of exposure that are linked to a risk of injury. Intervention strategies to prevent such injuries and their disabling consequences are examined for their effectiveness and cost-effectiveness. Finally, consideration is given as to how the most promising strategies can be successfully implemented on a wider scale.

Falls have been defined and recorded in several ways. This chapter adopts the World Health Organization's definition, according to which falls are "an event which results in a person coming to rest inadvertently on the ground or floor or other lower level" (*2*). In the WHO database of injuries, fall-related deaths and non-fatal injuries exclude those due to assault and intentional self-harm. Injuries and deaths resulting from falls from animals, burning buildings and vehicles, as well as falls into water and machinery, are also not coded as falls. Instead, they are recorded, respectively, as injuries due to animals, fire, transport, submersion and machinery.

An expert group convened by the National Institute of Child Health and Human Development defined falls as an external cause or type of exposure, the impact of which is "to come down by force of gravity suddenly; to tumble, topple, and forcibly lose balance" (*3*). The group listed the main factors relating to falls in childhood. These included:

- social and demographic factors, such as the child's age, gender, ethnicity and socioeconomic status;
- the physical development of the child;
- activity taking place before the fall – such as running, walking or climbing;
- the location of the fall;
- the height from which the fall occurs;
- characteristics of the surfaces with which contact is made – such as texture, smoothness and deformability.

All this information, if available, taken together with information on risk factors, can provide valuable clues as to how and why fall-related injuries occur, and greatly help efforts to prevent them.

Epidemiology of falls

According to the WHO Global Burden of Disease project for 2004, an estimated 424 000 people of all ages died from falls worldwide. Although the majority of fall-related deaths were among adults, they ranked as the twelfth leading cause of death among 5 to 9-year-olds and 15 to 19-year-olds (see Table 1.1 in Chapter 1). Morbidity from falls is much more common and represents a significant burden on health-care facilities around the world. Among children under 15 years, non-fatal falls were the 13th leading cause of disability-adjusted life years (DALYs) lost. In most countries, falls are the most common type of childhood injury seen in emergency departments, accounting for between 25% and 52% of assessments (*4, 5*).

The published literature on the incidence and patterns of fall-related injuries among children relates largely to high-income countries, where just 10% of the world's children live. In many of these countries, deaths from all types of injury are estimated to have dropped by over 50% over the past three decades (*6, 7*).

A systematic review of the literature from mainly low-income and middle-income countries in Africa, Asia and Central and South America on the incidence of unintentional childhood falls resulting in death or needing medical care, found the following.

- In Africa, the median incidence of falls among children and youth aged less than 22 years was 41 per 100 000 population (*8*).
- In Central and South America, the rate varied from 1378 to 2700 per 100 000 population aged less than 20 years (*9, 10*).
- In Asia, the median incidence was 170 per 100 000 population aged less than 18 years (43% of all injuries).
- The highest rate on the Asian continent was recorded in the United Arab Emirates with an incidence of some 1923 per 100 000 population (*11–14*).

The UNICEF–TASC surveys have also found falls to be a leading cause of morbidity and disability in children, resulting in high social and economic costs (*15*).

The studies reviewed suggest a substantial variability in the incidence of falls between regions – and sometimes within regions. In the absence of a common methodology and standard definition, however, data from different studies and settings cannot be compared directly and are potentially misleading. Less than a fifth of the studies documented deaths due to falls, only 12% used standardized or formal definitions for falls, and none provided reliable data on the severity of injuries or consequent disability resulting.

Mortality

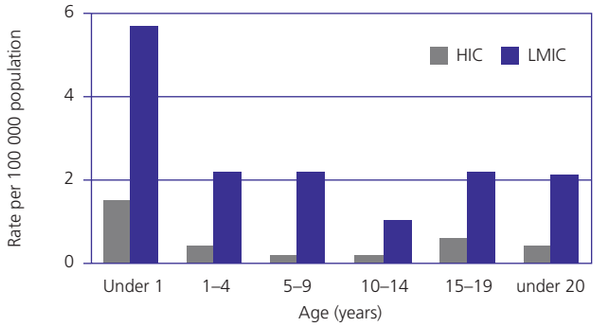
In 2004, nearly 47 000 children and youth under the age of 20 years died as a result of a fall. Fall-related mortality data compiled by WHO reveal important differences between regions, and between countries within regions (see Figure 5.1). High-income countries in the Americas, Europe and Western Pacific regions had average mortality rates of between 0.2 and 1.0 per 100 000 children aged less than 20 years. However, low-income and middle-income countries in the same regions reported rates up to three times higher. Low-income and middle-income countries in South-East Asia and the Eastern Mediterranean regions had the highest average rates – of 2.7 per 100 000 and 2.9 per 100 000, respectively. While it is quite possible that the levels are so much higher in some places, it is also possible that some misclassification of data has occurred. Child abuse, for instance, is sometimes wrongly classified in the category of falls (*16, 17*).

Age

In high-income countries, the average fall mortality rates, by age, are similar over the first 20 years of life. However, in low-income and middle-income countries, infants less than one year of age have very high rates (see Figure 5.2).

FIGURE 5.2

Fatal fall-related injury rates per 100 000 children by age and country income level, World, 2004

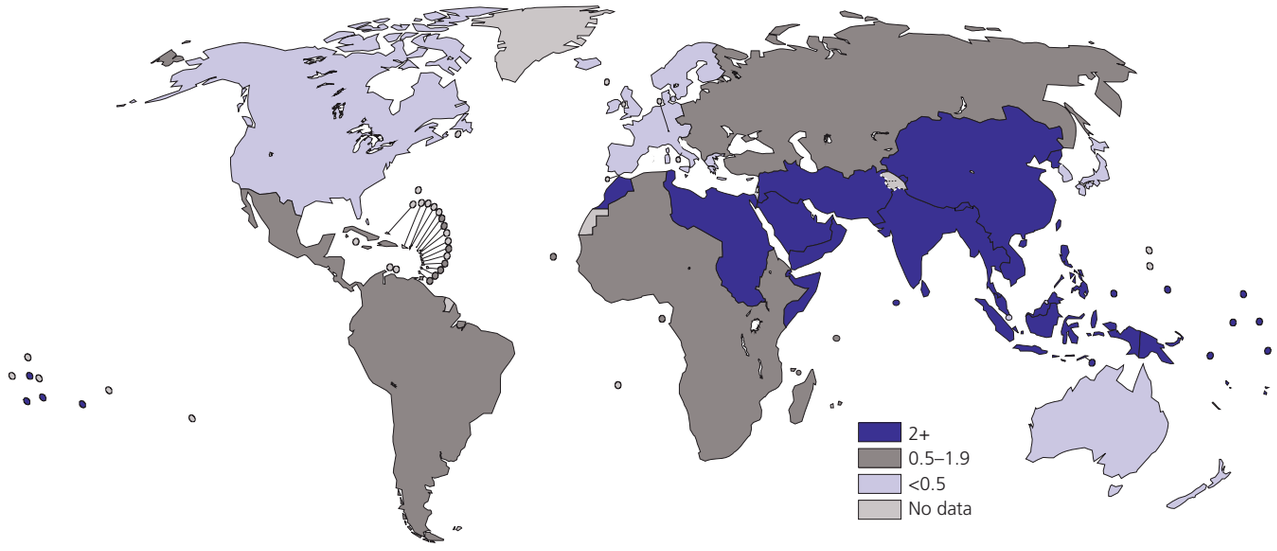


HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

FIGURE 5.1

Fatal fall-related injury rates per 100 000 children[a] by WHO region and country income level, 2004



Africa	Americas		South-East Asia	Europe		Eastern Mediterranean		Western Pacific	
LMIC	HIC	LMIC	LMIC	HIC	LMIC	HIC	LMIC	HIC	LMIC
1.5	0.2	0.7	2.7	0.3	1.0	2.2	2.9	0.4	2.2

[a] These data refer to those under 20 years of age.

HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

Community surveys conducted in Asia highlight the high incidence of fall deaths in the region. In Bangladesh, the overall fall mortality rate for the 0–17-year age group was 2.8 per 100 000 (*1*), and falls were the second leading cause of death through injury among infants aged less than one year (24.7 per 100 000 population). In Viet Nam, falls were the sixth leading cause of childhood death (4.7 per 100 000 aged 0–17 years) (*18*). In Jiangxi province in China, falls were the fourth leading cause of death (3.1 per 100 000 aged 0–17 years). Higher rates were reported in rural areas than in urban areas (*19*).

Falls are still an important cause of death in children in high-income countries, even though the incidence rates are considerably less than in low-income and middle-income countries. Falls are the fourth leading cause of trauma deaths in childhood in the United States (*20*) and the sixth leading external cause of death among Australian children aged 0–14 years (*21*).

Gender

Boys are overrepresented in fall mortality statistics (see Table 5.1), with the male-to-female ratio varying from 1.2:1 (in low-income and middle-income countries in South-East Asia) to 12:1 (in high-income countries in the Eastern Mediterranean region).

Type of fall

Based on data from the Global Burden of Disease project, which includes the fourth ICD coding digit from 70 mainly middle-income and high-income Member States, 66% of fatal falls among children occurred from a height, while 8% resulted from falls on the same level. Unfortunately, the relevant information was unavailable for a quarter of the reported falls (*22*).

Morbidity

Extent of the problem

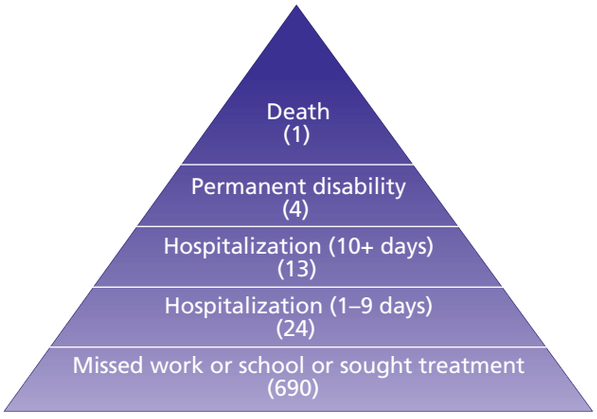
Global statistics on non-fatal injury are not readily available, though the incidence of non-fatal falls is clearly much higher than that of fatal cases. Data that are available indicate that falls are a leading, if not in fact the most common, type of injury resulting in hospitalization or emergency room attendance in most high-income countries (*20, 23–28*). Falls were also cited as the leading cause of injury among 13–15-year-olds in the Global School Health Survey, covering 26 countries (see Statistical Annex, Table A.3).

Most published studies of non-fatal injury in low-income and middle-income countries are hospital-based and may fail to capture data on children who are unable to access medical care (*29, 30*). Community-based studies suggest that there are many more significant fall-related injuries than just those seen at health-care facilities (*14, 31*).

The Asian community surveys recorded injury events that were serious enough to warrant seeking medical attention or that resulted in school days missed. Injuries not meeting these criteria were deemed insignificant in terms of health-care costs and social costs (*29, 31*). In the injury survey in Jiangxi province, China (*19*), for every one death due to a fall, there were 4 cases of permanent disability, 13 cases requiring hospitalization for 10 or more days, 24 cases requiring hospitalization for between 1 and 9 days, and 690 cases where care was sought or where at least 1 day of work or school was missed (see Figure 5.3). The survey highlighted the substantial cost of non-fatal injuries due to falls and the small proportion of cases seen in hospital settings – cases which, taken together, must contribute considerably to the overall cost of falls.

FIGURE 5.3

Inury pyramid for falls among children 0–17 years, Jiangxi province, China



Source: Reference *19*.

TABLE 5.1

Fatal fall injury rates per 100 000 children[a] by sex, country income level and WHO region, 2004

	Africa	Americas		South-East Asia	Europe		Eastern Mediterranean		Western Pacific	
	LMIC	HIC	LMIC	LMIC	HIC	LMIC	HIC	LMIC	HIC	LMIC
Boys	1.8	0.3	1.0	3.0	0.5	1.3	4.0	3.5	0.5	2.5
Girls	1.1	0.1	0.4	2.4	0.2	0.6	0.3	2.3	0.3	1.9

[a] These data refer to those under 20 years of age.

HIC = High-income countries; LMIC = low- and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

Similar patterns of injury were observed in Uganda, where there were higher rates of falls among children in rural than in urban areas (*32*). Data from various countries in Latin America and from Pakistan also reveal that falls are a common cause of non-fatal injury among children (*9, 33–36*).

Globally, 50% of the total number of DALYs lost due to falls occur in children less than 15 years of age. However, the burden of childhood falls is largely explained by the morbidity and disabilities that may persist for life. The skewed distribution of this burden geographically and the relative scarcity of statistics on non-fatal injury events make it more difficult to describe and address the problem of childhood falls.

Severity of falls

The severity of a fall-related injury is determined by the anatomy of the human body and the impact force to which the body is subjected – in the absence of any special protection on the body or impact-absorbing materials in the landing or contact surfaces (*37–41*). The impact force itself depends, among other things, on the height from which the fall occurs. These relationships are well described in high-income countries in relation to falls from playground equipment (*42–46*) and from windows and roofs (*47–49*).

The proportions of injuries due to falls, as well as the patterns of injury from falls generally, can differ considerably in developing countries from those in developed countries (*50*). For instance, a recent study conducted in four low-income and middle-income countries found that falls were the leading cause of unintentional injury among children under the age of 12 years. The types of injuries sustained were largely cuts and scrapes, fractures of the upper and lower extremities and contusions. In half of all cases, the children were left with some form of disability – in 41% of cases with a temporary disability of less than six weeks (see Statistical Annex, Table C.1).

Generally, the greater the height from which a child falls, the more severe the injury (*51*). The Jiangxi survey found that about 18% of falls were from heights of five metres or more and two thirds involved heights of between one and five metres (*19*). The Jiangxi and Beijing surveys (*19, 52*) revealed that as children grew older, an increasing proportion of falls were from greater heights – such as trees and rooftops, frequently, in the case of adolescents. A Nigerian study, on the other hand, found that only 25% of falls in childhood leading to hospitalization were from heights, the remainder occurring at ground level (*53*).

Injuries from falls from heights of more than two storeys typically involve falls from windows, balconies and roofs (*41, 51*). Falls from stairs and trees are also common, as are falls into ditches, wells, shafts and other holes in the ground (*19*). Trees are particularly hazardous, especially in some tropical countries where children are employed to harvest high tree crops (*50*) (see Box 5.1).

BOX 5.1

Falls from trees in Mozambique

In 2006, an injury and violence survey was conducted in Mozambique. The study covered 179 households from the urban district of Matola and 162 from the rural district of Boane, both areas in the southernmost part of the country.

Falls were the leading cause (31.7%) of injury in Boane district, while they accounted for 23.8% of injuries in Matola district, surpassed only by road traffic injuries, accounting for 34.7% of all injuries. Twenty-eight per cent of all the falls involved children and adolescents under the age of 20 years. Many of the falls were from trees, a common occurrence in developing countries.

In one of the most rural parts of Boane district, a widowed mother with seven children is in tears as she tells the story of her eldest son, José. José broke his leg after falling from a coconut tree while collecting fruit for the family's breakfast. Now aged 17 years, he is permanently disabled. One of his legs had to be amputated because he did not receive immediate care. His mother recalls that neighbours tried to help soon after the fall, but that it took many hours to get him to the nearest health-care facility. On arrival there it was apparent that the fracture was compound and the facility lacked the necessary equipment to handle his case. He was consequently referred to Maputo Central Hospital, a further three hours' drive away. It was 17 hours before José was seen by an orthopaedic surgeon. José's mother has now lost her primary breadwinner. She reflects on their experience, saying "these are the realities of the day-to-day life we have to deal with in Mozambique."

José's case is not an isolated one. Data from the emergency department surveillance system in Maputo Central Hospital show that falls account for 40% of those presenting to the emergency department, with children under 18 years of age making up almost two thirds of these cases. Seventy-five per cent of the serious fall injuries among children are the result of their falling from trees, usually around the home.

In the United States, many of the fall fatalities among children involve falls from poor-quality housing in low-income urban areas, typically from the second floor or higher (*51*). Falls from greater heights tend to occur more in the summer months. This is presumably because windows – the usual site for falls of pre-school-age children – are more likely to be open at that time of year, and older children are more likely to be outdoors playing on fire escapes, roofs and balconies (*47–49*).

A case–control study from New Zealand has shown that the risk of injury in a fall from playground equipment increases dramatically for heights of over 1.5 metres (*54*). After adjusting for various factors such as the child's age and weight and the presence of impact absorbing surfaces, children falling from over 1.5 metres were found to have four times the risk of injury compared to those falling from below that height. The risk of injury rose with increasing fall height, with children who fell from over 2.25 metres having 13 times the risk of injury compared to those who fell from 0.75 metres or below.

The extent to which falls from low heights result in life-threatening injuries, especially head injuries, has generated considerable controversy, largely in relation to suspected child abuse (*55–57*). What evidence there is on this does tend to point in the direction of possible abuse. Reported fatalities following short or minor falls are more common in situations where there are no unrelated witnesses who can confirm the history of events (*55–57*). When making clinical decisions, therefore, the height of a fall should not be the only criterion used to determine the threat to life that a particular injury poses (*58*).

Consequences of falls

Falls are the leading cause of traumatic brain injury, especially in young children, with a significant risk of long-term consequences (*20, 59–61*). In the United States, about one third of the 1.4 million people suffering traumatic brain injuries are children aged 0 to 14 years, who have disproportionately high rates of falls compared with other age groups (*62*).

A Canadian study noted that 36% of infants aged less than one year presenting to an emergency department following a fall had significant head injuries, and that falls were responsible for 90% of all head injuries seen in the emergency department (*20*). Falls are also the most common cause of fatal and serious head injuries among children in France and the United Kingdom (*63–65*).

While the incidence of spinal-cord injuries following a fall is generally low, most spinal-cord injuries, resulting in quadriplegia or paraplegia, are attributed to falls (*66–68*). A case study from Nigeria describes the lifelong disability resulting from such injuries, often the result of falls from tall palm trees (*69*).

Children tend to use their arms to protect their heads when falling from a height. Limb fractures, particularly of the forearm, are therefore the most common type of fall-related injury in children beyond the age of infancy (*37, 70–73*). An analysis in Australia of children falling from playground equipment showed that fractures accounted for 85% of playground injuries (*74*). There have been suggestions that the incidence of upper limb fractures has increased in recent years, while that of serious head injuries has declined. This claim needs to be investigated further in relation to safety standards in playgrounds (*75, 76*).

Even after incurring open or complex fractures, children in low-income countries can make a good recovery if they receive proper care (*77*). All the same, permanent disfigurement and functional impairment from such fractures are frequently seen in poorer settings (*5, 9, 78, 79*). Growth-plate fractures are particularly liable to result in permanent disability (*79*). Abdominal and chest injuries are uncommon in falls from one or two storeys, but more frequent in falls from greater heights (*47, 72, 80*).

The UNICEF–TASC survey in Jiangxi province, China, found that falls were the leading cause of permanent disability in young people aged 0–17 years, primarily due to the long-term consequences of brain and cervical spine injury. Such disability was estimated to be 3.5 times more frequent in boys than in girls (*19*). A study in Nicaragua also found that falls were the leading cause of permanent disability in young people less than 15 years of age (*33*). In Thailand (*81*) and Viet Nam (*18*), falls accounted for 1% and 4% of the total burden of permanent disability, respectively. Permanent disability in these surveys referred to the loss of a physical sense – such as sight or hearing – loss of mobility or loss of the ability to speak. However, emotional, psychological and cognitive long-term consequences were not included because of the difficulty in measuring them (*19*). As a result, the overall amount of permanent disability is likely to be considerably greater than the survey estimates suggest.

Cost of fall-related injury

In Canada, annual injuries from childhood falls were estimated in 1995 to cost 630 million Canadian dollars (*82*). Implementing strategies known to be effective is expected to result in a 20% reduction in the incidence of falls among children aged 0–9 years, 1500 fewer hospitalizations, 13 000 fewer non-hospitalized injuries, 54 fewer injuries leading to permanent disability and net savings of over C$ 126 million (US$ 120 million) every year (*82*).

In the United States, falls account for the largest share of the cost of deaths and injuries in children under 15 years of age – more than a quarter of all childhood unintentional injury-related costs, and costing almost US$ 95 billion in 2004 (*83*). For children aged 0–19 years, hospital data from 36 states suggest that the total expenditure for a case of acute care following a fall was second only to that of road traffic injury (*84*).

In Australia, the annual direct health-care cost of falls in children is estimated to be over 130 million Australian dollars, of which 28 million dollars is attributable to hospital inpatient care (*21*).

While sufficient data are not available from low-income and middle-income countries to obtain an estimate of the cost of fall-related injuries, it is clear that cost is substantial. In Lilongwe, Malawi, almost 10% of paediatric admissions were related to unintentional injuries, a third of which were as a result of fractures, generally from falls (*85*). An emergency department study in Turkey noted that falls accounted for 41% of injury admissions and contributed to a major part of the overall budget for paediatric trauma cases (*86*). The high risk of wounds becoming contaminated and of complications such as bone and joint infections, together with the scarcity of powerful antibiotics and microsurgical techniques, create significant problems for health-care services (*77, 85, 87, 88*). The length of paediatric hospital admissions involving osteomyelitis in a Gambian hospital, for instance, was found to be second only to that of admissions as a result of burns (*88*).

Limitations of data

Rates of fatalities resulting from falls are relatively low. Much of the estimated global burden of falls among children stems from subsequent disability. The lack of reliable data, in much of the world, on non-fatal outcomes is therefore a significant deficiency.

The mechanisms and patterns of fall-related injury among children are highly dependent on the context. Again, this information is generally not available for most low-income and middle-income countries – countries in which the burden of falls is the heaviest. In high-income countries, studies gathering data specifically related to the context and circumstances surrounding falls – and departing from the standard International Classification of Disease codes – have provided valuable information to help develop prevention measures.

Risk factors

As already mentioned, the incidence and patterns of fall injuries among children depend to a great extent on contextual factors. A systematic review of the published literature on risk factors for unintentional injuries due to falls in children identified age, sex and poverty as consistent independent risk factors (*4*). Other major risk factors influencing the incidence and severity of fall injuries were: the height of the fall; the type of surface; the mechanism (whether dropped, falling down stairs or falling using a baby walker); and the setting (whether day care or home care).

Drawing on these studies and other epidemiological findings, Table 5.2 shows the major factors influencing the incidence of unintentional childhood falls and their consequences.

Child-related factors

Age and development

Children's developmental stages – as well as the activities and environments associated with these stages – have a bearing on the incidence and characteristics of fall-related injuries (*89, 90*). Research into the ways that infants and small children learn to climb stairs (*91*) has found complex interactions between:

- their evolving motor and cognitive skills;
- the physical opportunities presented to them, such as access to stairs;
- their social opportunities or lack of them, such as strict supervision by caregivers.

TABLE 5.2

Haddon Matrix applied to the risk factors for childhood falls

Phases	Factors			
	Child	Agent	Physical environment	Socioeconomic environment
Pre-event	Age; gender; level of activity; pre-existing disability.	Unsafe product or equipment; unprotected rooftop, balcony or staircase; tree.	Lack of access to safe play spaces and opportunities; lack of preventive measures such as stair gates and guard rails.	Poverty; single-parent family; family size; maternal education; awareness of fall risks among caregivers, childcare providers and educators.
Event	Size and physical development of child.	Lack of protective equipment or barriers that reduce the severity of an injury in the event of a fall.	Height of fall; type of surface onto which child falls; lack of impact-absorbing surfaces.	Lack of awareness of potentially serious injuries associated with falls, e.g. concussion and brain injury.
Post-event	Child's general health; disability; post-injury complications.	Sharp objects and others hazards that increase risk of cuts and infections.	Lack of adequate pre-hospital care, acute care or rehabilitation.	Lack of first-aid skills; lack of access to health care; lack of resources to manage post-injury outcomes.

Most of the falls young children have might be considered a normal part of their development and learning experience. However, their curiosity to explore their surroundings is generally not matched by their capacity to gauge or respond to danger (*5, 92*). As they become older and increasingly independent, they have access to a wider range of territory and are capable of a greater range of physical activity. They also often strive to perform more challenging and daring acts – a behaviour known as "risk-taking".

In most high-income countries, children under one year of age are most likely to fall from furniture or car seats, or through being dropped. Between the ages of one and three years, children are most likely to fall from stairs or steps, baby walkers, furniture or play equipment. Older children typically fall from playground equipment or from being pushed (*89, 93–95*).

Evidence from low-income countries is less specific. However, a population-based study from Brazil, Chile, Cuba and Venezuela noted that falls involving young children occurred most commonly at home, though with older children, institutions, such as schools, and public places were the prime locations (*9, 96*). A study from three paediatric hospitals in Mexico found that falls from stairways and beds accounted for a high proportion of admissions of children under 10 years of age. The factors creating particular injury risks for these children were (*34, 97*): a lack of protective rails on beds (30%); unprotected staircases (48%); and easy access to roofs (40%). Falls from unprotected rooftops – on which children play as well as sleep – are common in countries such as Bangladesh, India and Turkey (*98, 99*).

Gender

Males outnumber females for fall-related injuries – and indeed most types of injury – among children and young people (*6, 100*). This is the case in most countries, and applies to both fatal and non-fatal falls (*4, 37, 53, 101, 102*).

The nature of childhood falls and injuries can be partly explained by patterns of child-rearing, socialization and role expectations. Risk-taking behaviour is also biologically determined. Irrespective of culture boys engage in rough play more frequently than do girls. Gender differences in the extent to which children are exposed to hazards are also common in most societies (*29*). Some researchers attribute proneness to injury in children to personality traits such as impulsiveness, hyperactivity, aggression and other behaviours more commonly ascribed to boys than girls (*12, 103*). While many psychological characteristics are indeed associated with increased risks of injury, a review of the literature suggests that the contribution of personality traits to childhood injuries is relatively small compared with that of environmental and social factors (*104*).

Differences in the way boys and girls are socialized by their parents were highlighted in a study examining the reactions of mothers to their child's behaviour on the playground. The study showed that mothers responded less often and were slower to intervene in instances of risky behaviour on the part of a son than they did in the case of a daughter (*105*). Parental practices have also been found to foster greater exploratory behaviours among boys than among girls and to impose fewer restrictions on boys than on girls.

Poverty

A recent systematic review of risk factors for fall-related injuries among children found a strong relationship between social class and the incidence of childhood falls (*4*). The complex associations between social deprivation and increased risks of childhood injury have several underlying factors (*5, 106–111*), including:

- overcrowded housing conditions;
- hazardous environments;
- single-parenthood;
- unemployment;
- a relatively young maternal age;
- a relatively low level of maternal education;
- stress and mental health problems on the part of caregivers;
- lack of access to health care.

In some cases, poor-quality housing may be made more hazardous for falls as a result of its location. Examples of this are dwellings built on sloping sites in mountainous areas (*112*) and slum settlements constructed on rocky terrain (*113, 114*).

Underlying conditions

Despite the relative lack of data, there is evidence that children who are minimally mobile, but who are perceived by a caregiver as immobile on account of their disability, are at increased risk for falling from a bed or other elevated surface (*92*). The presence of mental disability can increase the risk of unintentional injury, including falls, by a factor of up to eight *(115–117*). An emergency-department study from Greece concluded that falls and concussion were more common among children with psychomotor or sensory disability than in children who were not disabled (*118*). Children in wheelchairs are particularly at risk, regardless of their cognitive ability, with falls estimated to account for 42% of the number of injuries among wheelchair users (*92*).

Agent factors

Consumer products

In surveys of product safety in high-income countries, falls – generally involving infants in the first year of life – are among the most common non-fatal injuries. Such falls are associated with pushchairs (known as strollers in North America), prams, baby walkers, high chairs, changing-tables, cots (excluding portable cots) and baby exercisers

(*119, 120*). A study from the state of Victoria, Australia, suggests that baby bouncers (also called baby exercisers) are involved in the most severe non-fatal injuries related to products, with almost one in three injuries resulting in hospital admission. After baby bouncers, high chairs and pushchairs are the products linked to the most severe injuries from falls (*120, 121*).

A review of fall-related risk factors in the 0–6-year age group found that among children using bunk beds, the risk of a fall injury is greater for younger children, children from poorer families, children in newer beds, and children who fall onto non-carpeted floors (*4, 122*). Other reports suggest that while bunk beds and conventional beds may cause almost the same number of fall injuries among 5–9-year-olds, injuries from bunk bed falls are more severe than those from conventional bed falls as the fall is from a greater height (*120*).

Many products for leisure activities – such as skateboards, in-line skates, Heelys (a popular brand of shoes that convert from sports to roller shoes), ice-skates, swing ropes and trampolines – can result in fall-related injuries, particularly limb fractures, sprains and head injuries (*123–129*) (see Box 5.2). The European Union's injury database has identified children's bicycles, roller skates and swings as the three leading consumer products implicated in home and leisure activity injuries, most of which are from falls (*130*).

Despite the virtual absence of data on the issue, product safety is considered to be a significant problem for children in developing countries. In addition to product-related risks in occupational settings, globalization has led to the widespread use in developing countries of potentially dangerous products that are not always accompanied by the safety features or regulations generally found in developed countries. Heelys are one such case of increasing concern, as falls involving their use can result in significant head and limb fractures (*124, 131, 132*).

Playground equipment

Falls from playground equipment can lead to severe injuries and are commonly seen in hospital admission statistics in high-income countries (*120, 133–135*). A study from Victoria, Australia, found that falls from playground equipment accounted for 83% of emergency department admissions. Of these cases, 39% were related to falls from climbing equipment, 18% from slides and 14% from swings (*120*).

Several studies have discovered significant associations between certain structural features of playgrounds and fall injuries (*45, 54, 136–139*). A New Zealand study has shown that lowering the height of equipment to 1.5 metres could reduce the risk of children having to attend emergency departments following playground falls by 45% (*42*). Studies from Canada (*45*) and Greece (*138*) have found high risks of injury, particularly from falls, in playgrounds lacking the proper safety standards – such as having appropriate and sufficiently thick surface materials, and adequate handrails or guardrails.

BOX 5.2

Protective equipment to prevent wrist fractures

Falls are a common form of sport and recreational injury in children and adolescents. Activities that are associated with "outreach" falls – where the person falls forward and lands on an outstretched arm – have a significant likelihood of resulting in upper limb injuries. Such activities include snow and ice sports (such as skiing and ice skating) and sports involving wheels (such as roller skating and skateboarding).

Fractures of the ulna and radius, particularly of the distal radius, as well as severe upper limb injuries, are common outcomes of outreach fall injuries. The usual sequence of events leading to these wrist injuries is a loss of balance followed by a forward fall, with the person landing on an outstretched arm. The risk of injury is further increased by factors such as:

- high speed;
- hard or irregular surfaces;
- other physical hazards;
- risky manoeuvres, such as aerial jumps in skateboarding.

There is considerable evidence that the majority of distal radial fractures associated with sporting activities, particularly those in snow and those involving wheels, could be prevented by the use of wrist guards (*140*). In fact, children and young people who do not wear wrist guards are up to ten times more likely to sustain severe wrist injuries than those who wear them. This is the case, irrespective of the person's level of skill in the sport (*141*). Despite this, few participants wear them, with wearing rates estimated at less than 60% for in-line skaters and less than 30% for snowboarders.

Wrist guards are ergonomically designed devices that protect the palm of the hand and support the wrist without compromising range of motion. They reduce wrist fractures by absorbing impact energy and by sharing the load, so that the bones in the wrist and forearm take less of the strain of the fall (*142*). Fears that wrist guards may exacerbate injury risk, or lead to more fractures further up the arm, are largely unfounded. Currently, there is no international standard for wrist guards and there are suggestions that not all models provide full protection. Nonetheless, the overwhelming weight of evidence is in favour of their effectiveness.

The problem, as with other forms of protective equipment, is how to encourage young people to wear wrist guards. A range of approaches is needed, combining educational measures with laws and their enforcement at the sites where children and young people are likely to participate in these activities. These measures should be accompanied by the use of prominent role models seen wearing wrist guards, and advice as to their effectiveness at places where they are sold or rented out.

Animals

Studies from several developing countries point to the increasing number of cases in recent years of children and young people presenting to hospital as a result of falling from a horse. This may be due to the growing popularity of horse riding as a recreational sport, as well as to larger numbers of children working on farms (*143–145*). While

most injuries from falls from horses are minor ones, a study from the Netherlands estimated that up to 40% of children and adolescents treated in hospital after falling from a horse still suffered a disability four years later (*146*).

Animal racing also poses significant risks of childhood falls (*147–150*). Camel racing is a popular spectator sport, whose origins lie in the desert culture of West Asia and North Africa (*150*). Traditionally, race camels were ridden by young children from the family of the camel owner. In recent decades, though, migrant children as young as three or four years of age have performed as camel jockeys, sometimes trafficked for that purpose (*150, 151*). Falls are the commonest type of injury in camel racing, frequently resulting in head injuries, including fractures of the skull (*148, 149*).

Environmental factors

Physical environment

The "built environment" is a vital resource for the healthy development of children. At the same time, it is often the source for their fall-related injuries (*152*). Structural hazards in the built environment stem from the presence of dangerous or inappropriate features, or from the absence of protective features. Specifically, such factors include:

- a lack of building maintenance, particularly in low-income rented housing;
- design features in buildings and products that do not take account of the changing capabilities of young children – such as a lack of window guards in high-rise buildings;
- poor lighting in buildings and in streets.

Socioeconomic environment

Inadequate adult supervision is often cited as a major contributor to childhood injuries (*153, 154*). The issues involved, however, are complex and cut across many of the problems facing the most vulnerable families. As described in Chapter 1, the relative developmental immaturity of children leads to their having limited ability to recognize danger and foresee the consequences of their actions if left unattended. It is therefore often regarded as axiomatic that caregivers should supervise children and know what type of injuries the children risk at different ages, so as to prevent them from incurring fall injuries (*98*). Parents, social workers and medical personnel are generally further agreed that pre-school-age children, in particular, should be supervised *constantly* to minimize the risk of injury – with any unsupervised period lasting no longer than five minutes (*154*).

However, despite these generally agreed "facts", an over-reliance on supervision as the only or primary approach to prevent falls among children is ill-advised, for several reasons, including the following (*155–161*):

- Falls can occur even with adult supervision, as has been shown in several studies in high-income countries on injuries from baby walkers.
- What a caregiver considers an adequate level of supervision may not be consistent with the epidemiological evidence.
- Economic conditions, such as poverty, unemployment and the disruption of social networks, may seriously affect the quality of supervision. In poor families, children may not only be left unsupervised, but find themselves acting as caregivers to younger siblings. Conditions in which caregivers are under stress and have conflicting demands placed on their attention are often the most hazardous. Other factors that increase children's susceptibility to falls in poor households may include mental health problems affecting caregivers (*5, 90, 160–164*).

Illustrating the last point, a large urban slum in Rocinha, Brazil, was the site of a study of childhood injuries (*90*). Falls accounted for 66% of the injuries, an unsurprising finding given the steeply sloping terrain on which the settlement was constructed, its rocky outcrops and open drains, as well as the high levels of stress exhibited by the children's mothers.

Several studies in high-income countries have suggested that day-care facilities may pose significant risks of injury (*165, 166*). A systematic review, though, found two studies that compared fall injuries in day care with those in home care. These studies showed that the risk of a fall injury among infants and young children in the home was twice the comparable risk in day-care settings (*167, 168*). Nonetheless, there exist great differences in conditions within day-care centres – as indeed there are within home care. A more sophisticated analysis is therefore called for, that goes beyond simple categorization of care arrangements into "home care" and "day care".

Work environment

Child labour places children of both sexes at a significant risk of falls. This is partly because the demands placed on the children usually exceed their ability to cope, in terms of developmental skills, strength, stamina and size (*169*). Agriculture is also the most common setting for non-fatal serious falls resulting in disabling head and limb injuries. Particular dangers for children working in this sector include unprotected platforms; ladders and tall trees used for reaching high-growing crops; pits, wells and unlit shafts; and barns, silos and deep drainage ditches (*50, 170*).

Children and adolescents on farms are an important group at risk in high-income countries. Data from Canadian and United States registries found that falls accounted for 41% of injuries among children in this setting. In addition, 61% of falls from heights occurred among children who were not working but who lived on the farms (*143, 171, 172*).

Studies from various low-income countries suggest that falls are a common cause of serious injury for children working in the construction industry, with significant risks posed by open building sites (*173–175*).

Lack of treatment and rehabilitation

Community-based surveys in low-income and middle-income countries show that a significant proportion of children, including those with moderate to severe fall-related injuries, do not receive medical care. The reasons for this include: the distance to the hospital; prohibitive transport costs; and a lack of awareness on the part of the caregiver of the need for early attention (*9, 19, 33, 66, 176*).

The Jiangxi Injury Survey reported that many children sustaining fall injuries were either alone or with another child at the time of the injury – rather than with a caregiver. The survey also found that adult caregivers were generally unaware of basic first-aid procedures and did not know how to reach high-quality medical care (*19*). A Nigerian study noted that it was relatives or neighbours who managed most childhood injuries, and that less than 1% of injuries were seen by a health-care professional (*177*).

The risks of late recognition of intracranial haemorrhage, inadequate care of the airway, poor management of transfer between facilities, and inadequate acute trauma and rehabilitation care can profoundly influence the probabilities of survival and disability (*34, 176, 178, 179*). Rates of pre-hospital deaths are greater in places with less developed emergency medical services and longer periods of transfer to hospital (*178*). A study from the Islamic Republic of Iran found that 40% of fatalities following childhood falls occurred in pre-hospital settings, while 30% occurred in emergency departments and 30% in hospitals (*66*).

Interventions

The prevention of fall-related injuries among children is of paramount importance worldwide, given the large amount of resulting morbidity, the high costs of health care and the significant risk of death, particularly from head injuries. The measures employed must strike a careful balance between, on the one hand, promoting the healthy development of children – allowing them to play, explore and be physically active – and, on the other hand, recognizing the vulnerability of children living in environments designed primarily for adults.

The *Child safety good practice guide* (*180*) is one of several national or regional policy documents describing practical approaches for preventing fall-related injuries among children. The following section considers the most promising such interventions in a global context.

Engineering measures

Identifying, replacing or modifying unsafe products has been a leading strategy to prevent injuries from falls in many high-income countries. Major reductions in the incidence of childhood fall injuries have been achieved by removing or redesigning nursery furniture (see Box 5.3), playground equipment, sports and recreational equipment, and other items such as shopping carts and wheelchairs (*180, 181*). In some instances, a complete ban on a product has ensued. In other cases, there has been substantial modification of the original design – such as the introduction of a new braking mechanism for baby walkers (*182*). To be effective, such measures generally require continuous enforcement (*180, 182, 183*).

In some cases, sufficient evidence has accumulated from other situations for devices to be recommended to protect against fall-related injuries. Thus, despite a lack of intervention studies relating to horse riding, helmets are now recommended to reduce the risk of serious head injuries among young riders (*144*). All the same, studies from Australia, Canada, New Zealand and the United States suggest that rates of wearing helmets remain relatively low in these countries (*184–186*). Helmets and wrist guards are also strongly recommended for children engaging in ice skating, in-line skating and roller skating (*126*).

Environmental measures

Modifying the environment to make it more "child-friendly" is a passive intervention approach that benefits people of all ages. Major changes in the design and maintenance of playgrounds have substantially reduced the number of playground injuries in many high-income countries (*180*). Such modifications included laying rubber or bark ground surfacing of sufficient depth, and making equipment, such as slides, safer in terms of height and structure.

A community-based programme in the United States has demonstrated how modifying buildings can achieve substantial reductions in fall-related injuries among children. The "Children Can't Fly" programme (*49*) (see Box 5.4), combining individual counselling and a mass media campaign with the free distribution and installation of window guards, has proved effective in cutting the incidence of falls from high-rise buildings in low-income areas. How this strategy might be transferred to other settings depends on the structure of dwellings, the resources available and other factors. However, the use of window guards in many parts of Africa and other developing regions (*187*) suggests that this approach might be useful, if implemented along with other measures, such as the enforcement of building regulations.

BOX 5.3

Product safety and falls from nursery furniture

Many countries have found injuries associated with nursery furniture to be an important issue in children under the age of five years. In the first year of a child's life, these injuries may represent almost 20% of injuries treated in hospital (*188*). The introduction of injury surveillance systems and detailed systematic analyses of deaths in young children led, in the last two decades of the twentieth century, to a greater awareness in developed countries of injuries related to nursery furniture, including cots, baby walkers, high chairs, prams, pushchairs, baby bouncers and changing-tables (*121*).

While the overwhelming majority of non-fatal, hospital-treated injuries associated with nursery furniture are due to falls, the types of injury involving nursery furniture leading to deaths are more varied. Such injuries include suffocation and strangulation, as well as asphyxiation following a fall – for example, following the tipping over of a pram.

In 2002, the International Standardization Organization published guidelines for protecting children against injury from products (including buildings and installations), processes and services (*189*). These guidelines were aimed at those involved in setting or revising standards, as well as at designers, architects, manufacturers, service providers, communicators and policy-makers.

Several countries have established standards – usually voluntary but sometimes mandatory – for the most frequently-used nursery products. These product-specific standards are known as "vertical standards". Mandatory vertical standards have been introduced in developed countries on a country-by-country basis, where voluntary measures have failed. The European Union has a Product Safety Directive that clearly sets out who is responsible for product safety at each stage – from design through manufacture, to importation, wholesale and retail of products.

Standards can also be based on the hazards, rather than the products, and these are known as "horizontal standards". Australia, for instance, is in the process of introducing horizontal standards, following a review of the product safety system and the way in which standards were made.

Developing countries need now to adopt the best practices in product safety. Several developing countries already manufacture products for export, and follow safety standards set in the high-income countries importing the products. A horizontal approach to safety standards is often the most effective way to ensure safety for a wide range of existing, new and redesigned products.

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Laws and regulations

Laws can be powerful tools to reinforce the use of existing technology and influence behaviour. In New York City, following the passage of legislation requiring landlords to install window guards, a large decrease was observed in the number of fatal falls of young children from high-rise buildings (*41*). Since the introduction of both mandatory and voluntary standards for baby walkers in Canada and the United States, the tipping over of these items and structural failures in them appear to have become uncommon (*51, 190*).

Often, the potential effectiveness of promising regulatory approaches remains unclear. For example, the effectiveness of regulatory and enforcement procedures in day-care centres is still uncertain, largely because of methodological shortcomings in the evaluative studies conducted to date (*139*).

Even where the effectiveness of laws or regulations is clearly established, a lack of adequate enforcement may mean that a measure is not widely implemented. Despite the recognized benefits, for instance, of adopting standards for playgrounds, less than 5% of playgrounds surveyed in an Australian study were found to comply with the recommended guidelines on the depth of surface material (*191*).

Educational approaches

Educational and awareness-raising campaigns – particularly those conducted in isolation – have been criticized in several quarters (*5, 105, 189*). These criticisms have centred on the relative lack of evidence that these campaigns reduce injuries, the difficulty in changing human behaviour, and human weaknesses – such as inattention and the ability to be distracted – that undermine the potential effectiveness of "active" interventions. Critics have also pointed to the disproportionate burden of injury among poorer social groups, and the limited effect of health messages aimed at these groups.

Nevertheless, educating the parents of young children about falls is often regarded as an affordable and feasible intervention measure. An attraction of this strategy is the relative ease with which programmes can be updated with new information – such as new guidance on baby walkers (*189, 192–194*). An intensive community-wide programme in the United States to educate the general public and health-care workers about the dangers of

BOX 5.4

Children Can't Fly

"Children Can't Fly" was a programme developed by the New York City Department of Health in the early 1970s, to counter the high rates of death and injury among children following falls from windows. The programme involved persuading the city's health board to amend the laws, so that all landlords were required to provide window guards in high-rise apartments in which young children lived. This was the first such law of its kind in the United States.

The programme contained three components.

- *A voluntary reporting system*. All falls among children under 15 years had to be reported by hospital emergency rooms and the police. Home visits were made by nurses in the public health system to the household where the fall had occurred.
- *Education*. Parents were counselled on a one-to-one basis on how to prevent falls. A mass media campaign was conducted on radio and television and in the press, informing people of the risks of children falling from windows. This was accompanied by a community education programme, involving the dissemination of printed material.
- *Equipment*. Easily-installable window guards were provided free of charge, where required, to families with young children living in areas of high risk.

As a result of the programme, a significant reduction in the incidence of falls was recorded, particularly in the city's Bronx district, where the number of reported falls declined by 50%. Many other cities around the world have since followed New York City's lead. In addition to the lives saved, this intervention has been shown to be cost-effective in terms of savings in hospitalizations, rehabilitation and the costs of maintaining injured or permanently disabled children.

Source: reference *49*.

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infant walkers resulted in a 28% decline in the number of children presenting to emergency departments with injuries from falling down stairs related to the use of these walkers (*195*).

Educational campaigns, though, are generally regarded to be more beneficial when combined with other strategies, such as legislation or environmental modification. Such combined approaches often make the interventions easier to transfer to other settings, or indeed to implement in the original setting (*196*). A review in 2007 showed that education on safety in the home (with or without the provision of safety equipment) resulted in a 26% increase in the proportion of households with fitted stair gates. However, there was a lack of evidence that these interventions actually reduced injury rates (*197*). A more targeted study published in 2008 has now shown some modest reductions in fall rates (*198*).

In settings where the technology and resources exist, there is increasing interest in employing electronic communication to deliver safety messages, in the hope that such an approach will overcome the problems encountered by traditional methods of communication. One example was an early-childhood safety education programme delivered through a stall containing computers in a busy emergency department. This emergency department served a poor community with high levels of illiteracy. A randomized control trial suggested that the programme was successful in increasing knowledge and several types of safety behaviour. Its impact, however, on reducing injury rates is not as yet clear (*199*). An interesting finding was the observation that the benefits from more resource-intensive recommendations – such as to install child safety seats – depended on family income. As demonstrated in both developed and developing countries (*200, 201*), unless financial barriers and the particular situations of poor populations are addressed, "effective" interventions may increase, rather than decrease, disparities in the burden of injury, with the most vulnerable children being the least likely to benefit.

Combining strategies

Many intervention strategies combine several of the measures outlined above.

Home visitation programmes

Supportive home visitation programmes during early childhood have been used for a wide range of purposes. These include improvement of the home environment, family support and the prevention of behavioural problems in the children. A Cochrane review and other more recent studies have shown that home visits – including measures directed at poorer families – are effective in improving home safety and in reducing the risk of injury (*202–206*) and may result in modest reductions in injury rates (*198, 202*). More robust evaluation, though,

is required in this area. The visits appear to be most effective when the information provided is targeted, age-appropriate and combined with the provision and installation of safety equipment (*204–207*).

Community interventions

The use of multiple strategies repeated in different forms and contexts is a powerful means to foster a culture of safety (*208*). The prevention of falls is commonly included among the goals of community-based programmes for reducing childhood injury (*209*). Measures found to be particularly effective in this context include the installation of window guards in high-rise buildings, making playgrounds safer and removing baby walkers. In the "Children Can't Fly" programme in New York, important components were surveillance and follow-up, media campaigns and community education – as well as the provision to families with young children of free, easily-installable window guards (*49*).

Some programmes in developing countries have adopted the WHO Safe Communities model which includes safety audits of stairs and balcony rails, and campaigning for environmental improvements and safe recreational areas. However, good evaluations of the effectiveness of these programmes, particularly with regard to their impact on the incidence of childhood fall injuries, are still not available.

Adapting interventions

There is little evaluative evidence on interventions that can reduce the rate of falls and their consequences in developing countries (*210*). Many measures that have proved successful in reducing the incidence of fall injuries in developed countries are limited with regard to their feasibility and acceptability in developing countries. Nevertheless, the experience of intervention strategies in developed countries can suggest suitable programmes in poorer settings. There now exists a range of promising strategies to reduce the incidence of childhood falls in low-income and middle-income countries.

A recent overview of programmes in developed countries to prevent injuries from falls found that – other than general recommendations about greater supervision of children, interventions to reduce the height of playground equipment and appropriate ground surfacing in playgrounds – only one proven intervention was definitely transferable to developing countries (*210*). This was the "Children Can't Fly" programme already mentioned, that was effective in reducing falls from high-rise buildings in a low-income community in New York City. While the materials used and the context may differ, more widespread use in developing countries of barriers (such as the window guards in the "Children Can't Fly" programme) and safety equipment is likely not only to be effective but also affordable, feasible and sustainable. Specifically, it is reasonable to assume that reinforced construction and protective barriers around the periphery of roofs, as well as railings on stairs, can reduce the risk of falls among children. Furthermore, such measures can be strengthened by introducing and enforcing housing standards and building regulations (*105, 189*).

As already noted, the most effective interventions to prevent injuries related to falls from playground equipment have focused on the use of impact-absorbing materials, height restrictions on equipment and the overall design of playgrounds. While the materials may vary, the same principles apply in all countries. A study in a township in Johannesburg, South Africa, found that creating safer and improved recreational spaces and play areas for children was of prime importance for preventing injury, as well as violence, to children (*211*).

The effectiveness of home visitation programmes in early childhood in reducing the risk of falls and other injuries holds particular promise for low-income and middle-income countries. Many studies undertaken in high-income countries have focused on vulnerable families and used non-professional visitors (*202*). An exploratory study in Jordan of childhood injuries, including those from falls, has highlighted the promising nature of risk inventories prepared by health visitors (*162*).

Several studies from developing countries have considered the potential benefits of mass media and pamphlet campaigns (*97*). Others have examined home safety and injury prevention information targeted variously at parents, health-care workers, law enforcement officers, municipal officials, construction workers and policy-makers (*106, 162, 212–214*). Features of some of these promising programmes include:

- the inclusion of public safety messages that correspond to children's cognitive and developmental stages and to their settings (*97, 213*);
- the combination of education with specific environmental modifications to achieve greater safety (*90, 211*);
- the use of culturally appropriate modes of communication (*97, 211*);
- the formulation of messages that are relevant to the conditions of poor or marginalized communities (*90, 211*).

As already noted, research has so far failed to provide convincing evidence that educational and awareness-raising campaigns, in isolation, are effective in reducing the incidence of childhood fall injuries. It is possible that this reflects inadequate data and limitations in the design of evaluations (*197*). On the other hand, the lack of evidence may be a result of the fact that changes in knowledge and attitudes do not necessarily create corresponding changes in injury rates. The Injury Prevention Project Safety

Survey (TIPP-SS) of the American Academy of Pediatrics is a widely used educational programme in the United States that seeks to assess changes in behaviour. A recent study of TIPP-SS suggests that rather than behaviour, it is knowledge and attitudes that the survey actually measures (*215*). Before countries start to invest scarce resources, it is therefore important that educational campaigns that appear feasible are carefully evaluated for their ability to significantly reduce the rate of injuries.

Involving a range of sectors

It is always necessary to consider the broader social determinants that affect the incidence of childhood falls. Given the different settings and types of childhood fall, it is not surprising that prevention efforts cut across a range of sectors. For falls involving work in the agricultural sector, for example, groups involved in prevention include governmental and commercial bodies in that sector, landowners, farmers, manufacturers of equipment, occupational health workers, labour unions and community groups. Efforts to prevent falls in the home bring in municipal authorities, architects, builders, town planners, furniture designers, product manufacturers, health-care services, social services and nongovernmental organizations.

Children can incur injuries as a result of one or more of a range of factors relating to their caregivers. Such factors include poverty, ignorance, lack of control over the environment, fatigue, depression and malevolence. Agencies that might address some of these factors include those dealing with mental health and criminal justice, social service agencies, and community and nongovernmental organizations.

Conclusions and recommendations

Falls are the most common cause in many countries of injury-related hospital stays and emergency department visits involving children. Limb fractures and head injuries are common and traumatic brain injuries are most likely to result in lifelong disability. The predisposing factors and the types of fall vary considerably across different settings. Developing countries have a disproportionately high rate of fall-related injuries among children, and efforts to prevent these injuries are hampered by the lack of evaluative evidence of interventions that have been tried in these countries. Furthermore, although it is clear that the health-care sector has a pivotal role to play in preventing childhood injury, injury prevention in many countries often does not figure among the priorities for health.

Table 5.3 summarizes the main approaches to addressing childhood falls. The most effective strategies, in all countries, are those that combine proven or promising measures.

Recommendations

From the discussion in this chapter, a number of recommendations stand out, including the following.

- Countries should, where possible, develop and promote locally manufactured, cheap and effective measures to protect against childhood falls – such as window guards, roof railings and stair gates.
- Where building regulations exist, home modifications – such as the installation of window guards – should be incorporated into the regulations and enforced.
- Local authorities should address structural hazards in the built environment that pose fall risks for children, such as open drains and wells.

TABLE 5.3

Key strategies to prevent falls among children

Strategy	Effective	Promising	Insufficient evidence	Ineffective	Harmful
Implementing multifaceted community programmes such as "Children Can't Fly"	■				
Redesigning nursery furniture and other products	■				
Establishing playground standards for the depth of appropriate surface material, height of equipment and maintenance	■				
Legislating for window guards	■				
Using stair gates and guard rails		■			
Conducting supportive home visitation and education for at-risk families		■			
Holding mass media campaigns directed at parents, health workers		■			
Providing appropriate paediatric acute care		■			
Raising awareness through educational campaigns			■		
Implementing housing and building codes			■		
Covering wells and ditches and removing hazards			■		

- Local authorities should ensure that children have access to safe playgrounds and recreational spaces – thereby encouraging physical activity while at the same time reducing the risk of fall-related injury.
- Parental supervision is an important aspect of prevention, particularly when combined with other interventions.
- Acute care and rehabilitation should be available and devised appropriately for children, so as to minimize the long-term consequences of falls and prevent long-term disability.
- Community-based injury surveys that extend beyond assessments at health-care facilities are needed to obtain epidemiological data on fall injuries in low-income and middle-income countries. Data on the characteristics of injuries and the associated risk factors are of special importance. This research should help identify, for a given setting, the five leading causes and types of childhood fall injuries and point to the most cost-effective prevention strategies.
- Large-scale evaluation studies of interventions for reducing the incidence of childhood fall injuries and their consequences urgently need to be undertaken in low-income and middle-income countries.

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POISONING

HARRISON'S STORY

Harrison is the youngest of five children in an Australian family. One day, Lisa, his mother, changed her usual morning routine. Instead of going directly to the kitchen, checking that the cupboard doors were locked and preparing breakfast, she put on a video for Harrison's older sister. In that brief period, 18-month-old Harrison opened a cupboard, removed the cap from a container of dishwasher detergent and swallowed the powder.

Lisa heard his cry and ran to the kitchen to find him vomiting blood. An ambulance rushed Harrison to hospital where doctors were unsure if he would survive.

The container Harrison had managed to open had a cap that looked like a child-resistant closure. To secure this closure, the cap had to click twice. Instructions to this effect, though, were not displayed on the packaging and Lisa mistakenly thought the container was securely closed when she felt the first click.

Harrison survived, but his injuries changed his life and the lives of his family. Lisa publicized his case, which was then actively taken up by the media. Harrison's story, and the details of other small children who had sustained similar injuries, became first local and then national news. While Australian laws stipulated that all dishwasher gels and liquids with a pH value greater than 11.5 be supplied in containers with child-resistant closures, with specific warnings as to the caustic nature of the contents, powders were exempt from this regulation. The powder swallowed by Harrison was extremely alkaline – with a pH of 13.4.

The manufacturer of the dishwasher detergent was contacted. Faced with the evidence, the company placed warning labels on all its containers informing consumers of the "double-click mechanism" to engage the child-resistant closure. The company then redesigned the container itself, incorporating a device to limit the flow of powder and changing the closure to a "single-click" mechanism. Unfortunately, this was only one product of many on the supermarket shelves, leaving other manufacturers' products unchanged.

Government agencies and nongovernmental organizations lobbied for a change to the law, which was eventually amended. Dishwasher powder must now be distributed in child-resistant containers with specific warning labels if the pH exceeds 11.5. Furthermore, detergents with a pH greater than 12.5 have been removed from the domestic market. In addition, the performance standard for the child-resistant closure is also under review. The aim is to ensure that if a closure *appears* to be child-resistant, then it must function as such. There cannot be different stages of functionality, such as the "single-click" and "double-click" stages that Lisa's container incorporated.

Chapter 6
Poisoning

Introduction

"All things are poison and nothing is without poison, only the dose permits something not to be poisonous" – Paracelsus (*1*).

The home and its surroundings can be dangerous places for children, particularly for the possibility of unintentional poisoning. Children are naturally curious, exploring in and around the home. As a result, each year millions of calls are made to poison control centres (also called poison information centres). Thousands of children are admitted to emergency departments because they have inadvertently consumed some type of household product, medicine or pesticide. Most of these "accidental" poisonings could have been prevented.

This chapter focuses on cases of acute poisoning among children – predominantly unintentional ones. It covers the extent and nature of poisonings, the risk factors and the intervention measures that can be employed to prevent poisonings or to mitigate the consequences. The chapter does not deal with chronic poisoning issues related to lead, with indoor air pollution or with other effects of repeated or prolonged exposure to toxic agents. Also excluded are allergic reactions to food or poisoning stemming from infectious agents. The issue of snake bites, a major problem in some parts of the world, is addressed in the form of a box.

"Poisoning" refers to an injury that results from being exposed to an exogenous substance that causes cellular injury or death. Poisons can be inhaled, ingested, injected or absorbed. Poisoning may also be acquired in utero. The exposure may be acute or chronic and the clinical presentation will vary accordingly. The factors determining the severity of poisoning and its outcome in a child are interrelated. They include:

- the type of poison;
- the dose;
- the formulation;
- the route of exposure;
- the age of the child;
- the presence of other poisons;
- the state of nutrition of the child;
- the presence of other diseases or injuries.

The time interval between the exposure to poison and the appearance of clinical symptoms is an important window of opportunity. During this period, it is important to minimize absorption by removing or neutralizing the poison (in the case of ingestion), or to administer agents that prevent damage to the organs – such as the use of N-acetyl cysteine in cases of paracetamol poisoning. The longer the time interval, the greater is the chance of survival. In general, if poisons are ingested in solid doses, which have a slower onset of absorption, more time is available for interventions targeting the absorption process. For liquid poisons, on the other hand, absorption is usually too rapid to be easily prevented.

Poisoning with specific agents produces clinical syndromes that are frequently recognizable. All the same, the syndromes may be easily misdiagnosed or go unrecognized in a child. For this reason, treatment may be delayed, with serious consequences. Poisoning is therefore best prevented. Understanding the pattern of poisoning is helpful for reducing the risk of unintentional poisoning, as well as for preventing intentional poisoning (*2*).

Epidemiology of poisoning

According to the WHO Global Burden of Disease project, an estimated 345 814 people of all ages died worldwide as a result of "accidental" poisoning in 2004. Although the majority of these accidental poisonings were among adults, 13% occurred among children and young people under the age of 20 years (see Statistical Annex, Table A.1). Among 15–19-year-olds, poisoning ranks as the 13th leading cause of death (see Table 1.1). A survey of 16 middle-income and high-income countries revealed that, of the different external causes of unintentional injury death among children aged between 1 and 14 years, poisonings ranked fourth in 2000–01, after road traffic crashes, fires and drowning (*3*).

Mortality

Acute poisoning accounted for an estimated 45 000 deaths annually in children and young people under the age of 20 years (see Statistical Annex, Table A.1). The global death rate from poisonings for children younger than 20 years is 1.8 per 100 000 population. For high-income countries the rate is 0.5 per 100 000 while for low-income and middle-income countries it is four times higher, at 2.0 per 100 000. The map in Figure 6.1 shows the geographic distribution of fatal unintentional poisoning, by WHO region. Although mortality rates are generally low and do not exceed 4 per 100 000 population, Africa, the low-income and middle-income countries of Europe, and the Western Pacific region have the highest rates.

In general, low-income and middle-income countries have higher poisoning death rates than high-income

countries. The one exception is in the high-income countries of the Americas, where death rates are higher than in the middle-income and low-income countries, particularly in the 15–19-year age range (see Statistical Annex, Table A.1).

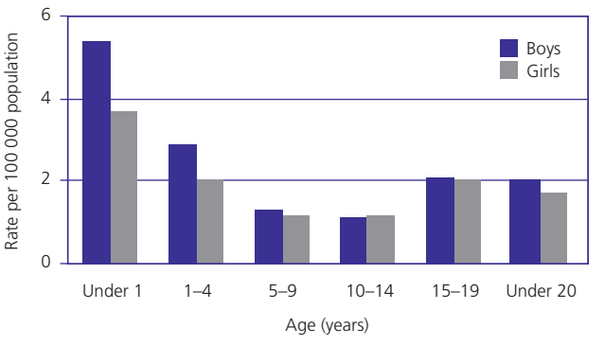
Reported mortality data from countries show higher rates than the estimated regional averages, but the trends are similar. For instance, in Sri Lanka, the case fatality rate from poisoning was found to be as high as 3.2% (*4*). In India, the reported figures for fatal poisonings ranged between 0.6% and 11.6%, while in Viet Nam the reported case fatality rate was 3.3% (*5, 6*).

Age

Children under the age of one year have the highest rates of fatal poisoning (see Figure 6.2), particularly those in low-income and middle-income countries. Generally, mortality rates are highest in infants and decrease with age until 14 years. After that, there is an increase again, almost everywhere, in children 15 years of age and older. In many settings, this increase may be due to substance use, or to unintentional or undetermined drug overdoses (*7*). In some places, the increase may be as a result of entry into the workplace, with its increased exposure to risks.

FIGURE 6.2

Fatal poisoning rates per 100 000 children by age and sex, World, 2004



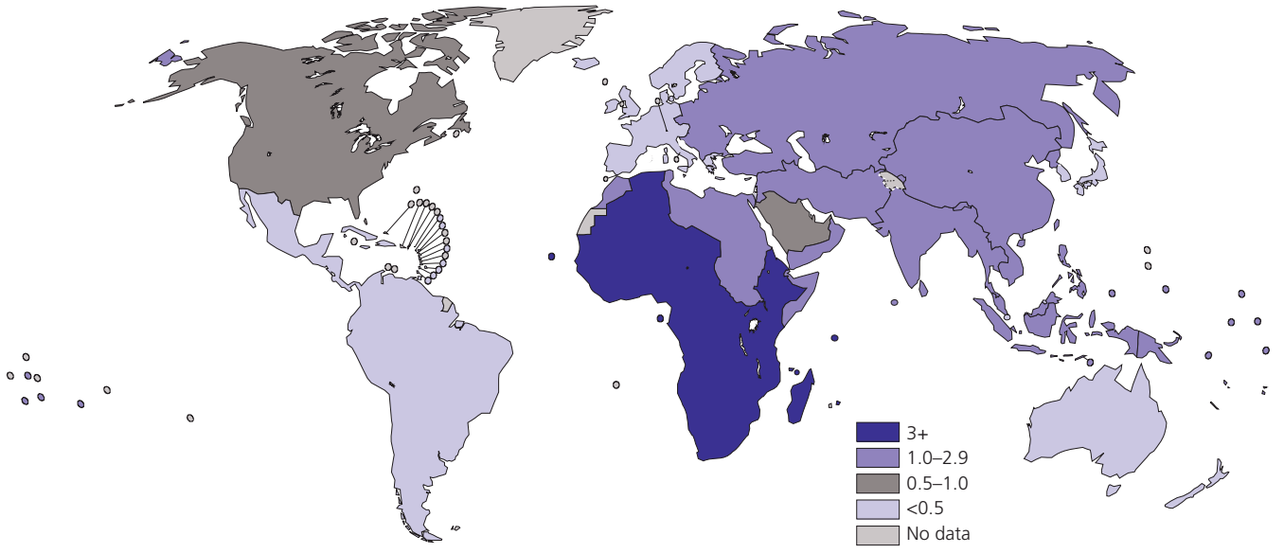
Source: WHO (2008), Global Burden of Disease: 2004 update.

Gender

Boys have higher rates than girls in all regions of the world except the low-income and middle-income countries of the Western Pacific region (see Table 6.1). The poisoning rate for boys in the WHO African region is 5 per 100 000 population, while for girls in the high-income countries

FIGURE 6.1

Mortality rates due to poisoning per 100 000 children[a] by WHO region and country income level, 2004



Africa	Americas		South-East Asia	Europe		Eastern Mediterranean		Western Pacific	
LMIC	HIC	LMIC	LMIC	HIC	LMIC	HIC	LMIC	HIC	LMIC
4.0	0.8	0.3	1.7	0.2	2.0	0.7	1.6	0.1	1.8

[a] These data refer to those under 20 years of age.

HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

of the Eastern Mediterranean and Western Pacific regions the rate is as low as 0.1 per 100 000 population.

Morbidity

In contrast to data on mortality, global data on non-fatal outcomes of poisoning are not readily available. Data at country level, though, usually obtained through poison control centres, specialized surveillance systems (such as the National Poison Data System in the United States) or the general injury surveillance systems that exist in many countries, are available. Unfortunately, much of the country information is from high-income countries. Some low-income and middle-income countries, though, including South Africa and Sri Lanka, have established poison control centres and begun to conduct research on poisonings.

One difficulty when comparing poisoning incidence rates between countries is the variety of classification systems used.

- In Sweden, the annual rate of enquiries to the poison control centre concerning non-pharmaceutical chemicals – a category that could include natural toxins, or recreational drugs – was about 1400 per 100 000 children aged between 0 and 9 years (*8*).
- In Japan, the poison centre received 31 510 enquiries in 1995 about poisoning in children under 6 years of age. The product most frequently involved was tobacco (20%). Enquiries relating to children less than 1 year old made up 35.7% of these cases (*9*).
- Data from 2006 from the American Association of Poison Control Centers showed that the most common poisonings among children were due to pharmaceutical products. Enquiries relating to children less than 6 years old made up 50.9% of cases and 2.4% of the total reported fatalities (*10*).
- In the United States in 2004, there were over 1.25 million poison exposures involving children less than 6 years of age – 425 per 100 000 children – reported to the Toxic Exposure Surveillance System (*11*). The substances most frequently involved were cosmetics and personal care products, cleaning substances and analgesics.

Data from published hospital admissions are available for poisonings in a number of high-income countries. Comparability is a problem here again, since admission criteria differ between countries and between urban and rural settings. Child poisoning admission rates in Australia have been consistently higher in rural areas than urban areas over a number of years. This is probably due to the fact that children are more readily admitted to hospital in rural areas, as doctors in these areas may err on the side of caution and refer children to hospital even when this is unnecessary. The actual agents involved, though, vary little between urban and rural cases (*12*).

Hospital discharge data are a better indicator of morbidity, since they include a confirmed diagnosis. A two-year study based on hospital discharges and death certificates in California, United States, showed that children aged 15–17 months had the highest overall injury rate and that poisoning was the second leading cause of injury in this group. More than two thirds of the cases involved the ingestion of medicines (*13*).

Although poisoning death rates are highest in infants under 12 months of age, the incidence of poisoning cases – as reflected in calls to poison control centres and emergency department visits – is generally higher in other age groups (*14, 15*). Non-fatal poisoning, in fact, appears to be more common among children aged 1 to 4 years (*9*). In a recent hospital-based study in four low-income and middle-income countries, only 2% of poisonings occurred in children under 1 year of age, compared with 54% in the 1–4-year age group (*16*).

The fatality rate among older children admitted to hospital following an accidental poisoning is generally less than 1% (*4, 17*). The higher mortality rate in very young infants may be explained by the greater susceptibility of the infant body to damage by toxins.

Types of poison

The prevalence and types of poisoning vary considerably across the world and depend on socioeconomic status and cultural practices, as well as on local industrial and agricultural activities.

TABLE 6.1

Mortality rates due to poisoning per 100 000 children[a] by sex, country income level and WHO region, 2004

	Africa	Americas		South- East Asia	Europe		Eastern Mediterranean		Western Pacific	
	LMIC	HIC	LMIC	LMIC	HIC	LMIC	HIC	LMIC	HIC	LMIC
Boys	4.9	1.2	0.4	1.7	0.3	2.4	1.3	1.7	0.1	1.5
Girls	3.0	0.4	0.3	1.6	0.2	1.7	0.0	1.5	0.1	2.1

[a] These data refer to those under 20 years of age.

HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

Data from poison control centres and hospitals (*4, 5, 18–24*) indicate that the most common agents involved in developed countries – as well as in some developing countries – are:

- medicines sold over the counter, such as paracetamol, cough and cold remedies, iron tablets, antihistamines and anti-inflammatory drugs;
- prescription medicines, such as antidepressants, narcotics and analgesics;
- recreational drugs, such as cannabis and cocaine;
- household products – such as bleach, disinfectants, detergents, cleaning agents, cosmetics and vinegar;
- pesticides – including insecticides, rodenticides and herbicides;
- poisonous plants;
- animal or insect bites.

The most common agents involved in childhood poisonings in low-income and middle-income countries are hydrocarbons used for fuel and lighting, such as paraffin oil (also known in some countries as kerosene) (*5, 25–31*).

A study conducted in Bangladesh, Colombia, Egypt and Pakistan showed that medications were responsible for 31% of poisonings in children under 12 years of age, followed by cleaning agents, which accounted for 20% (*16*).

Older children may be employed in the informal labour sector, in extractive metal industries that involve processing with toxic chemicals, or in agriculture, where pesticides are used. Children living in poverty may scavenge in dump sites containing toxic waste. In all these cases, there is a strong likelihood of exposure to toxic substances, including lead, mercury and organophosphates (*32*). Other children in the family, not directly involved in these activities, may come into contact with toxins brought into the home on the clothes or shoes of their siblings. Children may also be exposed to toxins leached into water or sprayed in the air.

Medicines

Medicinal drugs are the leading cause of non-fatal poisoning in children in middle-income and high-income countries.

- A hospital-based study from United Arab Emirates found that 55% of childhood poisonings were due to medicines. Analgesics, non-steroidal anti-inflammatory drugs and antihistamines were the most commonly ingested drugs in children in the 1–5-year age group (*21*).
- A study from Turkey reported that accidental ingestion of drugs was most common (57.7%) in children aged between 1 and 5 years and that the most frequent offending agent was analgesics (*33*).
- In the United States, in 2003, some 570 000 pharmaceutical exposures were reported in children less than 6 years old (*34*). This figure represented 23.8% of all poisoning reports, with analgesics accounting for almost 100 000 cases. Additionally, more than 50 000 children under the age of 5 years were treated in emergency rooms for an unintentional exposure to medicinal drugs. Prescription medicines were more commonly implicated than over-the-counter drugs (*34*).
- In England and Wales, during the period 1968–2000, medications accounted for 12.8% of unintentional poisoning deaths in children aged less than 10 years (*23*).

Organic fuels and solvents

Ingestion of hydrocarbon fuel used for cooking, heating or lighting is a common cause of childhood poisoning in low-income countries (*25–29*). Paraffin oil is the leading cause of childhood poisonings in many countries, where it may account for up to 16% of all paediatric poisonings, mainly in children aged between 1 and 3 years (*2, 16, 30, 31, 35–38*).

Organic solvents (such as paint remover, glue and acetone), as well as diethylene glycol (a component of anti-freeze), have also been implicated in mass unintentional poisonings of children through contaminated medicines or toiletries. In 1998, 109 children in Haiti fell ill after consuming paracetamol (known as acetaminophen in the United States) contaminated with diethylene glycol, and 85 of them died (*39*). In similar incidents in Bangladesh, India, Nigeria and Panama, children were poisoned as a result of poorly regulated manufacturing processes (*39*).

In addition to the unintentional ingestion of organic fuels and solvents, intentional inhalation of volatile substances (such as "glue sniffing") by adolescents can result in sudden cardiac death, since inhaled hydrocarbons are about 140 times more toxic than when ingested (*40*).

Pesticides

Children living in agricultural communities are at risk of acute pesticide poisoning. In the Central American region, in 2000, about 12% of all acute pesticide poisoning occurred in children less than 15 years of age, with an incidence rate of 5.7 per 100 000 population (*41*). In poor communities, where there is often little separation between work and the home, children may be exposed to pesticide residues present in work clothes, in the air from spraying and in household dust (*42*). In Nicaragua, children living near cotton farms have been found to suffer poisoning from organophosphates (*43*).

Some of the factors contributing to fatal food poisonings are the inappropriate use and storage of pesticides; the handling of food, while or after working, without proper washing of hands; and the unsafe disposal or reuse of pesticide containers. An example was the food

contaminated with thallium, a rodent poison, that was eaten by children in the Peruvian Andes in 1999, causing 24 deaths (*44*).

In addition to these types of indirect exposure to pesticides, there are direct exposures. A study in China found that children had been exposed directly to rodenticides used in and around the home (*45*). The International Labour Organization estimates that there are approximately 250 million working children between the ages of 5 and 14 years and that some 40% of these are exposed to toxic substances in the rural areas of developing countries (*42*).

Household chemicals

Chemicals around the house to which children may have access contribute significantly to unintentional poisonings in childhood. In the United States in 2004, among children less than 6 years of age, there were over 120 000 exposures to household cleaning agents, such as ammonia, bleach and laundry detergents (*11*). While most exposures to cleaning agents result in mild poisoning, bleach, dishwasher detergents and ammonia can lead to severe tissue damage. These agents are found in most households in developed countries. Several other studies have confirmed the existence of similar household agents in childhood exposures to toxic substances (*3, 21, 22, 46*).

Carbon monoxide

In the United States, some 1600 children under 5 years of age are treated in emergency departments each year and 10 die as a result of unintentional non-fire-related exposure to carbon monoxide. This type of poisoning among children most commonly occurs from furnaces, motor vehicles, stoves, gas pipes and generators (*47*). In low-income countries, indoor cooking fires in homes with poor ventilation can lead to carbon monoxide being produced as a result of incomplete combustion. This in turn can result in respiratory disease in children – from long-term exposure, rather than acute toxicity (*32, 33, 48*).

Other substances

Inorganic substances – including arsenic and the heavy metals lead, copper and mercury – are also responsible for some childhood poisonings. The majority of poisonings due to heavy metals and other inorganic substances are the result of chronic exposure and are therefore excluded from this discussion. In rare instances, though, acute exposure to these agents can result in poisonings. As an example, acute lead encephalopathy with an 11% rate of mortality was reported in Oman, after a lead-containing local medication was given by parents to young infants (*49*).

Plant toxin poisoning – involving plants such as ackee, oleander, datura and cassava – is less frequently reported. Such poisoning can cause morbidity. Death from ingesting plant toxins, though, is rare. Two exceptions are the tragedy in Haiti in 2001, in which 65 children died after eating unripe ackee fruit (*50*); and the consumption of *C. occidentalis* beans, the cause of recurrent outbreaks of encephalopathy among young children in western Uttar Pradesh, India (*51*).

Animal envenomations (poisoning from bites or stings) from snakes (see Box 6.1), scorpions and spiders are a relatively common form of child poisoning in certain areas of the world. These include parts of Asia, the Pacific and South America, and the desert areas of North Africa, West Asia and North America. Envenomations, for instance, in Saudi Arabia account for as much as 30% of all poisonings among children aged 6–12 years (*22, 52, 53*).

Cost of poisoning-related injury

Few studies have been done on the cost of poisonings, especially those affecting children or those occurring in low-income or middle-income countries. One study conducted in South Africa estimated that the direct costs alone of hospitalization due to paraffin poisoning were at least US$ 1.4 million per year (*54*). The average cost of treatment per patient amounted to US$ 106.50 in urban Pretoria (*36*) and approximately US$ 75.58 in the Cape Peninsula (*55*).

Data from the United States confirm the South African findings that poisonings and their management are costly (*56*). Figures from 2000 show that, in children under 15 years of age, there were a total of 219 000 poisonings, of which 141 were fatal and 14 000 resulted in hospital stays. The lifetime cost of poisonings in children in this age group was almost US$ 400 million, with medical treatment accounting for nearly 9% of the costs. This produces a conservative estimate of US$ 1780, on average, for each case of poisoning – including medical costs, lost earnings and lost quality of life (*57*).

Limitations of data

The epidemiology of poisoning can be studied from hospital admissions and discharge records, mortality data, emergency department records and surveillance systems, as well as from enquiries to poison control centres. Globally, though, data on the type of toxic agents that result in child poisoning and death are limited. There is substantial under-recording and under-reporting of childhood poisoning incidents. In addition, poisoning is not generally a notifiable condition, so few countries maintain records of poisonings. Even where surveillance systems exist, child poisoning cases are not necessarily reported or counted. Cases may escape detection, especially if those affected do not seek treatment in a health-care facility. Furthermore, poisoning in children may be attributed to the wrong cause if the effects are similar to those of other conditions. Even where poisoning is correctly diagnosed, the health-care worker or caregiver may not recognize the toxic agent that is responsible.

BOX 6.1

Snakebites

Snakebite is an eminently treatable, but neglected, injury affecting predominantly tropical developing countries. As is also the case with dog bites, recent improvements in injury coding and surveillance, including community surveys in low-income and middle-income countries, have led to an increased understanding of the issue.

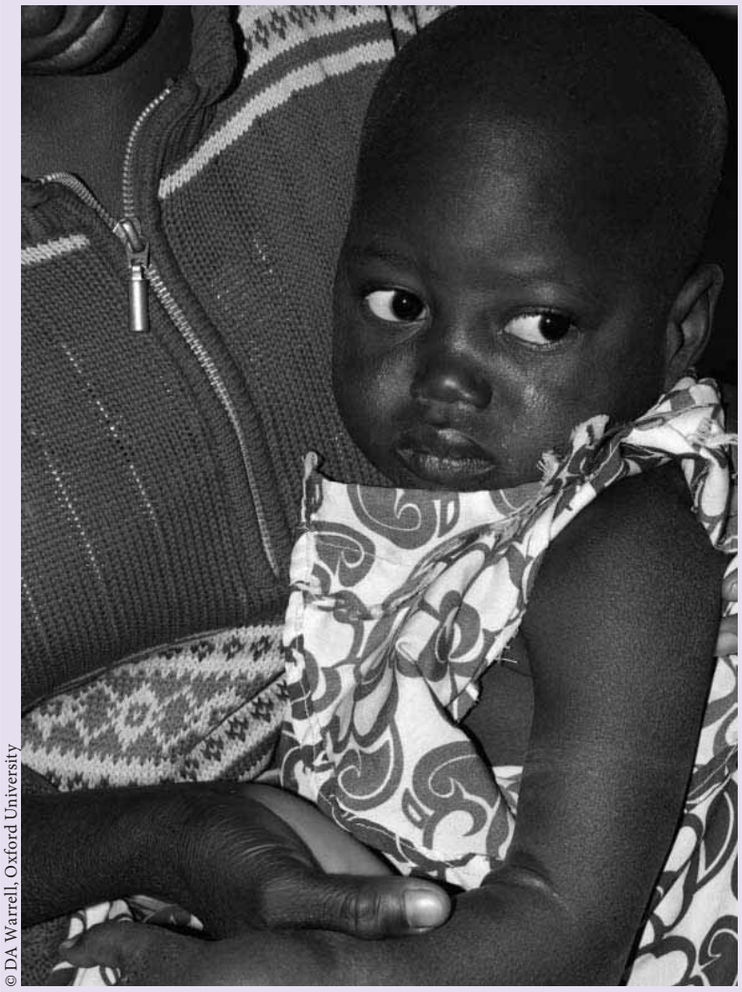
How great is the problem of snakebite?

The annual number of cases of snakebite worldwide is about 5 million, among which there are some 100 000 to 200 000 deaths (*53, 59*). In addition to the deaths, there are an estimated 400 000 snakebite-related amputations each year around the world (*60*). Children have both higher incidence rates and suffer more severe effects than do adults, as a result of their smaller body mass (*61, 62*). Snakebites are concentrated in mainly rural areas and vary considerably by season, with the peak incidence seen in the rainy and harvesting seasons (*63*).

Analysis of 2002 WHO mortality data suggests that snakebite contributes to 35% of all child deaths, globally, from venomous bites and stings, with boys about twice as likely to suffer as girls (*64*). Boys appear to have a higher risk, from a very early age, of more severe, upper limb bites (*65*). This type of injury is considerably more common in low-income and middle-income countries, largely in Asia (*53, 59*).

Unfortunately, although the specific antidotes for snakebites – antivenoms – are organic products, there is a worldwide shortage of this pharmaceutical (*59*). This has a severe impact on poor rural communities, who cannot afford the refined antivenoms used in high-income countries. As a consequence, many developing countries are driven to making crude sera that are both less safe and less effective. At the same time, those most at risk of snakebite, such as rice farmers and plantation workers and their families, are frequently far from medical care.

There are a number of snakebite studies in the published literature, but few report specifically on the impact on children – although fatality rates among children are generally higher (*63*). Furthermore, less than 10% of countries in WHO's South-East Asia Region, an area of high snakebite incidence, report paediatric snakebite mortality data. Nonetheless, the recent community health and injury surveys in Asia show that snakebite-related injury ranks as a leading cause of childhood morbidity and mortality in this region (*66*).



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Papua New Guinea has some of the highest snakebite rates in the world, with the country's rural central province recording an annual incidence of 561.9 cases per 100 000 population (*63*). Among paediatric snakebites treated at Port Moresby Hospital Intensive Care Unit, the fatality rate for 2003–2004 was 25.9%, compared to 14.5% for adults. Children also represent 36% of all snakebite-related ventilator bed-days in an intensive care unit, in which snakebite-related paralysis accounts for 60% of the ventilator bed-days (*63*).

Data from developed countries, on the other hand, reveal much lower snakebite-related injury and very low mortality rates.

- In Australia, 1512 snakebite hospitalizations were recorded between 2000 and 2002, resulting in a crude annual rate of 3.9 per 100 000 population. The highest rates – of 7.5 per 100 000 – were among boys aged 10–14 years (*61*).
- In the United States during the period 2001–2004, the estimated crude rate of snakebite presentations to emergency departments was 3.4 per 100 000 population, with an overall admission rate of 31%. The crude presentation rate was highest among children aged 10–14 years, at 5.5 per 100 000 population (*62*).

What can be done about snakebites?

Few studies have comprehensively examined this question for adults, and even fewer have looked at paediatric snakebite. The evidence is therefore somewhat anecdotal. Nevertheless, several general points can be made about why children are at particularly high risk of snakebite (*67*).

- Natural curiosity leads children to interact with animals in general, and in particular leads boys to interact with snakes.

- In rural areas in developing countries, children are often employed on the farm, thus incurring an increased risk of making contact with snakes.
- Children's small body weight means that a snakebite is likely to have a relatively great impact.

Hence children, especially boys, should be specifically targeted for snakebite prevention educational initiatives.

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The primary avoidance of snakebite relies on minimizing children's interaction with snakes. Approaches here include:

– wearing appropriate protective clothing – such as shoes or boots – particularly at night and in rural areas;
– avoiding demonizing snakes, as deliberate aggressiveness towards them is more likely to result in a snakebite;
– keeping sheds and fodder storage areas clear of mice and rats, as these attract snakes;
– keeping grassy areas well cut.

Regarding secondary prevention, two recommendations should be made.

- Compartment syndrome – where excessive pressure impairs blood supply, leading to possible nerve damage and muscle death – is often associated with tourniquet use following a snakebite, and is the most common reason for amputation in children in many areas of Africa. The use of tourniquets as first aid following snakebite should therefore be discouraged, and vigilance maintained against pressure-induced cell death (*68*).
- Traditional healers, who often initially treat snakebite, should be specifically targeted so that modern principles of medical care can be incorporated into their traditional methods. This can help avoid delays before treatment can be given in a health-care facility, and thus minimize the frequent serious harm that results from late treatment of snakebite.

Snakebite is a widespread and previously poorly-documented global injury problem, in which children and young people are disproportionately represented. Low-income and middle-income countries, particularly the rural areas, are the most affected. Most deaths and serious consequences from snakebites are entirely preventable by existing means, including making antivenom much more widely available. Better surveillance and reporting are necessary to assess the extent of this forgotten injury and to improve prevention strategies.

Data on child poisonings are further affected by problems with coding. The use of the International Classification of Disease coding of external causes of death, for example, does not capture sufficient detail on the agent involved (*58*). In addition, there is frequently insufficient information on which to make a determination of intent, with the result that many poisoning cases are classified as being of undetermined intent. Accurate information regarding intent is vital for prevention strategies. Studies show that poisonings of children up to the age of 10 years tend to be unintentional, while those of adolescents tend to be intentional in terms of deliberate consumption of the agent, but not necessarily with the intent to cause injury (*7*).

Risk factors

As with other injuries, the risk of a child being poisoned is affected by factors related to the child, the agent and the environment. These factors are interrelated and are highly dependent on the context (see Table 6.2). An understanding of these factors is important for the development of interventions to prevent and, where necessary, treat cases of child poisoning.

Child-related factors

Age

Age has a strong association with poisoning as it determines the behaviour, size and physiology of the child, thus influencing types of exposure and outcome (*69*). Infants and small children are closer to the ground than older children and tend to put their hands and small objects into their mouths. As a result they are at increased risk of exposure to toxins found at low levels or in the soil or dust – such as rodenticides. Many studies have confirmed that poisoning rates increase dramatically at around 2 years of age, as young children become more mobile and have increased access to toxins (*16*). Young children are particularly susceptible to the unintentional

TABLE 6.2

Haddon Matrix applied to the risk factors for childhood poisoning

	Child	Agent	Physical environment	Socioeconomic environment
Pre-event	Age and developmental factors (such as curiosity, judgement); gender; parental supervision.	Ease of opening package; attractiveness of substance; inadequate labelling; poor storage.	Cupboards within easy reach of children; absence of locking devices on cabinets; exposure to agents.	Lack of regulations and standards for toxic products and packaging; poverty; lack of awareness of toxicity and poisoning risks among caregivers.
Event	Child's secrecy about ingestion; parent not noticing unusual behaviour.	Toxicity of chemical; dose consumed; ease with which substance can be consumed (for instance, as liquid rather than solid).	Places where child can ingest substances without being seen.	Lack of awareness by caregivers of how to react; lack of appropriate and timely decontamination by health-care workers.
Post-event	Child's inability to communicate incident; lack of access to poison control centre.	Chemical agent without an antidote.	Lack of adequate pre-hospital care, acute care and rehabilitation.	No poison control centre or lack of information on how to contact centre; lack of access to emergency medical care.

ingestion of poisons, especially liquid ones (*70*). The risk of poisoning among young children is exacerbated by their size and physiological development. Most substances increase in toxicity as the dose increases relative to body mass. Some toxins are eliminated by enzyme systems in the body that develop as the child grows older.

In adolescents, where poisoning can be caused by alcohol misuse or the use of other recreational drugs, fatality rates are higher than in younger children (*71*).

Gender

Boys appear to be at consistently higher risk of poisoning than girls (*4, 36, 72*). With specific regard to poisoning from the ingestion of paraffin, though, some studies have shown no difference between boys and girls, while others have shown a preponderance among boys (*25, 28, 37*). The discrepancy in these findings may be explained by gender differences in socialization between different countries. In some cultures, girls are expected not to engage in outdoor activities or to adopt risk-taking behaviours (*27*).

Poverty

Socioeconomic status is strongly associated with injury and deaths from poisoning, not only between countries but also within countries (*73*). Studies from the United Kingdom show that the risk of dying from poisoning among children from poor backgrounds is more than three times higher than the risk for children in affluent areas (*74*). One study in Greece, however, showed no association between social and demographic factors and child poisonings (*75*). Nonetheless, socioeconomic status may well be the strongest risk factor for poisonings in children as it affects exposure, is itself associated with several other risk factors (such as physical underdevelopment in children) and is linked to poor outcomes of injury.

In developing countries, socioeconomic status is a strong predictor for household fuel consumption, itself linked to an increased exposure to paraffin. At the same time, poverty drives children into work that is usually poorly paid but with high risks of injury. Poor people tend to live with inadequate sanitary facilities – for washing, and sewerage and waste disposal – and limited storage space to keep harmful substances away from children. Poor dwellings are more likely to be close to areas sprayed with pesticides or to toxic dumps, or to draw their water from contaminated sources. Poverty and malnutrition can also place children at risk of poisoning by forcing them to consume unsafe but cheaply obtained foods – such as undercooked cassava or unripe ackee fruit, both of which are toxic.

The ability to withstand toxic effects depends, among other factors, on the nutritional and health status of the child. Children living in poverty are generally inadequately nourished and therefore more vulnerable to poisons than their healthier counterparts. In addition, conditions of poverty frequently prevent people from accessing health care.

Agent factors

Characteristics of the agent

The more concentrated or more potent the toxic agent, the greater the risk of severe morbidity and mortality. Chemical analyses of seven samples of paraffin from South African refineries found significant differences in their levels of toxicity (*76*).

The nature of the substance is also important. There is a higher incidence of injury associated with liquid agents than with solid compounds (*69*). Households

with children are more likely to have liquid medications. Liquid preparations are easier to swallow than powdered preparations, such as dishwasher detergents or tablets, because they do not stick to the mucosa of the mouth. Nor do they usually produce a burning sensation (which powdered preparations do) which would limit the amount consumed. Unfortunately, powdered chemicals are now being produced with an anti-caking agent, which increases the ease of flow of the powdered chemical, but which also makes ingestion easier.

The physical appearance of a toxic substance plays a large part in its attractiveness to children, while its chemical composition determines its effect. Features such as size, colour and texture may attract or deter a child from handling and ingesting a substance. Studies show that liquids rather than solids, clear liquids rather than dark coloured ones, and small solids rather than large solids have more appeal to young children and are therefore more likely to be ingested by them (*77*). Bright colours in solid medications may also make them more attractive to children.

Storage and access

The most obvious risk factor for ingestion of a substance is its presence in the domestic environment, within reach of the child. Dispensing substances – such as paraffin and medications – in unlabelled or incorrectly labelled containers without child-resistant closures also increases the risk of poisoning (*14, 26*). Paraffin oil is frequently stored in bottles or other containers meant for cold drinks, milk or fruit juice, which children associate with beverages (*36, 66, 78*). In some places, tablets are poured into unsealed envelopes or ziplock bags, and liquids into non-distinctive, poorly labelled containers. Children may also drink from containers, such as cups, which have previously been used for refilling heating or lighting appliances (*79*). White pesticide powders improperly stored close to food substances can be mistaken for flour, starch or milk, and have led to poisonings of entire families (*80*).

Even when dangerous products are stored in distinctive containers with visual warning labels – such as images of "skull and crossbones" – young children are unlikely to recognize the significance of these signs (*81*). Some studies have found carelessness, overcrowding or limited space to be the cause of incorrect storage (*14, 36*). Research in Australia has shown that many products leading to child poisoning incidents were recently purchased or else not kept in their usual place of storage (*80, 82*). Medicine and bathroom cabinets, and kitchen cupboards and drawers appeared to be the safest storage places, while handbags, refrigerators, shelves and bathroom ledges were the least safe (*83*). Even safe packaging cannot compensate for unsafe storage.

In developed countries, many products are required by law to be distributed in child-resistant packaging (*84*). This usually involves either a bottle with a child-resistant closure or a blister pack. Child-resistant closures make it more difficult for a child to open a container because they require a series of complex actions – such as squeezing and turning, or pushing downwards and turning. The standard for the testing of child-resistant closures adopted in most countries requires that at least 85% of children aged from 42 to 51 months must be unable to open the container within five minutes, and at least 80% must fail to open the container following a non-verbal demonstration (*85*).

No closure, though, is perfect. In the child testing, up to 20% of children aged between 42 and 51 months may be able to overcome the child-resistant closure. Many parents are unaware that young children may indeed be able to access the contents of child-resistant packaging. Child-resistant closures should therefore never take the place of good supervision (*24*).

Environmental factors

Season and climate

There are significant seasonal variations in the incidence of poisoning cases for different poisoning agents. Summer is the time of greatest risk for the ingestion of paraffin, medications and organophosphates and for bites from scorpions and snakes (*25, 36*). Several explanations have been put forward. Children on their summer holidays are more likely to be outdoors or to be left at home unattended or in the care of an older child or elderly relative (*65, 86, 87*). Children may also consume more fluids because of the warmer weather. Around national or religious holidays, parents or siblings may be less alert to hazards or children may exhibit more attention-seeking behaviour (*88*).

Although the incidence of poisoning is higher during the summer months, a few types of poisoning are more common in winter or during cold weather. These include carbon monoxide poisoning – from heating appliances – and poisoning through ingesting cough or cold medicines, as these are often considered harmless and left unattended (*89*).

Socioeconomic environment

Several case–control studies in low-income and middle-income countries have highlighted social and demographic risk factors in the poisoning of children. These factors include the presence of young parents, residential mobility and limited adult supervision (*65, 90, 91*). Although parents and caregivers may have been present at the time of the poisoning incident, studies confirm they were usually engaged in household duties or attending to personal needs. In a significant proportion of cases, poisoning occurred when a child was left in the care of another child or with a grandparent (*65, 87, 91, 92*).

Poor living conditions, local beliefs and customs and ignorance of the dangers of chemicals are other risk factors associated with acute poisoning (*14*). Previous poisoning may also be a risk factor (*72*).

The socioeconomic environment has an effect on the exposure to the risks of poisoning as well as on outcomes. The absence in many countries of policies, standards or laws governing the manufacture, labelling, distribution, storage and disposal of toxic substances place children at risk of poisoning. Poor quality control in the manufacture of medicines exposes children to toxic contaminants in these products. The unregulated packaging and distribution of medicines and other potentially toxic substances in sachets and containers that are not child-resistant increases the ease with which children can gain access to them. The uncontrolled storage and dumping of pesticides near homes and in water supplies expose children, especially those from poorer households, to toxins.

The toxicity of agents is also influenced by the political environment. In the United Kingdom during the 1970s, a significant proportion of child poisonings were attributed to medicines, such as aspirin, barbiturates and safapryn, a drug that was a dangerous combination of paracetamol and aspirin (*23*). Aspirin is no longer prescribed for children and barbiturates have been replaced by less toxic agents such as benzodiazepines. In addition, the chemical industry now produces less toxic pesticides. Economic forces, though, are responsible for the continuing use in developing countries of outdated agents, both pharmaceutical and non-pharmaceutical, that often carry high risks.

Lack of prompt treatment

In the event of a poisoning, quick and appropriate triage, diagnosis and treatment are vital. Poison control centres do an excellent job of advising the public when a poisoning is suspected, as they rely on regularly updated databases and standard management protocols. However, many countries do not have such a system in place. Even if they do, people may not have access to the centres.

The availability of health-care facilities and the ability to access such facilities rapidly affects the outcome of poisoning injuries. Although there are no data comparing fatality rates of poisonings in rural or remote areas – where health facilities are more likely to be scarce and of lower quality – one would expect poisonings in more remote areas to have more serious outcomes. Certainly, fatality rates in countries with limited health-care facilities are higher than rates in more developed areas. Once a child has been transported to a hospital, the prompt recognition of the signs and symptoms and treatment for the correct type of poison involve knowledge of the latest clinical developments and skill in toxicology analysis.

Interventions

Interventions are usually based on risk factors that are amenable to change and that are targeted at high-risk populations.

Engineering measures

Reduction of toxicity

Removing a poisonous substance effectively may not always be possible. An alternative approach is to lower the level of the toxicity of the offending agent or to neutralize it in some way. One way of doing this is to reduce the concentration of the active ingredient. In Saint Lucia, a policy of selling acetic acid only in diluted form led to a fall in the rate of childhood poisonings. Previously, concentrated vinegar had been easily available, and had been responsible for several poisoning deaths (*93*). Another example of lowering toxicity is the reformulation of methylated spirits as principally ethyl alcohol, rather than the more toxic methanol.

In a similar way, less toxic pesticides may be used to prevent cases of acute pesticide poisoning (*32*). However, safer pesticides are generally more expensive, so that financial incentives or subsidies are probably needed if they are to be used in poorer countries. Introducing organic pesticide management or an integrated vector management system (*94*) will also lead to a fall in the number of cases of acute pesticide poisoning. To operate such systems, though, requires scientific expertise (*41*).

Reducing the toxic effects of ingestible poisons by adding an antidote to the substance has also been attempted, but has not been proved to be effective. In the United Kingdom, paracetamol was manufactured with added methionine, an antidote to paracetamol overdose (*95*). This product, though, was withdrawn because it was more expensive than the paracetamol-only formulations that remained on the market. In addition, the use of oral methionine was questioned, as the substance was associated with allergic reactions.

Safer packaging and storage

The success in reducing unintentional child poisoning through safer packaging and storage over the past three decades has relied on:

- *education* of parents and caregivers – about the risks and how to protect against them;
- *legislation* – to prevent unsuitable containers (such as are normally used to store food or drinks) being used to store harmful substances; and to make packaging around harmful substances resistant to tampering by children.

In South Africa, paraffin oil is used for heat for cooking and is frequently stored in bottles previously used for storing beverages. A successful programme to tackle this dangerous practice involved the free distribution of containers with child-resistant closures (see Box 6.2). As a result, the annual incidence of poisoning fell, over a period of 14 months, from 104 per 100 000 to 54 per 100 000 (*80*).

In affluent countries, medicines stored in the home are more likely to be implicated in childhood poisoning than they are in poorer countries. In many places, tablets or capsules are emptied into cheap containers such as paper or plastic envelopes. In developed countries, commercially packaged medicines are sold in a variety of preparations and strengths – in standard screw-capped or clip-capped bottles, in bottles with child-resistant closures and in blister packs. To avoid errors of dosage, particularly among elderly people, some medications are dispensed in special boxes where multiple morning, lunchtime and evening doses are stored together.

Child-resistant packaging is one of the best-documented successes in preventing the unintentional poisoning of children (*96*). In England and Wales, unintentional poisoning deaths of children aged under the age of 10 years fell steadily from 151 per 100 000 in 1968 to 23 per 100 000 in 2000 (*23*). Similarly, in the United States, the annual rate of unintentional ingestion of 15 regulated substances in children younger than 5 years fell from 5.7 per 1000 in 1973 to 3.4 per 1000 children in 1978 – with nearly 200 000 unintentional ingestions prevented during that period (*97*). Both these reductions were largely as a result of the introduction of child-resistant packaging.

Safe storage of poisons in the home requires a secure location where a child cannot overcome barriers of locks or height. Although children will devise complex strategies to get hold of medicines, doing so takes time. The main reason, therefore, for storing poisons *out of reach of children* is that this is a delaying strategy – as indeed is child-resistant packaging.

Child-resistant packaging has been proved effective for medications, fuels, household chemicals and pesticides. The cost to manufacturers and distributors may be an obstacle, but this is likely to be outweighed by the large savings from treating children who have been unintentionally poisoned. The costs to households may be offset by government subsidies, such as the free distribution of such containers (*91*). Child-resistant packaging should be used on all drugs sold over the counter, to help prevent children consuming these potentially lethal products (*98*).

Reducing an agent's attractiveness

One study has shown that the appropriate design of packaging can be an effective means of reducing the attractiveness for children of harmful substances (*99*). Other studies, on the ingestion by children of paraffin, have recommended that containers be made of darkened material in which the contents are invisible (*25*). The reason for this is that, since paraffin may be easily mistaken for water, a non-transparent, dark container is less likely to be associated with a drinkable liquid than a transparent, light-coloured container. Another suggestion is to modify the taste and colour of paraffin as well as modifying the containers in which it is stored

BOX 6.2

Change the packaging, save a life

Some 40 000 to 60 000 children in South Africa ingest paraffin oil each year, and suffer consequent poisoning. Between 170 and 500 of those admitted to hospital with paraffin poisoning do not survive. This figure, though, may be much higher because many serious cases do not reach hospital in time and are therefore not included in the statistics (*100*). The majority of children affected are under the age of 5 years. In addition to their suffering, and that of their families, there are substantial costs, borne by the state, for hospital care and treatment.

Concerned groups are being called upon to step up efforts to protect children in poor and marginalized communities, where the majority of paraffin poisoning incidents and deaths occur. Local research has highlighted the effectiveness of child-resistant closures in avoiding the ingestion of poisons among children (*65*). Child-resistant closures – packaging that is difficult for children under the age of 5 years to open, but which an adult can easily open – are the only proven intervention that will reduce the incidence of paraffin ingestion among children. In 1994, a study in a rural community in South Africa showed that the free distribution of child-resistant closures reduced the incidence of paraffin ingestion by 47.4% over a period of 14 months, compared to a control community where there were no child-resistant containers (*65*).

Every child has a right, enshrined in South Africa's constitution, to grow up in an environment that is not harmful to his or her health or well-being. The mandatory use of child-resistant closures could save the lives of more than 80 children in the country each year and reduce incidence rates of paraffin ingestion by half.

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(*27*). In Australia, changing the colour of paraffin to blue led to a decrease in the incidence of paraffin ingestion (*101*).

The addition of bitter agents is another method of stopping children from consuming significant quantities of harmful substances. Studies have shown that this approach may be useful, though it is possibly more appropriate for household products of mild to moderate toxicity rather than for pharmaceutical products (*102, 103*).

Labelling containers with warning stickers showed no deterrent effect on children at risk aged under 6 years (*81, 104*). The possible effectiveness of warning labels depends very heavily on their being understood by all, and assumes some degree of literacy. It has even been suggested that in some cases, warning labels may attract children (*81*).

Environmental measures

Studies show that 56% of unintentional poisonings in young children occur within the child's home, and another 17% occur in or around someone else's home (*16*). Reducing children's access to poisons in the home can be achieved in a number of ways.

Removing toxic agents

The most effective way to prevent children coming into contact with a poison is to remove the poison itself. An example of this is the Manchineel tree. The fruit of this tree looks like an edible green apple but the fruit, bark and sap are all toxic. Poisonings from the Manchineel tree, especially among children, used to be common in the Caribbean, despite warning signs and educational campaigns. Eventually, the trees were removed by the authorities from the beach areas where they were prevalent and replaced by coco plum trees, with a consequent fall in the number of poisoning cases.

Alternatively, toxic agents may be replaced by other substances with a lower toxicity. As examples, the following highly toxic substances have been largely replaced in many places by less toxic substances having a similar intended effect (*23*):

- barbiturates (a class of sedative-hypnotic drugs) by benzodiazepines;
- cresol (a preservative) by chlorocresol;
- aspirin by paracetamol;
- toxic anti-inflammatory drugs with less toxic non-steroidal anti-inflammatory drugs.

Sometimes the change from toxic to less toxic substances occurs as a side effect of economic development. The incidence of paraffin ingestion, for instance, has been found to fall when countries move from using individual fuel sources, such as bottled paraffin, to safer alternatives such as electricity and natural gas supplied by public utilities (*32*).

Laws and regulations

A comprehensive strategy to prevent childhood poisoning must include laws supported by enforcement. This has been shown in the case of child-resistant closures. The laws on child-resistant closures and a high degree of compliance by manufacturers have seen falls in mortality rates in several developed countries.

Child-resistant packaging

Standards and policies for child-resistant packaging currently only exist in a handful of high-income countries, such as Australia, Canada, New Zealand, the United States and the European Union. The absence of laws (or their lack of enforcement) and policies on manufacturing, storing, distributing and disposing of hazardous products has led to deaths of children as a result of contaminated medicines and toothpaste. In the Bhopal catastrophe, methyl isocyanate – a poisonous gas, heavier than air, that is used in the production of pesticides – was released into the atmosphere. In the absence of a strong local legislative framework, international standards and laws need to play a role in regulating global companies, currently often able to operate with lower levels of care than in their country of origin.

In 1970, the United States introduced child-resistant packaging in its Poisons Prevention Packaging Act. With rates of compliance among manufacturers of between 60% and 75%, the incidence of unintentional ingestion of baby aspirin was reduced by 45%–55% and of regular aspirin by 40%–45% in children less than 5 years old (*105*). Poisoning deaths among children under 5 years of age, resulting from the ingestion of substances regulated by the 1970 law, declined from 450 in 1962 to 216 in 1972 and 33 in 2005 (*106*).

The European Union has laws (*107*) mandating the storage of toxic substances in child-resistant containers that are:

- clearly and appropriately labelled;
- in places that are not within reach of children or near to foodstuff;
- labelled in such a way that the substances in question cannot be mistaken for food.

This clearly places the onus for protecting children from toxic substances on households as well as on manufacturers and distributors. These laws may account for the low rates of child poisoning seen in much of Europe.

Blister packs

Blister packs (non-reclosable packaging) for medicines in tablet or capsule form are increasingly being used for dispensing. Soon after they were introduced such packs were considered to be child-resistant, because of the time it takes to remove each individual tablet or capsule and led to some reductions in child poisoning (*108*). However,

as the use of blister packs has increased, it has become clear from poison centre data that young children can access medications from such packs. While removing and swallowing the tablets from a single strip of a blister pack may be less likely to be harmful than having access to a full bottle of the comparable liquid form, for many medicines even a few tablets can be a toxic or even a lethal dose for a young child. One advantage of blister packaging is that parents may better recall how many tablets had been used before the child swallowed some – thus being able to calculate the maximum number that may have been ingested. The disadvantage of blister packs is their transportability. Studies have shown that children often remove medications from handbags, particularly those belonging to the grandmother (*109*). This has prompted the development of a European standard for child-resistant blister packs, using a child test panel similar to the one for the reclosable child-resistant packaging standard.

Educational approaches

Although not an effective intervention strategy by itself, education on how to prevent poisoning has been shown to be a useful component of prevention programmes (*110–114*). Education on poisoning should aim to:

- raise awareness;
- increase knowledge and skills on poison prevention;
- change attitudes and behaviours;
- influence policy and legislation;
- create good practices within organizations.

Educational interventions should be used in combination with other interventions seeking to prevent poisoning.

Most poisonings in young children occur at home, with parents or caregivers nearby and engaged in household tasks. While continuous direct supervision (always within eyesight) would reduce the access of children to poisons, it is not practical to promote such a strategy. Continuous supervision is difficult to achieve even for caregivers in affluent households with few children. In poorer households, there are likely to be more children to be cared for and other competing household tasks to be performed. In such circumstances, passive measures are likely to be more effective.

The effectiveness of public awareness and general education campaigns in reducing the incidence of child poisoning cases is open to question. Educational campaigns in isolation have not had a significant impact on the ingestion of harmful substances (*110, 115*). One study in the state of Massachusetts in the United States showed no significant increase in compliance following a campaign of advice on how to prevent poisoning (*111*). Research has also shown that mothers and caregivers take fewer precautions against child poisonings if these precautions involve more effort, and especially if they involve changes in behaviour. Passive interventions, as already stated, are likely to be more successful and should be promoted (*112*).

It has been suggested that messages used in educational programmes directed at caregivers (including parents) may be more effective if they address the factors influencing the behaviour of the caregivers. Further, home visits by health-care workers to reinforce the messages of the educational programmes have been shown to be effective (*113*).

Educational programmes with a narrower, more specific aim may be more successful. Such programmes may include:

- point-of-sale warnings from pharmacists on the possible dangers of the medication being dispensed;
- public awareness campaigns that "child-resistant does not mean child-proof";
- messages to parents and caregivers reminding them to test child-resistant closures and to ensure that these closures have been properly re-engaged;
- messages to parents and caregivers that common household products may be dangerous for young children – even such "healthy" or "natural" products as iron tablets or essential oils.

A recent systematic review on the effect of home safety education and the provision of safety equipment on poisoning prevention practices revealed that although these interventions improve poison prevention strategies, their impact on poisoning prevention rates remains unclear (*116*).

Managing poisoning

Management of a poisoning requires immediate advice and first aid, followed by directed treatment where necessary.

Acute management of poisoning

Box 6.3 outlines the general principles governing the management of all cases of acute poisoning (*48, 117*).

Early and accurate diagnosis and management of poisoning decrease the risk of morbidity and mortality. It is therefore vital that caregivers seek help from a poison centre or a professional health-care worker. An assessment, including the previous history, should be made if possible, though this may be difficult with children. It is important to keep the airway clear, the breathing regular and the circulation flowing.

The agent is likely to be known, but the dosage may have to be estimated. Treatment should be based on the greatest exposure that could have occurred. There are many sophisticated tests and procedures, but their effectiveness has in some cases been questioned. Some of these tests may in any case not be possible to perform in most developing countries.

BOX 6.3

Managing acute poisoning: the general principles

1. **Remove the child** from the source of exposure and decontaminate the child, as described below, if the poison has been inhaled or absorbed through the skin or mucous membranes. Contaminated clothing, including shoes and socks, and jewellery should be removed. Where toxins have been inhaled, the child should be removed to an environment of fresh air.

2. **Assess** what agent, or agents, and doses are involved, the time since ingestion and the current clinical status – as well as other factors related to the child, such as age, gender and the presence of other illnesses. Toxic screening has limited value as it delays management and is seldom available in developing countries.

3. **Stabilize** the child. The general approach to acute poisoning involves giving priority to the airway, breathing and circulation – as for any emergency.

4. **Decontaminate** the child, if appropriate. It is important to limit the absorption of an ingested agent. Gastrointestinal decontamination is reserved for severe or life-threatening cases, where the poison is still in the gastrointestinal tract and can be removed. The airways must be secured and gut motility assured before embarking on gastrointestinal decontamination.

   Specific decontamination measures include the following.

   - *Topical decontamination*. Whatever the means of exposure, any body surface – including the eyes – that is exposed to a toxin should be flushed well with large amounts of water, saline or other fluids specific to the poison.
   - *Activated charcoal* may be used to absorb many organic poisons. It is ineffective, though, for hydrocarbons, caustics, alcohols and some heavy metals. Though not proved to achieve a better clinical outcome, activated charcoal does result in a decrease in absorption of the poison if it is used within one hour of ingestion. Complications associated with activated charcoal include aspiration and constipation.
   - *Gastric emptying* can be achieved in two ways.
     - One means of gastric emptying is through vomiting, but it is no longer a routinely used method as its effectiveness is in doubt. There may also be complications with vomiting and it is contraindicated in children less than six months of age, in children with unprotected airways or when the ingested substance is an organic solvent, such as petrol or paraffin oil, or a corrosive agent.
     - The second means is through gastric lavage. In this method, the stomach is washed out with small aliquots of normal saline until its contents are cleared. This procedure should only be performed if indicated and is not recommended for children less than six months of age.
   - *Catharsis* to increase gastrointestinal motility and hence hasten the expulsion of unabsorbed poison. There is little evidence, though, to support the use of catharsis as a means of reducing gastrointestinal absorption following an overdose, and the complications of fluid loss and electrolyte imbalance outweigh any benefits.
   - *Whole bowel irrigation* can be used to physically eliminate highly toxic substances not absorbed by charcoal. Its use is neither supported nor refuted if substances such as iron, lead and paraquat have been ingested. A non-absorbable liquid such as polyethylene glycol solution is used to induce a liquid stool until the rectal effluent clears. Complications include fluid and electrolyte imbalance, bloating and vomiting.
   - *Alkaline diuresis* enhances elimination of some acidic substances. An example is bicarbonate administered to enhance the elimination of aspirin.
   - *Dialysis* – including haemodialysis, peritoneal dialysis, haemofiltration and haemoperfusion – may be used in specific circumstances to clear certain water-soluble poisons from the circulation.
   - *Antidotes*. Envenomations should be treated with antivenom, most commonly for snakebite and scorpion stings, and also for some spiders' bites. Atropine is used for carbamates; atropine and pralidoxime for organophosphorus pesticide poisoning; naloxone for opioids; acetylcysteine for paracetamol overdoses; and chelating agents for some heavy metals.

5. **Provide supportive therapy**, including the treatment of complications. The main management in acute poisoning includes: airway stabilization; seizure control; correction of hypoglycaemia; correction of hyperthermia; treatment of shock and pain; and the use of antidotes.

Poison control centres

Poison control centres provide advice to individuals and health-care institutions. They direct first aid where appropriate, and refer more severe poisonings to a health-care facility. Poison control centres are responsible for less severe outcomes in cases of poisoning. They also eliminate much unnecessary contact with more expensive health-care services (*118*). They were initially set up in high-income countries and have since been established in many low-income and middle-income countries (see Box 6.4).

There are problems, though, in establishing poison control centres in less developed countries. Often, the need for such centres is not properly appreciated. There is likely to be a shortage of adequately trained staff, and poor clinical and laboratory toxicology services for further management of cases (*119*). In addition, the effectiveness of poison control centres depends on good telephone communications, which may in some places be limited, though this obstacle is likely to be overcome by the increasing use of mobile telephones (*120*).

It is estimated that for every dollar spent on a poison control centre contact there is a saving of nearly eight dollars, as more than 70% of cases are resolved over the telephone (*118*). If these centres did not exist, an estimated 600 000 additional possible poisoning cases would receive

treatment at a health-care facility each year, at an added cost of US$ 545 million.

Involving a range of sectors

There is a wide range of groups and sectors that need to be involved for the successful prevention of accidental poisoning of children. In addition to the health-care sector, parents and caregivers, there are: the education sector; the justice ministry; the departments of trade and industry; consumer groups; nongovernmental organizations concerned with child safety; producers and retailers of pharmaceuticals, agrochemicals and other toxic substances; and industries that handle toxic substances and in which children are employed.

In the Netherlands, a programme to prevent unintentional poisoning among children aged 0–4 years resulted in a 15% reduction in the number of poisoning cases and a 50% fall in the number of admissions to health-care facilities. The programme involved health-care workers, parents, kindergarten teachers, the mass media, nongovernmental organizations, and the pharmaceutical and chemical industries (including retailers and distributors) (*122*). Another example of a multisectoral collaboration to prevent poisonings is the establishment of poison control centres in developing countries (*120*).

Industry has an important role to play in reducing the number of toxic substances produced, both directly and as by-products. In developed countries, as demand for more environmentally-friendly products has increased, industry has responded by modifying products, with the increased cost met by concerned consumers. Products have in this way been modified to produce safer versions, not through planned interventions but as a result of independently occurring social changes. Financial incentives to industry, that have led to a reduction in carbon emissions, may also be effective in reducing the range of household poisons to which young children are exposed. Both legislation and a strong voluntary engagement of the corporate sector are likely to be required to ensure the safe storage and disposal of toxic products and by-products.

Evaluating interventions

Evaluation is vital in determining whether policies and programmes for poisoning prevention are effective. An essential element of evaluation is having an injury surveillance system or else the ability to collect data from health-care settings. In the Netherlands, surveillance data that had been gathered were used successfully to evaluate a range of interventions – from child-resistant closures to educational campaigns for safer storage (*123*).

Conclusions and recommendations

Despite reductions in the incidence of child poisoning following specific interventions, cases of poisoning still contribute towards a significant proportion of child injuries.

One of the greatest obstacles in the way of effective prevention and control of poisoning is the lack of reliable data. Few data collection systems exist and those that do are mainly in developed countries. As a result, it is difficult to estimate the scale of the problem precisely in those places where the incidence may be the greatest.

Several interventions have been tried, with varying levels of success (see Table 6.3) (*124–126*). Measures that have been found effective to some degree include poison control centres, child-resistant packaging, and

BOX 6.4

The National Poisons Information Centre in Sri Lanka

In Sri Lanka in 2005, poisoning accounted for almost 90 000 hospital admissions and 1785 deaths. Around a third of these cases were in children under the age of 18 years.

The first poison control centre in the world was established in 1953 in the state of Illinois, United States, largely in response to the number of poisoning cases involving children. One of its aims was to instruct doctors on how to deal promptly with accidental overdoses, cases of chemical poisoning and animal bites or stings. More generally, the centre provided information on the toxic ingredients of substances and their chemical effects.

In Sri Lanka, the National Poisons Information Centre was set up in 1988 – the first such centre in South Asia (*121*). Deaths from insecticide poisoning were of special concern, and three pesticides in particular – monocrotofos, methamidofos and endosulfan – were found to be killing agricultural workers and their children. As a result, the importation of these pesticides was banned in Sri Lanka.

In the first 10 years of its existence the National Poisons Information Centre dealt with 4070 enquiries *(121)*. Of these, 3671 were by telephone (about a third of them relating to children and young people under 20 years of age), 368 were personal visits to the centre, and 31 written enquiries. Over 90% of the telephone calls were from health-care personnel, most of the rest coming from members of the public. Around half the enquiries were in connection with suicide attempts, and a further third concerned unintentional poisoning incidents (*4*).

The centre is staffed by three information officers covering the hours from 8:00 to 17:00 every day. Calls outside working hours are referred to the intensive care unit at the National Hospital of Sri Lanka (*4*).

In 1993, again in response to a continuing problem with pesticides, several new measures were put in place to strengthen the National Poison Information Centre. These included:

- a 24-hour service for health-care professionals and doctors;
- a laboratory facility for analysing blood, urine and stomach contents;
- the ability to supply antidotes to hospitals.

As a result of these and other services provided by the centre, the incidence of morbidity and mortality from poisoning in Sri Lanka has fallen.

education (including training of parents and caregivers) combined with home visitations (*113, 116*). Many of the successful prevention interventions have been tested only in developed countries.

Recommendations

- Data collection systems need to be improved in ways appropriate to the setting. The data obtained will help to identify populations at risk and their specific risk factors, as well as facilitating the design and implementation of interventions.
- More research is needed on the ability to reproduce and transfer across cultural boundaries successful prevention interventions on childhood poisoning.
- Poison control centres, with well-trained personnel, should be set up as widely as possible. In places where they have operated, they have saved many lives and large amounts in health-care costs (*127*).
- Countries should set laws and standards relating to the manufacture, storage, distribution and disposal of potentially toxic substances.
- Countries should introduce laws mandating child-resistant packaging for medications, and for pesticides, rodenticides and other potentially toxic household items. The effectiveness of such packaging should be evaluated, particularly where blister packs are concerned.
- Industry needs to play a greater role in reducing the presence of toxins and in safely packaging items that are sold to households. Greater care needs to be taken in the production process itself, to ensure that by-products and waste do not contaminate the environment.
- Treatment protocols should be developed to assist with the initial assessment and management of potential child poisoning cases. These protocols should target the most frequently involved and most toxic pharmaceuticals (*128*).

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TABLE 6.3

Key strategies to prevent poisoning among children

Strategy	Effective	Promising	Insufficient evidence	Ineffective	Potentially harmful
Removing the toxic agent	■				
Legislating for (and enforcing) child-resistant packaging of medicines and poisons	■				
Packaging drugs in non-lethal quantities	■				
Establishing poison control centres	■				
Locking away medicines and other toxic substances		■			
Removing or regulating availability of toxic substances that are easily mistaken for edible items			■		
Teaching children to avoid poisonous substances			■		
Reducing the attractiveness of medications and poisonous products			■		
Providing home safety education and safety equipment			■		
Clearly labelling toxic products				■	
Introducing non-standardized, non-reclosable packaging for tablets					■

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CONCLUSION

ANAPUMA'S STORY

Children are powerful agents of change and should be included during the development and implementation of child injury prevention projects at local, national and international levels.

The following is an essay written by sixteen-year-old Anupama Kumar of Kerala, India. She won the UNICEF Voices of the Youth road safety essay competition and received her award during the World Youth Assembly, held at the Palais des Nations of the United Nations in Geneva, Switzerland in April 2007.

"1.2 million die in road accidents each year. A child is killed in an accident every three minutes. Road safety is increasingly becoming a major killer and a worldwide concern, particularly for young people. What can we do to address the issue?

The media has been a largely overlooked factor in creating road safety awareness. Celebrity endorsements, coupled with television messages on prime-time slots and peer education programmes would provide an accessible and engaging means of promoting awareness, particularly among young people. They would convey the message that safe driving is "cool" driving, and constantly reinforce that drunken driving, using a cell phone on the road and driving without a seat-belt (or helmet) are not only dangerous, but "seriously unfashionable". Celebrities could also actively encourage walking or cycling whenever and wherever possible.

Role-plays, "make-believe" situations, movies and field trips could be used as effective learning tools for children at school. Safe Road User awards at the school level would provide an incentive for many children to follow road safety rules. Road safety education programmes can also be extended to adults at the workplace, particularly those from disadvantaged backgrounds. This would hold particular importance for parents, and efforts must be made to involve them as much as possible.

There is a need for stricter licensing laws, particularly with regard to public transport operators. Laws could require prominent display of the driver's licence on his or her vehicle while driving, in addition to safety regulations (such as adequate maintenance and the use of the seat-belt) and random breath testing policies. Policies could provide for the creation of better roads and pavements, supervised playing areas for children and monitored crossings near schools.

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Citizens must campaign for safer, wider roads and better sidewalks to limit accidents. Speed governors in each vehicle would provide a low-cost solution to speeding. There is also a need to provide well-maintained, safe and efficient public transport systems, particularly in developing nations. Fingerprint identification systems, similar to those in laptop computers, could be used in each vehicle, with each vehicle responding only to a programmed set of fingerprints.

For any effective change in the safety of our roads, however, we need to consciously change our attitudes towards providing safer roads – not just for ourselves or for young people, but for everyone."

Chapter 7
Conclusion and recommendations

Introduction

Earlier chapters have discussed in detail the nature and objectives of child injury prevention. In addition, for each of the five leading causes of unintentional injuries incurred during childhood, the magnitude of the problem, the risk factors and the specific interventions have been described. This chapter brings together the main points of the report and presents a set of generic recommendations that governments and others involved in the field of child injury should consider using to develop their national or local strategies to prevent child injury. The chapter concludes with suggestions as to how those concerned with the issue, including the children themselves, could become more involved in child injury prevention.

Main messages from the report

This report, the first world report on the topic of child injuries, presents the current knowledge about the five most important causes of unintentional injury to children under the age of 18 years as well as some of the actions that need to be taken in order to tackle the problem. The following are the report's main messages.

Child injuries are a major public health issue

Injuries mar the lives of millions of young people and their families each year. The World Health Organization estimates that, in 2004, around 830 000 children under the age of 18 years died as a result of an unintentional injury. Recent community-based studies conducted by UNICEF, however, have suggested that the number could be much higher. Tens of millions more children are non-fatally injured and many of these require hospital treatment. For survivors, the impairment that injuries can cause and the resulting need for care and rehabilitation have far-reaching impacts on a child's prospects for health, education and social inclusion and on their parents' livelihood.

The unequal burden of injury is an additional reason to address the problem. Children in poorer countries and those from poorer families in better-off countries are the most vulnerable. More than 95% of injury deaths among children occur in low-income and middle-income countries. Approximately 40% of the deaths among those under 18 years of age in high-income countries are the result of an injury – an indication of the fact that these countries, although doing better, still have a serious problem.

If countries do not address their child injury problem it is likely to escalate and as a result, unnecessary lives will be lost to causes that are largely preventable.

Injuries directly affect child survival

Specific concern for the lives, health and well-being of children is voiced in a series of international agreements and initiatives. Most notable of these is the Convention on the Rights of the Child, adopted in November 1989 during a session of the United Nations General Assembly, which affirms that each child has the right to the highest attainable level of health and the right to a safe environment. The Convention requires that "all appropriate legislative, administrative, social and educational measures to protect the child from all forms of physical or mental violence, injury or abuse, neglect or negligent treatment, maltreatment or exploitation, including sexual abuse" are taken by countries (*1*). Most countries in the world have ratified this convention, and it represents a powerful statement of their collective views on the responsibilities towards children.

In addition, the fourth objective of the Millennium Development Goals is to reduce by two thirds the mortality of children under five years of age by the year 2015 (*2*). Most countries are focusing on reducing infectious diseases. However, in many places the relative proportion of deaths as a result of injuries in this age group is significant enough to hamper the attainment of the goal if it is not addressed at the same time.

Child survival has been described as "the most pressing moral dilemma of the new millennium" (*3*). As injuries are a leading cause of death and disability among children worldwide, to prevent those injuries is particularly important for the wider issue of child survival and the improvement globally of child health. Injury programmes need to be integrated into other child health strategies, with ministries of health playing a pivotal role. In addition, injuries need to be included as one of the indicators in overall child survival programmes.

Children are susceptible to injuries

There is a strong association between the stage of life and the type of injuries sustained by a child. The age of a child, the stage of his or her development, how the child interacts with the world, and the type of activities the child undertakes are all relevant to this association. Among infants, for instance, fires, drowning and falls are the leading causes of injury death. Among 1–4-year-olds, as children start to move more independently, drowning becomes the leading cause of injury-related death in many places, followed by road traffic crashes and fires – the three of which combined accounting for almost two

thirds of injury deaths in that age group. Over the age of five years, road traffic injuries, drowning and fires are the predominant causes.

In addition to these biological factors, there are other risk factors for child injuries. These include socioeconomic factors such as poverty, the absence of protective factors, and the environment in which children live. The quality, availability and access to medical care are important factors that can influence not only the likelihood of surviving an injury but also the long-term consequences.

"We have a duty to protect children from injury and violence. Children live in a world designed for adults, but they have special needs and are more vulnerable than adults to certain factors in their environment which may place them at additional risk of injury" Ann M. Veneman, Executive Director, UNICEF.

Child injuries can be prevented

Simply reproducing safe strategies that are relevant to adults will not protect children sufficiently. Various developmental issues, risk taking behaviours, levels of activity and the child's degree of dependence make the matter more complicated. Prevention programmes that take into account these vulnerabilities and use a multidisciplinary approach have been shown to be the most effective for reducing child mortality as a result of injury. A number of countries have achieved remarkable reductions in their child injury death rates, in some cases by more than 50% (see Box 7.1).

There is no single blueprint for success but six basic principles underlie most of the successful child injury prevention programmes around the world. These are:
- legislation and regulations, and their enforcement;
- product modification;

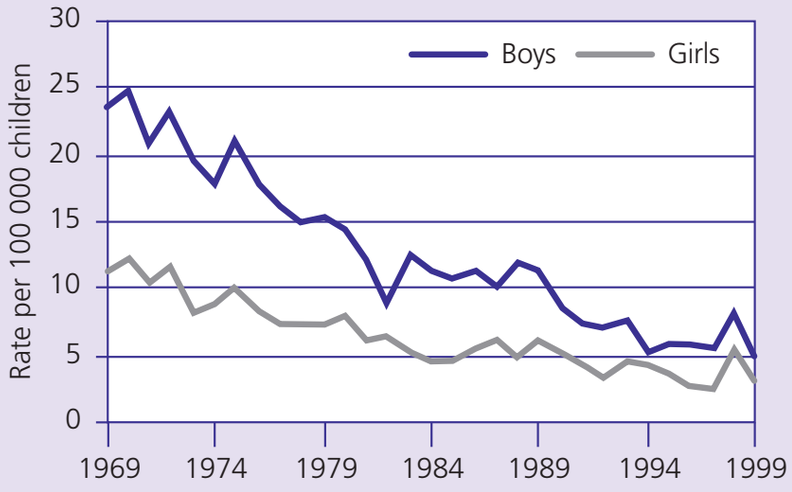
BOX 7.1

How did Sweden achieve its reductions in child injuries?

Since the early 1950s, Sweden has seen a reduction in child injuries, championed largely by the paediatrician Dr Ragnar Berfenstam (*4*). In 1969 the injury death rate in Sweden for boys and girls under the age of 18 years was 24 per 100 000 and 11 per 100 000 children, respectively. Over the last three decades, Sweden has been able to bring the rates down to 5 per 100 000 for boys and 3 per 100 000 for girls. These dramatic reductions have been achieved using a range of approaches cutting across several sectors, and involving children and the community.

The health sector played an important and leading role in the initiation and follow-up on a wide range of actions which included:
- environmental planning: traffic was diverted away from residential areas and towns so that children could walk to school, play and return home without encountering busy streets; Sweden had originated the idea of Safe Communities long before it was taken up by others;
- measures against drowning: much of the early reduction in child injury was attributed to water safety interventions; rates among children aged 0–14 years fell from 8 per 100 000 in 1951 to 1 per 100 000 children in 1985 (*4*);
- safety measures in the home;
- home visits by health professionals;
- traffic safety measures – such as helmets and child-restraints – taking into account the limited capacity of small children to adopt safe practices in traffic;
- improved product safety and standards;
- improved health care services for children;
- safety measures at school.

TRENDS IN CHILD INJURIES, SWEDEN, 1969–1999



Source: Laflamme, Karolinska Institute, Sweden.

– environmental modification;
– supportive home visits;
– the promotion of safety devices;
– education and the teaching of skills.

In countries where the greatest reductions have been recorded, a combination of these approaches has been employed. In addition, countries that encourage a culture of safety and display strong political commitment have made great progress in reducing their child injury burden.

As important as the idea of "what works" is the notion of "what to avoid". Certain prevention strategies have been tested in high-income countries and found to have no beneficial effects. There are some that even have negative consequences. Countries planning child injury prevention programmes should be aware of these dangers.

Furthermore, a reliance on the single, stand-alone injury prevention strategy of educating children (or their parents) in order to change children's behaviour – while common – is sadly misplaced. This is not to say that education is unnecessary. It is indeed a valuable component that should be incorporated into most injury prevention strategies, and a useful tool to encourage the use of passive measures – actions that people have to do themselves, such as putting on a helmet. However, there is no evidence to show that education on its own can reduce injuries.

Child injury prevention strategies should be based on available evidence (see Table 7.1). Interventions should be prioritized after considering the scale of the problem, and the known effectiveness, cost-effectiveness and cost of each intervention.

> *"Evidence is the foundation for setting priorities, crafting policies, and measuring results. Evidence can have great persuasive power at the policy level."* Dr Margaret Chan, WHO Director-General.

The cost of doing nothing is unacceptable

For many parents, the grief of losing a child unexpectedly can take decades to heal and for many it never does. For some families the emotional pain is even greater if simple measures could have been taken to prevent the incident. Even if the outcome is not fatal, the medical costs and the special care that is often needed for a severely injured or disabled child can put a huge financial demand on parents and cause great difficulties for families or caretakers.

In addition to what parents, siblings, families and communities have to endure, child injuries also place a significant strain on often overstretched health care systems. The cost of primary prevention programmes is much cheaper than treating a child, sometimes for months, because of a preventable injury. Many wealthier countries have already implemented cost-effective primary prevention programmes that have led to a reduction in health-care costs. In the United States, for instance, it has been estimated that for every one US dollar spent on a child car seat, there is a saving of 29 dollars in direct and indirect health care costs and other costs to society. If similarly effective interventions to prevent child injury

TABLE 7.1

Key approaches to addressing child injuries

Key approaches	Traffic	Drowning	Burns	Falls	Poisoning
Legislation, regulations and enforcement	Speed limits; comprehensive drink-driving laws; child restraints	Four-sided pool fencing	Hot water tap temperature legislation; smoke alarms	Playground equipment standards	Manufacture, storage and distribution of harmful substances requiring safe packaging
Product modification	Vehicle-front modification; child restraint systems	Personal flotation devices	Non-tip lanterns and candle holders	Baby walker modification; safety glass	Medication packaging; child resistant closures
Environmental modification	Child friendly infrastructure; safer routes to school; safer play spaces	Barriers – such as well coverings and fencing	Separation of cooking area from living area	Window guards on tall buildings; roof railings; non-climbable banisters	Safe storage of potentially harmful substances
Education and skills development	Helmet wearing; using child restraints	Swimming training and supervision	First aid – "cool the burn"	Supportive home visitation to identify fall hazards	Immediate first aid
Emergency medical care	Child-sized equipment; child-friendly environment	Immediate resuscitation	Burns centres	Appropriate paediatric acute care	Poison control centres

were implemented around the world, many thousands of lives would be saved (see Box 7.2). Injury prevention can thus be a very cost-effective public health strategy, with the costs of interventions often much lower than the costs of the consequences of injury.

> *"...We cannot accept these injuries as just accidents that will happen. If a disease were killing our children at the rate that unintentional injuries are, the public would be unbelievably outraged and demand that this killer be stopped."* Former United States Surgeon General, C. Everett Koop, 2001.

Few countries have good data on child injury

Data on injury and its determinants are essential for identifying priority issues and high-risk groups, and also for understanding the underlying causes of injury. In addition, agreement on the definitions of specific injuries is essential for accurate measurement and comparability. The availability of good quality data and of trained people to analyse such data are therefore important in the search for effective prevention interventions (see Box 7.3). By the same token, a lack of data can hold back action for want of evidence, prevent priorities from being correctly set, and hamper research and the evaluation of interventions.

In developed countries, detailed analysis of sound data has undoubtedly been instrumental in achieving high rates of success in child injury prevention. Elsewhere, data on child death and injury are generally either of a poor quality or missing. Furthermore, discrepancies in data collected are sometimes used as excuses not to do anything, where they could instead serve as a foundation to strengthen information systems.

A major difficulty in child injury prevention, as with all injury prevention, is obtaining reliable estimates of the scale and pattern of child injury and death. To this end, the volume, quality and availability of national and regional data needs to be increased through a combination of:

- better data collection systems;
- improved surveillance;
- use of hospital discharge systems (including ICD external cause codes);
- more community-based surveys on child injury (using standard protocols).

Research on child injuries is too limited

Reductions in child injury mortality have been achieved in some developed countries as a result of the application of evidence-based programmes based on rigorous research and priority-setting. Unfortunately, such research is not widespread even in all high-income countries and is particularly limited in low-income and middle-income countries, resulting in a significant gap in knowledge.

BOX 7.2

Saving 1000 children a day

In 2002 more than 875 000 children died from preventable injuries while millions more were injured or permanently disabled. Many of these injuries, such as poisonings, falls, and burns, occurred in or near the home. Others, including those caused by road traffic crashes, occurred as children were on their way to school or during other activities. Household and environmental factors also contribute to the overall risk of childhood injury.

In the past several decades, significant progress has been made in understanding better the epidemiology of injuries in children. Developing effective interventions to prevent these injuries, however, has not progressed as far. A number of intervention strategies – including the use of helmets, seat-belts, and pool fences – have been shown to be effective at preventing injury-related deaths in children. Sadly though, the benefits of these interventions have not been fully realized in many places. As a consequence, hundreds of thousands of children die every year.

To highlight what can be achieved through effective interventions, a comprehensive review of prevention strategies for childhood injuries was carried out, quantifying their unrealized benefits in terms of the number of children's lives saved (*5*). More than 80 studies and 46 interventions were reviewed, from which quantifiable effectiveness data on 12 intervention strategies for injury prevention among children were identified. These strategies related to unintentional childhood injuries from road traffic, poisoning, drowning, and burns. Data on the effectiveness of these particular interventions were then applied to the global burden of fatal child injuries.

Among these interventions, the use of fences or other barriers preventing access to water bodies alone could save more than 50 000 lives of young children each year. Similarly over 50 000 deaths from fire-related burns are potentially preventable using smoke detectors. On a lower scale, the use of child-proof containers could prevent nearly 5000 deaths from kerosene poisoning.

For road traffic injuries, better data allow the modelling of more interventions. A very promising intervention is the strengthening of traffic codes and fines, including the suspension of licences for traffic violations, which could save 80 000 children's lives annually. The use of motorcycle or bicycle helmets for children, daytime running lights for motorcycles, speed reduction measures, and child restraints can potentially save between 30 000 and 40 000 lives each if implemented alone, however, the combined effect of these interventions is not yet quantifiable.

Current data do not allow refined estimations of the potential benefits of a package of interventions for child injury prevention – a research agenda for the future. However, crude estimates indicate that if a set of 12 intervention strategies (which have been tested in a wide range of settings) covering road traffic, drowning, poisoning and burns were implemented around the world, more than 1000 children's lives could be saved each day.

While the urgent need to research new intervention strategies for preventing injury deaths in children remains, this study has shown the huge benefits that can be realized by implementing interventions that have already been tried and tested. While the estimate obtained of the potential benefits of interventions to prevent child injuries is a somewhat crude one – due to limitations in the data available – the over-all message is clear: children all over the world are needlessly dying as a result of unintentional injuries for which there are known interventions.

Source: reference *5*.

BOX 7.3

The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP)

CHIRPP is an emergency department-based injury surveillance programme operated by the Public Health Agency of Canada (PHAC) in collaboration with 14 hospitals (*6*). The programme began in 1990 within Canada's ten children's hospitals. Although several general hospitals now participate, as of October 2007, 84% of the 1.8 million records in its database relate to children and young people less than 20 years old.

CHIRPP was set up to complement existing sources of information on injury mortality and hospitalization. Its main strength is the information it holds on the circumstances in which injuries occur. Information about such injuries is gathered in emergency departments directly from injured patients, or accompanying adults, who are asked to complete a one-page form containing open-ended questions about where and how the injury occurred. Clinical staff provide information on the type of injuries and their severity, the parts of the body affected, and whether the patients were admitted or discharged. Information from the forms is then coded and entered into a central electronic database at the PHAC.

Among the 40 variables used to describe the circumstances in which injuries occur is a narrative of up to 100 characters that describes the event. The narrative is particularly valuable as a source of information for which specific codes are not available. Events associated with particular places, activities (such as specific sports) or products that do not have International Classification of Disease codes are easy to identify in CHIRPP data. Between its detailed codes and its narratives, the database provides a wealth of information about how injuries happen.

Analysts at CHIRPP receive, on average, four to five requests each week for information on injuries. Responding to these requests may take anything from a few minutes to several months of work. About two thirds of requests come from the media. Most of the remainder are from Health Canada's Product Safety Bureau and from nongovernmental organizations such as Safe Kids Canada.

CHIRPP produces reports on a wide range of injury issues. Many of its short reports, fact sheets and monographs are posted on the PHAC web site (*7*). The areas it has examined include:

- the impact of legislation on bicycle helmet use;
- the effect of new regulations allowing body-checking in younger ice-hockey players;
- the impact of new Canadian standards for playground equipment.

CHIRPP's reports containing detailed data on all aspects of injuries associated with baby walkers led to Health Canada's Product Safety Bureau deciding that baby walkers posed significant and unnecessary risks to young children. This led in turn, in June 2007, to Canada's Minister of Health upholding an earlier prohibition on baby walkers, including their advertising, sale and importing. Canada remains the only country to date to ban all types of baby walkers.

Other investigations being carried out by various organizations, using CHIRPP's data, concern:

- the use of trampolines in homes and playgrounds;
- all-terrain vehicles;
- baby bath seats;
- the ingestion of magnets;
- falls from windows and balconies;
- injuries associated with diving structures;
- scalds from tap water;
- nursery products.

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Research on child injury should not only concern the evaluation of intervention studies but also include:

- economic analyses;
- programme effectiveness studies;
- behavioural and developmental science research;
- health utilization analyses.

Research into the whole spectrum of child injuries in developing countries – from primary prevention through to rehabilitation – needs much higher levels of funding. Such research will not only benefit developing countries enormously, but has the potential to uncover solutions not yet found in high-income countries.

There are too few practitioners in child injury prevention

Most countries around the world have limited human capacity to prevent the epidemic of child injuries, deliver emergency and ongoing care following an injury, and provide appropriate rehabilitation services. This problem is particularly acute in poorer countries where the bur-den of child injury is greatest. In many

settings around the world public health training does not address issues related to child injury. Medical courses teach students how to treat trauma but usually overlook prevention. Furthermore, government staff in sectors relevant to child injury do not as a rule receive training on injuries and do not work in a structure that enables information on injury prevention to be shared effectively (see Box 7.4).

BOX 7.4

Developing knowledge and skills for child injury prevention

While capacity building in the field of child injury prevention is not limited to human resources, knowledge and skills are nonetheless a clear priority. One tool to develop the knowledge base around injury is TEACH-VIP.[1] This is a comprehensive injury prevention and control curriculum, developed over three years through the efforts of WHO and a network of over 60 experts on injury prevention in 19 countries. The course material is designed for classroom instruction, and contains PowerPoint slide presentations, supporting lecture notes and learning exercises addressing a range of topics relevant to injury prevention and control.

TEACH-VIP is a modular curriculum, whose content allows for the flexible arrangement of lessons. Training courses may therefore be structured differently depending on the particular audience or physical setting.

Within a year of being launched in October 2005, TEACH-VIP was being used for training in over 60 countries. Experience has shown that it is suitable for a wide variety of audiences – including students in public health and medical and nursing sciences, injury prevention practitioners, injury response service providers and government personnel. This is important, as the prevention and control of injury requires collaboration across a range of sectors and disciplines, with participants working with a common understanding of the issues.

TEACH-VIP provides training that is of both general and specific relevance to child injury prevention. Lessons of general relevance include those relating to research methodologies, injury surveillance and coding, trauma care, the communication of injury information, and general injury prevention. Lessons that are specifically relevant cover road traffic injuries, falls, burns, drowning, animal bites and poisoning. In addition, TEACH-VIP contains a range of lessons on intentional injuries involving children and young people, including ones on youth violence and child abuse and neglect.

Aside from knowledge transfer, there is also a need for a more targeted development of skills. WHO has created a distance mentor-ing programme known as MENTOR-VIP,[2] designed to assist junior injury practitioners in developing specific skills through a structured collaboration with a more experienced person who has volunteered to act as a mentor. MENTOR-VIP thus provides a means to match demand for technical guidance with offers to provide technical support.

[1] Available at the web site: http://www.who.int/violence_injury_prevention/capacitybuilding/teach_vip/en/index.html

[2] Available at the web site: http://www.who.int/violence_injury_prevention/capacitybuilding/mentor_vip/en/index.html

Child injury prevention is the responsibility of many sectors

Child injury prevention, by the very nature of the type of injuries involved, should be a responsibility shared between governments, nongovernmental organizations, academic institutions, international agencies and the business sector.

The health sector has a leading role to play (*8*), particularly with regard to:

- collecting and analysing data;
- carrying out research on risk factors;
- implementing, monitoring and evaluating interventions;
- delivering appropriate primary, secondary and tertiary care;
- campaigning for greater attention to the issue of child injuries.

All the same, a multisectoral approach is indeed necessary. The sectors of transport, police, education, law and environment all play a major role in the prevention and control of childhood injuries. Preventing injuries from falls in schools comes under the remit of the education ministry, for instance, while the legal sector will be responsible for legislating for mandatory child-resistant containers. The collaboration between sectors has to cross organizational boundaries, so that the public sector, private organizations and non-profit groups can combine their expertise.

Child injury prevention is underfunded

Well-targeted investment of financial resources is needed to tackle the problem of child injuries. Over the last decade, as countries have focused on the Millennium Development Goals, much funding has been provided to address infectious diseases – the major killer of children under five years of age. It would be a tragic mistake if this good investment were to be lost after children had survived their infancy, because injury prevention had earlier been ignored. The cost-effectiveness of some child injury prevention strategies has been found to be at least equal to that of other well-accepted strategies to prevent childhood illnesses.

It is essential to engage the donor community if interventions are to be tested and implemented, especially in poorer countries. Child injury prevention needs to be a stated priority of public and private funding agencies.

Awareness needs to be created and maintained

The magnitude, risk factors and preventability of child injuries are not widely appreciated at all levels, from policy-makers and donors to the local community. This lack of understanding means that the resources required are not being allocated to prevention efforts and the political and organizational structures that are needed are not being put in place.

It is of prime importance to show that resources can be efficiently and effectively used in this area for the benefit of public health. Sustained campaigning is therefore required to raise awareness about the public health, social and economic impacts of child injuries, and how these injuries can be prevented. Awareness, of course, also needs to be created about how some risk factors are connected to other issues – such as obesity, mobility and disaster management – and how tackling these issues would reduce child injuries and improve children's health overall.

Recommended actions

Governments and others involved are encouraged to consider the following seven recommendations when developing child injury prevention programmes.

Recommendation 1: Integrate child injury into a *comprehensive approach* to child health and development

A comprehensive strategy for child health and development should include all leading causes of ill health and disability among children, and therefore include injuries. Existing child survival programmes need to introduce child injury prevention strategies as part of the basic package of child health services. The current renewed emphasis on primary health care provides an opportunity for governments, ministries of health and civil society organizations to restructure their child health programmes to include child injuries.

The success of child health programmes should be measured not only by traditional measures of infectious disease mortality but also by other indicators of fatal and non-fatal injury.

Recommendation 2: Develop and implement a *child injury prevention policy* and a plan of action

Each country should prepare a child injury prevention and control policy bringing in a wide range of sectors. Agencies involved should include those concerned with transport, health, planning, consumer product safety, agriculture, education, and law. There should also be representation across the disciplines, with child development experts, injury epidemiologists, engineers, urban planners, clinicians, social scientists and others all participating. Concerned groups should be brought in from government, the private sector, nongovernmental organizations, the media and the general public.

The policy should take the needs of all children into account, particularly those who are vulnerable, such as poor and homeless children, children with disabilities and female children, and should be linked to other child health strategies.

A country's child injury policy should promote the development of national standards and codes on issues that have a direct bearing on child injury, including such items as products and appliances, playground and school safety, and residential building regulations and laws.

A national strategy needs to set ambitious but realistic targets for at least five or ten years. It should have measurable outcomes and sufficient funding to develop, implement, manage, monitor and evaluate actions. Once the child injury prevention strategy is established, national and local action plans should be prepared laying down specific actions to be taken and allocating resources for these actions.

Recommendation 3: *Implement specific actions* to prevent and control child injuries

Specific actions are needed to prevent and control child injuries and to minimize their consequences. These actions – forming a part of the national child health strategy – should be based on sound evidence, be appropriate in terms of culture and other local context, and have been tested locally. The evaluation of interventions should be an integral part of the programme.

Chapters 1 to 6 discussed in detail specific interventions for each type of injury, their impact on the frequency and severity of injuries, and their cost-effectiveness where this was known. No standard package of interventions will be suitable for all countries. Table 7.1, though, summarized the main approaches, with some examples, that can be used.

If specific interventions are not introduced, it is unlikely that simple awareness on its own will bring about significant reductions in child injuries and deaths.

Recommendation 4: *Strengthen health systems* to address child injuries

The health system as a whole should be strengthened to provide high quality care to injured children, as well as rehabilitation and support services. These improvements should include:

- the development and maintenance of an efficient system of pre-hospital care;
- good quality acute management of injured children in hospitals and clinics, with appropriate child-specific equipment and drugs;
- suitable rehabilitation programmes, addressing both the physical and psychological long-term consequences of injuries;

– coordination with allied sectors to ensure holistic care and management of the injured child.

The health system should also be strengthened to provide financial protection and social support to the families and households of injured children. If this is not done, households may be pushed into poverty as a result of child injuries, especially in poorer countries.

Appropriate training programmes should be a priority. Many countries do not have sufficient personnel with the skills and experience needed to develop and implement an effective child injury prevention programme.

Governments should start this process by designating a focal person or coordinator for child injury prevention within the health ministry. The particular organizational model to be used may depend on the national situation, but it is important that accountability for child injury prevention and control is explicitly set out.

Recommendation 5: Enhance the *quality and quantity of data* for child injury prevention

An important element in dealing with child injuries is ascertaining the magnitude and characteristics of the problem, as well as assessing national policies on child injury and the capacity to handle such injuries. A thorough understanding is needed, not only of the volume of child injury deaths, non-fatal injuries and disabilities, but also of:

– the children who are most affected;
– the types of injury that are most prevalent;
– the geographic areas where the greatest problems are found;
– the particular risk factors;
– the child health policies, programmes and specific injury interventions that are in place.

In addition to these things, standardized definitions are needed that are used across countries, not only for injuries but for disability as well.

Sources of data can differ depending on the type of injury. Road traffic injury data, for instance, may be obtained from police, health ministry and health care settings, and transport ministries. Data on falls, on the other hand, may be obtained from injury surveillance systems, community-based surveys and paediatric admission records. In any case, the limitations of these sources of data and their potential to influence what needs to be observed, should be considered before making use of them.

Information systems on child injuries should be:

– simple and cost-effective to implement;
– appropriate to the levels of skill of the staff using them;
– consistent with national and international standards (including external cause coding).

Where possible, these systems should be integrated into other child health information systems, such as demographic and health surveys, integrated management of childhood disease surveys and verbal autopsy studies.

Data should be widely shared among the relevant authorities and concerned groups, particularly those responsible for child health, education and social services, such as child development agencies.

There are scant data on the economic impact of child injuries in most countries, though it is known that the impact is substantial. There are also no studies on the cost-effectiveness of prevention interventions. Assessing the direct and indirect economic costs, where this is possible, as well as the proportion of gross national product attributable to child injuries, can help increase awareness of the scale of the problem.

Recommendation 6: Define *priorities for research*, and support research on the causes, consequences, costs and prevention of child injuries

A research agenda for child injuries should be developed at regional and national levels. The agenda should be based on evidence from a broad range of sectors. Research in all the main areas related to child injury should be strengthened, including on:

– economic analysis – including the cost of child injuries and the cost of interventions;
– large-scale intervention trials, especially in poorer countries;
– non-fatal outcomes of injury and disability;
– how best to integrate injury interventions into child health programmes.

Research, if it is to be successful, requires focused investments in human and technical capacity, particularly in low-income and middle-income countries. A critical mass of trained researchers on injuries and their prevention needs to be built up.

Research skills should be strengthened in a range of disciplines, including those of:

– epidemiology;
– clinical trials;
– economics;
– engineering;
– sociology;
– behavioural and developmental psychology;
– product evaluation;
– policy analysis.

Recommendation 7: *Raise awareness* of and target investments towards child injury prevention

That child injuries are predictable and preventable is often not understood, by the lay public and also by

policy-makers, medical personnel and donors. It is vital, therefore, that awareness is created about the fact that these injuries can generally be prevented. It is an enormous advantage if well-known personalities or political leaders can actively champion the cause of child injury prevention. In addition, an active civil society movement for child injury prevention, grass-roots local organizations for child safety, and sensitive and responsible media reports can all bring about the necessary cultural changes in society.

International conferences, furthermore, provide opportunities to exchange knowledge and establish networks and partnerships. Complementary strategies, such as introducing child injury prevention into school and university curricula, can also help sensitize young people to the risk of child injuries.

Well-targeted financial investments can reduce child injuries and deaths considerably. Assessing the costs against the benefits of specific interventions and setting priorities accordingly is important for all countries. International nongovernmental organizations and large corporations can help raise awareness at the global and national level, as can – at the local level – socially aware employers and ordinary committed citizens.

Translating recommendations into reality

The previous section presented seven recommendations which should be considered when implementing a child injury prevention strategy. Child injury prevention, though, is the responsibility of many. Reducing the risk of injury for children requires the involvement and commitment of a broad range of groups – from international agencies through to children themselves. The following are some of the actions which can be taken by the various groups involved.

International, development and donor organizations

- make – in a highly visible way – child injury prevention a priority at an international level;
- fund and promote research, interventions and evaluations on child injury prevention;
- encourage governments to take sustainable action on child injury prevention;
- support capacity-building efforts.

Governments

- make child injuries a priority;
- identify an agency or unit to lead child injury prevention – either within the broader child health strategy or the more specific child injury prevention plan;
- appoint at least one full-time person with responsibility for injury prevention, including child injuries, in an appropriate ministry;
- establish a sustainable data collection system based on the country's needs and particular local issues related to children;
- develop a multisectoral plan of action for child injury prevention, including the setting of targets (see Box 7.5);
- coordinate activities and collaborate across sectors for the implementation and evaluation of child injury prevention programmes;
- enact, implement and enforce laws and standards that have been proven to reduce injuries;
- ensure sufficient funds and human resources for child injury prevention efforts;
- provide affordable access to all levels of health care and services for all children;
- promote the integration of health and safety concerns and an injury impact evaluation into all new projects;
- include children and young people in the development and implementation of projects at the national and local levels.

Nongovernmental organizations

- encourage governments to undertake proven child injury prevention activities and help in implementing such interventions;
- identify local safety problems;
- campaign for a safer environment, standards and behaviours;
- campaign for the rights of those affected by injury;
- undertake pilot prevention programmes on child injury in the community;
- support capacity-building;
- build and extend networks and partnerships with others involved in child injury prevention.

The private sector

- recognize the importance of child injuries and their prevention;
- apply "design for safety" from concept, through production, to quality control – including risk assessment and product approval;
- ensure that products comply with safety standards, regulations and codes;
- work with regulators to achieve harmonized standards and regulations worldwide;
- advertise merchandise responsibly and emphasize the safety aspects;
- fund ongoing research and development in the area of child injury prevention;
- fund the development and evaluation of safety-promoting educational material – such as games, toys, DVDs and videos.

The media

- report responsibly, accurately and sensitively the traumatic consequences of injuries – with information on prevention *always* included in reports;
- promote child injury prevention by featuring stories of young survivors and their families, highlighting good practices in injury prevention;

BOX 7.5

Developing a National Action Plan for child injury prevention: the experience of the Czech Republic

In 2004, the Child Safety Action Plan was launched in 18 European countries under the umbrella of the European Child Safety Alliance (*9*). Its aim was to coordinate actions on child injury in the participating countries. A set of standard indicators was agreed on to assess the burden of injury, to facilitate comparisons between different countries and to provide compelling arguments for stronger national commitments to injury prevention. The Alliance gathered examples of best practice from partner countries, and shared them among the members (*10*). With the help of the secretariat and particular groups of experts, each country was encouraged to develop a National Child Safety Plan setting out goals and priorities for action on child safety.

In the Czech Republic, the initiative was taken up by the Ministry of Health, which, in 2005, established a multidisciplinary working group to address the problem. This group worked on a basic strategy and examined how all the relevant sectors – including those of traffic, public health, welfare, education, sports and consumer protection – could contribute to reducing the injury burden among children. From the beginning, a practical approach was stressed. Various models of good practices were endorsed, including those for "Safe Communities", "Healthy Cities" and "Healthy Schools". University departments served as the research centres.

With support provided by the European Child Safety Alliance and the involvement of WHO's country office in Prague, the working group completed a draft National Action Plan for Child Injury Prevention. This plan is currently awaiting endorsement from the government. Its principal aim is to engage government departments and a wide range of other concerned organizations and individuals, including health care practitioners, to work together for a safer and healthier child population. The formation of a National Child Injury Register provides information on prevention activities and health care.

The plan stresses the safety of children on the road – including through modifications to the traffic environment – injuries in the home, school safety and child consumer protection.

- Road safety education in the Czech Republic has a long history. However, a fresh approach is now necessary to improve the road traffic competences of children. With proper training, a child can acquire knowledge, skills and the ability to analyse and solve safety problems.
- In the home environment, where the majority of injuries treated in health-care units occur, the situation still lags behind. Injuries in the home are generally less serious, but far more numerous, than those on the roads. One problem is that the role of health care practitioners in public safety education is still not properly accepted as part of injury prevention and care. It is usually the police who are the most active in education on personal safety, particularly as regards the prevention of violence.
- In the school environment – where injuries most often occur through sport – topics such as injury prevention and the prevention of obesity should be addressed at the same time as improving the general fitness of children.
- Czech laws and regulations should adopt the European standards and enforce them strictly. The country has had a good experience with European standards, which it adopted in 2002, relating to playground surfaces and equipment. In the following years, playground safety dramatically increased. The regulation for mandatory helmet use among child cyclists has lowered the number of head injuries, even though it only applies to public roads and not to cycling in other places.

WHO's "Safe Community" programme has been introduced in the Czech Republic. One city has already been designated a "Safe Community" and there are other applicants in line. National injury-free days are celebrated each year in 17 "Healthy Cities". Gradually, with strong commitment from the Working Group members and the Ministry of Health, the prevention of child injury is being firmly placed on the agenda of policy-makers and decision-makers.

– feature safe practices in radio and television dramas, and other broadcast programmes;
– initiate or support child injury prevention campaigns.

Teachers and community leaders

– teach injury prevention at school from a young age;
– ensure that schools, playgrounds, and the access to schools are all safe;
– set up and maintain safe public places and safe sports and recreational facilities;
– promote injury prevention at universities and integrate the topic into existing professional programmes;
– foster research into child injury prevention in educational settings;
– include children and youth when implementing interventions for child injury at a community level.

Parents

– create a safe environment for children to live in;
– properly store materials which are harmful to children – such as fireworks and poisoning agents;
– supervise potentially hazardous activities;
– inform and educate children about the risk factors for injuries as well as how injuries can be prevented;
– encourage children to wear safety devices;
– act as role models for children by adopting safe behaviour and using safety devices;
– lobby for change in the community.

Children and young people

– act as role models by adopting safe methods to reduce injury risks – such as using safety devices, and playing in safe locations;
– promote injury prevention among peers and family;
– refrain from engaging in high-risk behaviours;
– contribute to determining priorities for action;
– become involved in injury prevention campaigns and programmes (see Box 7.6).

Conclusion

The commitment to reduce the burden of childhood diseases has often been proclaimed by international

and national declarations. All the same, high levels of childhood mortality, morbidity and disability still persist. In many countries one of the reasons for this is the impact of childhood injuries, affecting children of all ages.

BOX 7.6

Youth Declaration for Road Safety

The first ever World Youth Assembly for Road Safety was held at the United Nations in Geneva, Switzerland in April 2007. Nearly 400 delegates from over 100 countries met to share experiences and ideas and identify ways to strengthen road safety efforts in their home countries. In particular, they discussed how young people could be more involved in such efforts.

The two-day event was organized and led by young people. It culminated in the adoption of a Youth Declaration for Road Safety which was handed to the United Nations (*11*). In accepting the Declaration, Sheikha Haya Rashed Al Khalifa, President of the United Nations General Assembly, called it an important statement that the World Youth Ambassadors for Road Safety should use to campaign for much greater attention to road safety in their countries.

In an additional, moving tribute to victims of road traffic crashes, the delegates gathered on the steps of the Palais des Nations and released 1049 white balloons. As she released her balloon, Yomna Safwat from Egypt dedicated hers to her young brother killed in a road crash, saying "These balloons as many as they are, are without question outnumbered by the tears shed over loved ones needlessly lost on the road. In tribute to these young souls, each balloon is a cry out to the world to take action, to save the youth and to prevent road deaths and injuries. I send my balloon to my dear brother, Mohammed Karim, with a message that your life has not been lost in vain, but will fuel the efforts of the youth all around the world to make roads safer."

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The global community has the knowledge, an armoury of interventions and the resources to prevent this loss of healthy life in the youngest members of our community. This report is a plea for evidence-based interventions and sustained investments by all sectors – public, private and civil – in injury prevention and control for children. It is time to unleash the promise of governments and create a world where children can learn, play, grow up and live without being killed or injured.

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Statistical Annex Explanatory notes

Background

Each year, Member States with vital registration systems send detailed information to the World Health Organization using the International Classification of Disease (ICD) codes (*1*). Death registration data containing usable information on the causes of death are available from 111 countries. The majority of these are in high-income countries, although Latin America, the Caribbean and Central Asia are also well represented (*2*).

The World Health Organization uses these data, supplemented by additional information from surveys, censuses, epidemiological studies and health facilities, to develop regional and global estimates of mortality and morbidity for various causes of illness and injuries. First published in 1996, the Global Burden of Disease (GBD) represents the most comprehensive examination of global mortality and morbidity available (*2*).

In 2000, a new assessment of the global burden of disease was undertaken, the original one having been carried out in 1990. The GBD project for 2000 used all available and relevant information to create the best possible population-based data. Even for regions and causes where data were sparse, the GBD used evidence at hand and the best available methods to make inferences. Since then subsequent versions of the GBD estimates have appeared in the 2002 and 2004 WHO World Health Reports (*3, 4*). Updated estimates of the global burden of injury for the year 2004 are presented in this report (*5*).

In addition to the GBD data, this report also uses data from the Global School Health Survey, UNICEF community surveys and a pilot surveillance study on unintentional injury among children conducted in four developing countries. A brief outline of the methodology of each of these data sources is presented in the following pages.

World Health Organization data

Deaths and non-fatal injuries are categorically attributed to a single underlying cause using the rules and conventions of the ICD (*1*). The cause list used for the GBD 2004 project has four levels of disaggregation and includes 135 specific diseases and injuries. Overall mortality is divided into three broad groups of causes, as follows:

- Group I: communicable diseases, maternal causes, conditions arising in the perinatal period and nutritional deficiencies;
- Group II: noncommunicable diseases;
- Group III: intentional and unintentional injuries.

Injury categories within Group III are further defined in terms of external cause codes.

For the purpose of this report the following ICD version 10 codes (or the associated version 9 codes) have been used.

- *Road traffic injuries*: V01–V04, V06, V09–V80, V87, V89, V99:
  - excludes injuries sustained while repairing a vehicle (W00–W59) or shutting a car door (W00–W59);
  - excludes assault by crashing a vehicle (Y03), intentional self-harm (X81–X83).
- *Drowning*: W65–W74:
  - excludes drowning or submersion due to cataclysms (X34–X39);
  - excludes transport incidents (V01–V99) or water transport incidents (V90, V92).
- *Burns*: X00–X59:
  - excludes fire from arson (X97), secondary to an explosion (W35–W40) or a transport incident (V01–V99);
  - excludes exposure to electric current, radiation and extreme temperature (W85–W99);
  - excludes contact with heat and hot substances (X10–X19).
- *Falls*: W00–W19:
  - excludes assaults (Y01–Y02) or intentional self-harm (X80–X81);
  - excludes falls from animals (V80), burning buildings (X00) or a vehicle (V01–V99);
  - excludes falls into fire (X00–X04, X08–X09), water (W65–W74) or machinery (W28–W31).
- *Poisoning*: X40–X49:
  - excludes poisoning with suicidal or homicidal intent (W60–W69, X85–X90, Y10–Y19);
  - excludes the adverse effects of therapeutic drugs administered in the correct dosage (Y40–Y59).

Absolute numbers and rates per 100 000 population are presented by sex and WHO region for the following age groups: under 1 year, 1–4 years, 5–9 years, 10–14 years, 15–19 years and under 20 years.

WHO Member States are grouped into six regions: the African Region, the Region of the Americas, the South-East Asia Region, the European Region, the Eastern Mediterranean Region and the Western Pacific Region. Countries within these six regions are further divided by income level, based on World Bank estimates of gross national income (GNI) per capita for the year 2004 (*6, 7*). On the basis of their GNI per capita, economies are

classified as low-income and middle-income (less than US$ 10 066), or high-income (US$ 10 066 or more). The countries included in each of the WHO regions, divided into low-income and middle-income and high-income categories, are shown in Table D.1.

Global estimates of mortality due to injury

The GBD 2004 update uses the latest population estimates for WHO Member States prepared by the United Nations Population Division (*8*), as well as life tables published in the 2006 World Health Report (*9*). The methodology employed to generate the GBD 2004 revision was similar to that used in previous revisions (5). The estimates were derived from an extensive analysis of mortality data for all regions of the world, together with systematic reviews of epidemiological studies and other health service data. They were based on complete or incomplete vital registration data, together with information from sample registration systems covering around 70% of the global mortality. Survey data and indirect demographic techniques provided information on the levels of child and adult mortality for the remaining 30% of estimated global mortality. Data on causes of death from death registration systems with incomplete coverage were adjusted to take into account the likely differences in patterns in the cause of death that would be expected in the uncovered and often poorer subpopulations (*5*).

For countries lacking vital registration data, mainly in Africa, cause-of-death models were used for an initial estimate of the most likely distribution of deaths across the broad categories of communicable and noncommunicable diseases and injuries, based on estimated total mortality rates and income. A regional model of the pattern of specific causes of death was then constructed based on local vital registration and data from verbal autopsies (a method of medically determining the cause of death based on interviews with the next of kin or caregivers). This proportionate distribution was then applied within each broad group of causes. Finally, the resulting estimates were adjusted according to other epidemiological evidence from studies on specific diseases and injuries. For the 2004 data presented here, the choice of death registration data to estimate within-group cause distributions for the various WHO regions was consistent with that used in previous GBD estimates – the only exception being Africa. The regional pattern on cause of death distributions for Africa in this 2004 update is based on death registration data from four countries, and verbal autopsy data from seven countries, unlike the earlier estimates which used data from rural South Africa only.

Special attention has also been paid to injuries, where there are often problems of misattribution or miscoding. For example, the category "injury undetermined whether accidentally or purposely inflicted" (Y10–Y34 in ICD 10) can often include a significant share of deaths due to injury. Except where more detailed local information is available, these deaths have been proportionately allocated to the other injury causes of death. Deaths coded as "unspecified accidents" (E928.9 in ICD 10), have also been redistributed proportionally across other causes of unintentional injury death.

Table A.1 presents estimates for fatal child unintentional injuries (and the subtypes of this group) by age groupings, sex and WHO regions and country income levels.

Global and regional ranking of deaths and DALYs

The DALY (disability-adjusted life years lost) measure is used to quantify the burden of disease (*2*). It is a health-gap measure that combines information on the number of years of life lost from premature death with the loss of health from disability.

As in the analysis for the deaths, the burden of injury in the 2004 update is similar to the method used for the 1990, 2000 and 2002 estimates. It utilizes the 1990 disability weights relating to injury (*2, 10*). The GBD 1990 project methods defined a case of injury as one severe enough to warrant medical attention or one that leads to death. As was done in previous revisions, the GBD 2004 update used many sources of information to estimate the years lived with disability as a result of an injury or disease. These included national and international surveillance data and disease registries, health survey statistics, data on use of hospital and medical services, and international and country-specific epidemiological studies (*2*). The results reported here are based on analyses for the GBD 2000 of health-facility data obtained after an extensive period of consultations with Member States.

The proportion of incident cases resulting in long-term disabling sequelae was estimated for each injury category from a review of long-term epidemiological studies of injury outcomes.

To produce the rankings in Table A.2, deaths and disabilities were first divided into the three broad groups of causes mentioned earlier. Next, deaths and disabilities within each of these groups were divided into categories. For example, injuries were divided between unintentional and intentional injuries. Following this level of disaggregating, deaths and disabilities were further divided into subcategories. Unintentional injuries, for example, were subdivided into road traffic injuries, poisonings, falls, fire-related burns and drowning. The same procedure was followed for the other two broad groups of deaths and disabilities. The rankings were produced by ordering the subcategories.

The 15 leading causes of death and DALYs for children under the age of 15 years are reported in Table A.2 for all WHO Member States and for each of the six WHO regions.

Global School-based Student Health Survey

The Global School-based Student Health Survey (GSHS) is a collaborative surveillance project designed to help countries measure and assess behavioural risk and protective factors among children aged 13 to 15 years in the following 10 key areas (*11*):

- alcohol and other drug use;
- dietary behaviours;
- hygiene;
- mental health;
- physical activity;
- protective factors;
- respondent demographics;
- sexual behaviours;
- tobacco use;
- violence and unintentional injury.

The GSHS is a relatively inexpensive school-based survey which uses a self-administered questionnaire to obtain information about young people's health behaviours. It is conducted primarily among students aged 13–15 years and uses a two-stage cluster sampling design; a common school-based methodology; and three questionnaire components: a core module, core-expanded questions, and country-specific questions. The questionnaire is administered during school during a single standard school period.

At the time of analysis for this report, 28 countries had voluntarily conducted the survey and submitted their final results to WHO. Data from 26 of these countries which had complete information on unintentional injuries are presented in Table A.3.

UNICEF data

Several tables and figures appearing in the report have been taken from the UNICEF/The Alliance for Safe Children (TASC) data sources. This has been done in an attempt to overcome some of the limitations of the Global Burden of Disease studies. However, the UNICEF data are from only one continent, Asia, and thus cannot be generalized to the rest of the world. Nevertheless, these data have strong policy and programme implications (*12*).

Since 2002, as part of their collaborative project on child injury prevention, UNICEF and TASC have jointly conducted six national or subnational surveys on child injuries in South and East Asia. The specific survey sites were Bangladesh, China (Beijing and Jiangxi provinces), the Philippines, Thailand and Viet Nam.

These community-based surveys examined all causes of mortality from injuries and other illnesses, though for the purpose of this report and the Statistical Annex, only the injury data will be included. Their objectives were to gain a better understanding of the injury incidence, risk factors, associated economic and social costs, health-seeking behaviours of injured people, and overall knowledge, attitudes and practices of communities regarding injury prevention.

In brief, the following methodology was employed.

- A representative sample of households was drawn up in each national or subnational survey using the census sampling scheme.
- Standardized methodology was used in all six sites, with similar questions, fieldwork, quality assurance and procedures of analysis.
- The recall period for morbidity was one year in all surveys, and for mortality it was three years, except in the first survey in Viet Nam, where it was one year.
- The cause of death was ascertained through medical certificates where they existed, or through verbal autopsy where medical certificates were unavailable, using the standard WHO verbal autopsy guidelines (*13*).

The survey questionnaire consisted of six modules. The first four modules were designed to collect demographic information on household members, causes of mortality and morbidity, and circumstances and consequences of injury events, and to provide a description of household injury hazards. The other two modules were used for a nested case–control study of drowning. Sociodemographic information was gathered from the head of the household and information on non-fatal injuries from the injured person, if an adult, or from the caregiver if a child, and from a relative if the injury was fatal. The detailed methodology may be found in the recently published Innocenti Report (*14*).

Table 1 summarizes the sample sizes, definitions and methods employed in each of the sites. Altogether, in the combined surveys 516 818 households were visited, involving 2 157 291 individuals of whom 788 194 were children.

While all survey sites classified injury severity in the same way, the case definitions for injury or illness varied slightly between the various settings. The following five categories were used.

- ***Fatal injury (death)***. An injury resulting in death, whether immediate or delayed, but as a direct result of the injury. This classification was the same for all surveys.
- ***Severe injury (permanent disability)***. Injury that resulted in permanent disability – such as blindness, deafness, loss of an extremity or the inability to walk, or the loss of mental abilities. Emotional and psychiatric causes were not included because of the difficulty of diagnosis and classification. This classification was the same for all surveys.
- ***Serious injury***. Injury requiring hospitalization for 10 days or more – that is, requiring a major surgical procedure. This classification was the same for all surveys.
- ***Major injury***. An injury requiring hospitalization for less than 10 days. This definition was designed to

TABLE 1

Methodology utilized in surveys

	Bangladesh	China		Philippines	Thailand	Viet Nam
		Beijing	Jiangxi			
Survey year	2003	2004	2005	2003	2003	2000
Household	171 366	28 084	100 010	90 446	100 179	26 733
Members	819 429	81 604	319 543	418 522	389 531	128 662
Children	351 651	13 508	98 335	178 938	98 904	46 858
Strata	urban/rural	18 districts	urban/rural	national	5 regions urban/rural	8 regions urban/rural
Allocation method	PPS	PPS	PPS	PPS	PPS	PPS (square root allocation)
Primary Sampling Unit (PSU)	District	District committee	Street committee	Region	Province	Province
Method	SRS	PPS	PPS	SRS	PPS	SRS
Secondary Sampling Unit	Upazilla (rural) Mohalla (urban)	Street committee	Neighbourhood committee villages	Census blocks	Census blocks (urban) Villages (rural)	Districts
Method	SRS	PPS	PPS	PPS	PPS	SRS
Tertiary Sampling Unit	Union (rural) Households (urban)	Neighbourhood committees	200 household census blocks	Barangay	Households (urban)	90 household census blocks
Method	SRS (rural) Systematic (urban)	PPS	PPS	Systematic	Systematic	SRS
Sampling Unit	Household	Household	Household	Household	Household	Household
Observation Unit	All Members	All Members	All Members	All Members	All Members	All Members

PPS = Probability-proportional-to-size; SRS = simple random sampling.

Source: reference *15*.

capture injuries that required significant care but did not necessarily require surgical intervention. This classification was the same for all surveys.

- ***Moderate injury***. An injury requiring medical care or for which school or work was missed for a period, or where the child was unable to carry out activities of daily living and for which hospitalization was not required. The definition used a period of one day in Beijing, Jiangxi and Viet Nam, and three days in Bangladesh, the Philippines and Thailand.

There are some differences between the UNICEF/TASC dataset for fatal child injury and the Global Burden of Disease (2004 update) dataset for the two regions covered by this survey. It is most likely that these differences result from the following considerations.

- *The different methods used for the two datasets*. The UNICEF/TASC data come from direct, household surveys using representative samples, as noted in Table 1, while GBD data come from vital registration and proportional mortality models, as described in the previous section.
- *Definitions of injury*. The UNICEF/TASC surveys do not conform to ICD 9 or 10 as they are based on verbal autopsy and incident interviews. In addition, they include drowning as a result of floods and other cataclysms, which the GBD data exclude.
- *Definitions of age*. The UNICEF/TASC data are for children under 18 years, whereas the GBD data shown in Table 2 pertain to children and young people under 20 years.

The major difference between the data from these two injury systems was the drowning rate among children. Drowning was the leading cause of child death in all five countries surveyed and was on average 3.4 times more frequent than deaths from road traffic fatalities (*15*).

Global childhood unintentional injury surveillance

In 2007, because of the lack of standardized data for child injuries from low-income and middle-income countries, and the limited number of multicountry datasets, WHO

TABLE 2

Differences between datasets in causes of death

Causes of death (rates per 100 000 population): Global Burden of Disease data compared with UNICEF/TASC survey data			
	GBD 2004 update		UNICEF/TASC surveys
	South-East Asia Region	Western Pacific Region (low-income countries)	All 5 countries
Drowning	6.2	13.9	30.1
Road traffic injuries	7.4	8.6	8.9
Falls	2.7	2.2	2.6
Poisoning	1.7	1.8	0.8
Burns	6.1	0.6	0.4

commissioned a pilot study on global childhood unintentional injury surveillance (GCUIS). The goals of the study were:

- to pilot-test a standardized protocol for facility-based childhood injuries;
- to determine the nature and magnitude of childhood injuries and their burden on the health-care system.

While the pilot study focused on unintentional injuries, the ultimate aim of the project was to improve ongoing injury surveillance in the target countries.

A standard proforma was administered to caregivers of injured children less than 12 years old presenting at an urban emergency department in the following four countries: Bangladesh, Colombia, Egypt and Pakistan. The surveillance form was based on the International Classification of External Causes of Injuries (short form) (*15*), as well as forms used previously in Pakistan, South Africa and the United States.

The operational definition of an injury was "any type of unintentional injury on any body part of a child under 12 years of age seen in one of the designated GCUIS emergency rooms". The respondent for the surveillance system was the caregiver arriving with the child at the emergency department, while the unit of analysis was the injured child.

Using a standardized electronic form in Epi Info Version 3.3.2, the study recorded:

- demographic information;
- injuries, measured in terms of mortality and disability;
- risk factors – including age, gender, level of education, time, location and activity;
- socioeconomic information;
- outcome data during treatment in the emergency department;
- injury-specific risk factors for road traffic injuries, falls, burns and poisoning;
- clinical criteria – including waiting time, injury severity score and distance travelled;
- prevention measures.

Each site, with a pilot surveillance system derived from the same protocol, was requested to submit up to 550 cases, based on non-random, sequential sampling, to the coordinating centre at Johns Hopkins University. The data were collected between January and December 2007, with each country taking on average 25 weeks to collect 550 cases.

Preliminary results from the pilot study are presented in Table C.1 of this Statistical Annex.

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TABLE A.1

All unintentional injuries

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Absolute numbers[c]

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	61 832	120 427	119 805	87 875	159 174	549 113
	HIC	2 322	2 365	2 075	2 476	11 132	20 370
	LMIC	59 340	117 919	117 561	85 268	147 695	527 783
African Region[d]	LMIC	21 273	38 407	31 400	16 284	16 444	123 808
Region of the Americas	All	5 008	6 625	5 588	5 999	16 838	40 057
	HIC	669	1 054	735	1 097	5 171	8 725
	LMIC	4 339	5 571	4 853	4 902	11 667	31 332
South-East Asia Region[d]	LMIC	16 432	36 461	43 927	30 377	49 099	176 297
European Region	All	2 305	5 143	3 586	4 077	13 849	28 960
	HIC	150	488	409	591	3 550	5 188
	LMIC	2 155	4 656	3 177	3 486	10 299	23 773
Eastern Mediterranean Region	All	8 592	14 189	16 062	11 811	18 347	69 002
	HIC	1 340	528	538	511	1 175	4 091
	LMIC	7 253	13 660	15 525	11 301	17 172	64 910
Western Pacific Region	All	8 051	19 460	19 072	19 195	44 251	110 029
	HIC	164	295	393	278	1 236	2 366
	LMIC	7 888	19 165	18 679	18 918	43 015	107 663

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	60 528	106 150	90 227	58 354	85 993	401 253
	HIC	919	1 534	1 222	1 289	3 879	8 843
	LMIC	59 501	104 518	88 889	57 011	81 975	391 894
African Region[d]	LMIC	19 083	26 326	23 259	10 348	9 206	88 223
Region of the Americas	All	4 055	4 581	3 275	2 975	5 695	20 581
	HIC	498	689	493	621	2 211	4 512
	LMIC	3 556	3 893	2 782	2 355	3 484	16 069
South-East Asia Region[d]	LMIC	15 473	47 155	37 986	26 386	42 759	169 760
European Region	All	2 048	3 032	1 863	1 861	4 358	13 163
	HIC	135	345	250	302	1 017	2 049
	LMIC	1 914	2 686	1 614	1 559	3 341	11 114
Eastern Mediterranean Region	All	6 281	10 985	10 995	6 345	9 719	44 325
	HIC	119	301	282	221	251	1 174
	LMIC	6 161	10 684	10 714	6 124	9 468	43 151
Western Pacific Region	All	13 481	13 973	12 732	10 384	14 116	64 685
	HIC	167	199	199	145	399	1 108
	LMIC	13 314	13 774	12 534	10 239	13 717	63 577

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	122 360	226 577	210 032	146 230	245 167	950 366
	HIC	3 241	3 899	3 297	3 765	15 010	29 213
	LMIC	118 842	222 437	206 450	142 278	229 670	919 677
African Region[d]	LMIC	40 356	64 733	54 660	26 633	25 649	212 031
Region of the Americas	All	9 063	11 206	8 862	8 974	22 533	60 638
	HIC	1 167	1 743	1 227	1 717	7 382	13 237
	LMIC	7 895	9 464	7 635	7 257	15 150	47 401
South-East Asia Region[d]	LMIC	31 906	83 615	81 914	56 764	91 858	346 057
European Region	All	4 353	8 175	5 450	5 938	18 207	42 123
	HIC	284	833	659	893	4 567	7 236
	LMIC	4 069	7 342	4 791	5 045	13 641	34 887
Eastern Mediterranean Region	All	14 873	25 174	27 057	18 156	28 066	113 327
	HIC	1 459	830	819	732	1 426	5 266
	LMIC	13 414	24 344	26 238	17 425	26 640	108 061
Western Pacific Region	All	21 532	33 433	31 804	29 579	58 367	174 715
	HIC	330	494	592	423	1 635	3 474
	LMIC	21 202	32 938	31 212	29 156	56 732	171 240

TABLE A.1 *(CONTINUED)*

All unintentional injuries

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Rate[e] per 100 000 population

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	94.3	47.2	38.1	27.8	51.4	43.6
	HIC	39.2	10.0	6.9	7.9	34.6	16.5
	LMIC	99.7	51.0	41.4	30.0	53.3	46.5
African Region[d]	LMIC	159.4	79.7	60.1	35.0	40.2	61.5
Region of the Americas	All	61.9	20.9	14.2	15.1	43.7	25.5
	HIC	28.5	11.7	6.5	9.0	42.8	18.6
	LMIC	75.6	24.5	17.3	17.8	44.1	28.4
South-East Asia Region[d]	LMIC	85.1	48.2	47.1	33.1	57.0	48.1
European Region	All	42.7	24.8	13.4	13.4	41.1	24.8
	HIC	6.7	5.5	3.6	5.0	28.5	11.1
	LMIC	68.6	39.3	20.4	18.9	48.5	33.9
Eastern Mediterranean Region	All	127.3	54.4	50.3	36.9	59.9	54.2
	HIC	369.8	38.0	32.4	32.4	84.4	64.1
	LMIC	113.6	55.4	51.2	37.2	58.8	53.7
Western Pacific Region	All	63.9	37.1	27.2	25.6	55.9	38.0
	HIC	16.9	6.9	6.8	4.7	19.9	10.3
	LMIC	67.8	39.8	29.0	27.4	58.9	40.4

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	98.1	44.3	30.6	19.6	29.3	33.8
	HIC	16.3	6.9	4.3	4.3	12.7	7.6
	LMIC	106.4	48.2	33.4	21.3	31.2	36.7
African Region[d]	LMIC	145.9	55.6	45.2	22.5	22.7	44.5
Region of the Americas	All	52.4	15.1	8.6	7.8	15.1	13.5
	HIC	22.3	8.0	4.5	5.4	19.2	10.1
	LMIC	64.6	17.8	10.3	8.8	13.3	15.0
South-East Asia Region[d]	LMIC	85.8	67.0	44.0	31.0	53.3	49.9
European Region	All	40.1	15.4	7.3	6.4	13.5	11.8
	HIC	6.3	4.1	2.3	2.7	8.6	4.6
	LMIC	64.2	23.9	10.9	8.8	16.3	16.5
Eastern Mediterranean Region	All	97.3	44.1	36.0	20.8	33.2	36.4
	HIC	33.7	22.3	17.3	14.1	18.4	18.7
	LMIC	101.0	45.4	37.1	21.1	34.0	37.4
Western Pacific Region	All	121.0	30.1	20.2	15.1	19.4	24.7
	HIC	18.2	5.0	3.7	2.6	6.9	5.1
	LMIC	130.1	32.4	21.8	16.3	20.5	26.5

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	96.1	45.8	34.4	23.8	40.6	38.8
	HIC	28.0	8.5	5.6	6.1	23.9	12.2
	LMIC	102.9	49.7	37.6	25.8	42.6	41.7
African Region[d]	LMIC	152.7	67.8	52.7	28.8	31.5	53.1
Region of the Americas	All	57.3	18.0	11.5	11.5	29.6	19.6
	HIC	25.5	9.9	5.5	7.3	31.3	14.4
	LMIC	70.2	21.2	13.9	13.4	28.8	21.8
South-East Asia Region[d]	LMIC	85.5	57.3	45.6	32.1	55.2	49.0
European Region	All	41.4	20.2	10.4	10.0	27.6	18.4
	HIC	6.5	4.8	3.0	3.9	18.8	7.9
	LMIC	66.4	31.8	15.8	14.0	32.7	25.4
Eastern Mediterranean Region	All	112.7	49.4	43.3	29.0	46.9	45.5
	HIC	203.5	30.2	24.9	23.3	51.7	41.6
	LMIC	107.4	50.5	44.3	29.4	46.7	45.7
Western Pacific Region	All	90.7	33.8	23.9	20.6	38.4	31.7
	HIC	17.6	6.0	5.3	3.7	13.6	7.8
	LMIC	97.0	36.4	25.6	22.1	40.5	33.8

TABLE A.1 *(CONTINUED)*

Road traffic injuries

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Absolute numbers[c]

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	7 535	24 853	41 662	27 366	72 476	173 892
	HIC	925	636	896	1 274	7 878	11 608
	LMIC	6 606	24 149	40 656	26 045	64 480	161 935
African Region[d]	LMIC	3 217	11 616	18 536	7 813	6 962	48 145
Region of the Americas	All	350	1 655	2 205	2 635	9 829	16 674
	HIC	87	293	362	602	3 716	5 060
	LMIC	263	1 363	1 843	2 033	6 113	11 614
South-East Asia Region[d]	LMIC	1 101	3 468	7 631	6 856	15 942	34 999
European Region	All	303	754	1 208	1 450	7 567	11 282
	HIC	31	112	182	337	2 778	3 440
	LMIC	272	642	1 027	1 113	4 789	7 842
Eastern Mediterranean Region	All	2 224	4 800	7 628	5 153	8 915	28 719
	HIC	789	140	171	202	469	1 770
	LMIC	1 434	4 661	7 457	4 951	8 446	26 949
Western Pacific Region	All	335	2 491	4 343	3 412	23 143	33 724
	HIC	17	91	181	133	915	1 338
	LMIC	318	2 400	4 162	3 279	22 228	32 386

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	4 545	19 846	27 554	13 322	23 219	88 486
	HIC	151	567	652	752	3 132	5 252
	LMIC	4 377	19 237	26 831	12 556	20 020	83 020
African Region[d]	LMIC	1 200	8 134	13 800	4 342	4 066	31 542
Region of the Americas	All	290	1 150	1 308	1 413	3 865	8 026
	HIC	67	250	285	428	1 881	2 910
	LMIC	223	901	1 023	985	1 985	5 117
South-East Asia Region[d]	LMIC	1 144	4 907	4 004	3 297	4 097	17 449
European Region	All	137	541	777	750	2 621	4 827
	HIC	21	113	134	182	810	1 260
	LMIC	116	428	643	569	1 811	3 567
Eastern Mediterranean Region	All	1 430	3 486	4 611	2 164	2 961	14 651
	HIC	47	129	124	76	163	539
	LMIC	1 383	3 357	4 486	2 088	2 798	14 112
Western Pacific Region	All	326	1 585	2 983	1 342	5 541	11 777
	HIC	16	75	108	66	278	544
	LMIC	310	1 510	2 875	1 276	5 263	11 234

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	12 079	44 699	69 217	40 688	95 694	262 377
	HIC	1 075	1 202	1 547	2 025	11 010	16 860
	LMIC	10 983	43 386	67 487	38 601	84 499	244 956
African Region[d]	LMIC	4 418	19 751	32 337	12 155	11 028	79 688
Region of the Americas	All	640	2 806	3 513	4 048	13 694	24 701
	HIC	154	542	647	1 030	5 597	7 970
	LMIC	486	2 263	2 866	3 018	8 097	16 731
South-East Asia Region[d]	LMIC	2 246	8 375	11 635	10 153	20 040	52 448
European Region	All	440	1 295	1 985	2 200	10 188	16 109
	HIC	52	225	316	519	3 588	4 700
	LMIC	388	1 070	1 669	1 681	6 600	11 409
Eastern Mediterranean Region	All	3 654	8 286	12 238	7 317	11 875	43 370
	HIC	836	269	295	278	632	2 309
	LMIC	2 817	8 017	11 943	7 039	11 244	41 060
Western Pacific Region	All	661	4 076	7 326	4 754	28 684	45 501
	HIC	33	166	289	199	1 193	1 881
	LMIC	628	3 910	7 037	4 555	27 491	43 620

TABLE A.1 *(CONTINUED)*

Road traffic injuries

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Rate[e] per 100 000 population

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	11.5	9.7	13.3	8.7	23.4	13.8
	HIC	15.6	2.7	3.0	4.1	24.5	9.4
	LMIC	11.1	10.4	14.3	9.2	23.3	14.3
African Region[d]	LMIC	24.1	24.1	35.5	16.8	17.0	23.9
Region of the Americas	All	4.3	5.2	5.6	6.6	25.5	10.6
	HIC	3.7	3.3	3.2	5.0	30.7	10.8
	LMIC	4.6	6.0	6.6	7.4	23.1	10.5
South-East Asia Region[d]	LMIC	5.7	4.6	8.2	7.5	18.5	9.6
European Region	All	5.6	3.6	4.5	4.8	22.5	9.6
	HIC	1.4	1.3	1.6	2.8	22.3	7.4
	LMIC	8.7	5.4	6.6	6.0	22.6	11.2
Eastern Mediterranean Region	All	33.0	18.4	23.9	16.1	29.1	22.6
	HIC	217.9	10.1	10.3	12.8	33.7	27.8
	LMIC	22.5	18.9	24.6	16.3	28.9	22.3
Western Pacific Region	All	2.7	4.8	6.2	4.6	29.2	11.7
	HIC	1.8	2.1	3.2	2.3	14.8	5.8
	LMIC	2.7	5.0	6.5	4.7	30.4	12.2

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	7.4	8.3	9.3	4.5	7.9	7.5
	HIC	2.7	2.5	2.3	2.5	10.3	4.5
	LMIC	7.8	8.9	10.1	4.7	7.6	7.8
African Region[d]	LMIC	9.2	17.2	26.8	9.5	10.0	15.9
Region of the Americas	All	3.7	3.8	3.5	3.7	10.3	5.3
	HIC	3.0	2.9	2.6	3.7	16.3	6.5
	LMIC	4.1	4.1	3.8	3.7	7.6	4.8
South-East Asia Region[d]	LMIC	6.4	7.0	4.6	3.9	5.1	5.1
European Region	All	2.7	2.8	3.0	2.6	8.1	4.3
	HIC	1.0	1.3	1.3	1.6	6.8	2.8
	LMIC	3.9	3.8	4.3	3.2	8.9	5.3
Eastern Mediterranean Region	All	22.2	14.0	15.1	7.1	10.1	12.0
	HIC	13.2	9.5	7.6	4.9	11.9	8.6
	LMIC	22.7	14.3	15.5	7.2	10.0	12.2
Western Pacific Region	All	2.9	3.4	4.7	2.0	7.6	4.5
	HIC	1.7	1.9	2.0	1.2	4.8	2.5
	LMIC	3.0	3.6	5.0	2.0	7.9	4.7

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	9.5	9.0	11.4	6.6	15.9	10.7
	HIC	9.3	2.6	2.6	3.3	17.6	7.0
	LMIC	9.5	9.7	12.3	7.0	15.7	11.1
African Region[d]	LMIC	16.7	20.7	31.2	13.1	13.5	19.9
Region of the Americas	All	4.0	4.5	4.5	5.2	18.0	8.0
	HIC	3.4	3.1	2.9	4.4	23.7	8.7
	LMIC	4.3	5.1	5.2	5.6	15.4	7.7
South-East Asia Region[d]	LMIC	6.0	5.7	6.5	5.7	12.0	7.4
European Region	All	4.2	3.2	3.8	3.7	15.4	7.0
	HIC	1.2	1.3	1.4	2.2	14.8	5.2
	LMIC	6.3	4.6	5.5	4.7	15.8	8.3
Eastern Mediterranean Region	All	27.7	16.3	19.6	11.7	19.8	17.4
	HIC	116.6	9.8	9.0	8.8	22.9	18.3
	LMIC	22.6	16.6	20.2	11.9	19.7	17.4
Western Pacific Region	All	2.8	4.1	5.5	3.3	18.9	8.3
	HIC	1.8	2.0	2.6	1.7	9.9	4.2
	LMIC	2.9	4.3	5.8	3.5	19.6	8.6

TABLE A.1 *(CONTINUED)*

Drowning

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Absolute numbers[c]

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	4 165	30 119	24 486	26 202	28 636	113 607
	HIC	119	658	351	310	868	2 307
	LMIC	3 998	29 432	24 113	25 865	27 720	111 128
African Region[d]	LMIC	874	7 989	2 926	3 143	3 147	18 079
Region of the Americas	All	168	1 575	993	1 224	2 458	6 418
	HIC	42	285	100	118	303	847
	LMIC	126	1 290	893	1 105	2 155	5 570
South-East Asia Region[d]	LMIC	1 760	4 494	6 851	5 638	7 279	26 022
European Region	All	55	1 589	937	807	856	4 244
	HIC	10	131	66	37	142	387
	LMIC	44	1 457	871	770	714	3 856
Eastern Mediterranean Region	All	569	2 912	2 398	2 369	3 372	11 620
	HIC	51	173	68	89	299	681
	LMIC	517	2 739	2 329	2 280	3 073	10 939
Western Pacific Region	All	692	11 531	10 360	12 993	11 475	47 051
	HIC	15	69	117	65	124	391
	LMIC	676	11 463	10 243	12 928	11 351	46 660

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	6 035	18 149	14 524	11 905	11 073	61 686
	HIC	49	299	149	83	88	668
	LMIC	5 918	17 831	14 354	11 815	10 979	60 897
African Region[d]	LMIC	3 571	2 189	1 134	1 474	2 304	10 672
Region of the Americas	All	103	911	402	430	328	2 174
	HIC	26	159	47	37	30	300
	LMIC	77	752	355	393	297	1 874
South-East Asia Region[d]	LMIC	1 090	4 869	4 811	3 231	3 748	17 749
European Region	All	78	746	314	373	195	1 707
	HIC	11	58	20	16	24	128
	LMIC	68	688	294	358	171	1 579
Eastern Mediterranean Region	All	453	1 693	1 314	884	969	5 312
	HIC	0	44	48	2	3	98
	LMIC	453	1 648	1 265	882	966	5 214
Western Pacific Region	All	671	7 723	6 529	5 504	3 523	23 950
	HIC	12	38	33	28	31	142
	LMIC	660	7 685	6 496	5 477	3 492	23 809

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	10 200	48 267	39 010	38 107	39 708	175 293
	HIC	168	958	500	393	956	2 974
	LMIC	9 916	47 263	38 467	37 680	38 699	172 025
African Region[d]	LMIC	4 445	10 178	4 060	4 618	5 452	28 752
Region of the Americas	All	272	2 487	1 395	1 654	2 785	8 592
	HIC	68	445	146	155	333	1 148
	LMIC	203	2 042	1 248	1 499	2 452	7 444
South-East Asia Region[d]	LMIC	2 850	9 362	11 662	8 870	11 027	43 771
European Region	All	133	2 334	1 251	1 181	1 051	5 950
	HIC	21	189	86	53	166	515
	LMIC	112	2 145	1 165	1 128	885	5 435
Eastern Mediterranean Region	All	1 021	4 605	3 711	3 253	4 342	16 932
	HIC	51	217	117	92	302	779
	LMIC	970	4 388	3 595	3 161	4 040	16 153
Western Pacific Region	All	1 363	19 255	16 889	18 497	14 998	71 002
	HIC	27	107	151	93	155	532
	LMIC	1 336	19 148	16 738	18 404	14 843	70 469

TABLE A.1 *(CONTINUED)*

Drowning

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Rate[e] per 100 000 population

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	6.4	11.8	7.8	8.3	9.3	9.0
	HIC	2.0	2.8	1.2	1.0	2.7	1.8
	LMIC	6.7	12.7	8.5	9.1	10.0	9.8
African Region[d]	LMIC	6.6	16.6	5.6	6.8	7.7	9.0
Region of the Americas	All	2.1	5.0	2.5	3.1	6.4	4.1
	HIC	1.8	3.2	0.9	1.0	2.5	1.8
	LMIC	2.2	5.7	3.2	4.0	8.1	5.0
South-East Asia Region[d]	LMIC	9.1	5.9	7.4	6.1	8.4	7.1
European Region	All	1.0	7.7	3.5	2.7	2.5	3.6
	HIC	0.5	1.5	0.6	0.3	1.1	0.8
	LMIC	1.4	12.3	5.6	4.2	3.4	5.5
Eastern Mediterranean Region	All	8.4	11.2	7.5	7.4	11.0	9.1
	HIC	14.2	12.5	4.1	5.7	21.5	10.7
	LMIC	8.1	11.1	7.7	7.5	10.5	9.0
Western Pacific Region	All	5.5	22.0	14.8	17.3	14.5	16.3
	HIC	1.6	1.6	2.0	1.1	2.0	1.7
	LMIC	5.8	23.8	15.9	18.7	15.5	17.5

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	9.8	7.6	4.9	4.0	3.8	5.2
	HIC	0.9	1.3	0.5	0.3	0.3	0.6
	LMIC	10.6	8.2	5.4	4.4	4.2	5.7
African Region[d]	LMIC	27.3	4.6	2.2	3.2	5.7	5.4
Region of the Americas	All	1.3	3.0	1.1	1.1	0.9	1.4
	HIC	1.2	1.9	0.4	0.3	0.3	0.7
	LMIC	1.4	3.4	1.3	1.5	1.1	1.8
South-East Asia Region[d]	LMIC	6.1	6.9	5.6	3.8	4.7	5.2
European Region	All	1.5	3.8	1.2	1.3	0.6	1.5
	HIC	0.5	0.7	0.2	0.1	0.2	0.3
	LMIC	2.3	6.1	2.0	2.0	0.8	2.4
Eastern Mediterranean Region	All	7.0	6.8	4.3	2.9	3.3	4.4
	HIC	0.0	3.3	3.0	0.2	0.2	1.6
	LMIC	7.4	7.0	4.4	3.0	3.5	4.5
Western Pacific Region	All	6.0	16.6	10.4	8.0	4.8	9.1
	HIC	1.3	1.0	0.6	0.5	0.5	0.7
	LMIC	6.5	18.1	11.3	8.7	5.2	9.9

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	8.0	9.8	6.4	6.2	6.6	7.2
	HIC	1.5	2.1	0.9	0.6	1.5	1.2
	LMIC	8.6	10.6	7.0	6.8	7.2	7.8
African Region[d]	LMIC	16.8	10.7	3.9	5.0	6.7	7.2
Region of the Americas	All	1.7	4.0	1.8	2.1	3.7	2.8
	HIC	1.5	2.5	0.7	0.7	1.4	1.3
	LMIC	1.8	4.6	2.3	2.8	4.7	3.4
South-East Asia Region[d]	LMIC	7.6	6.4	6.5	5.0	6.6	6.2
European Region	All	1.3	5.8	2.4	2.0	1.6	2.6
	HIC	0.5	1.1	0.4	0.2	0.7	0.6
	LMIC	1.8	9.3	3.8	3.1	2.1	4.0
Eastern Mediterranean Region	All	7.7	9.0	5.9	5.2	7.3	6.8
	HIC	7.2	7.9	3.6	2.9	11.0	6.2
	LMIC	7.8	9.1	6.1	5.3	7.1	6.8
Western Pacific Region	All	5.7	19.5	12.7	12.9	9.9	12.9
	HIC	1.4	1.3	1.4	0.8	1.3	1.2
	LMIC	6.1	21.1	13.7	13.9	10.6	13.9

TABLE A.1 *(CONTINUED)*

Fire-related burns

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Absolute numbers[c]

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	5 486	15 490	7 871	3 994	4 942	37 784
	HIC	46	190	155	83	80	554
	LMIC	5 436	15 291	7 708	3 908	4 857	37 200
African Region[d]	LMIC	2 434	8 592	4 565	1 895	341	17 826
Region of the Americas	All	144	464	228	127	179	1 142
	HIC	15	130	108	52	44	349
	LMIC	129	334	119	76	135	793
South-East Asia Region[d]	LMIC	1 832	3 547	2 021	1 349	3 438	12 187
European Region	All	89	521	135	109	136	989
	HIC	5	31	15	19	24	94
	LMIC	84	490	120	89	112	895
Eastern Mediterranean Region	All	844	1 764	715	454	635	4 413
	HIC	26	6	5	1	1	39
	LMIC	818	1 757	710	454	634	4 374
Western Pacific Region	All	139	595	200	56	208	1 198
	HIC	0	24	26	11	11	72
	LMIC	139	571	174	45	197	1 126

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	7 384	18 296	7 850	6 987	17 471	57 988
	HIC	20	160	107	76	51	415
	LMIC	7 359	18 127	7 739	6 908	17 413	57 546
African Region[d]	LMIC	4 574	8 438	1 727	1 713	398	16 850
Region of the Americas	All	131	361	170	109	79	849
	HIC	13	103	69	44	26	255
	LMIC	119	257	101	65	53	595
South-East Asia Region[d]	LMIC	1 768	6 556	4 712	3 604	14 155	30 794
European Region	All	111	359	100	85	86	741
	HIC	6	38	14	17	15	90
	LMIC	105	321	87	68	71	651
Eastern Mediterranean Region	All	754	1 825	974	784	2 329	6 666
	HIC	0	3	4	1	0	9
	LMIC	753	1 822	970	783	2 329	6 657
Western Pacific Region	All	41	749	163	689	417	2 060
	HIC	1	16	20	14	10	62
	LMIC	40	732	143	675	407	1 998

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	12 870	33 786	15 722	10 981	22 413	95 772
	HIC	66	351	262	159	131	969
	LMIC	12 795	33 418	15 447	10 815	22 270	94 746
African Region[d]	LMIC	7 008	17 030	6 291	3 608	739	34 676
Region of the Americas	All	275	824	397	236	258	1 991
	HIC	28	233	177	96	70	604
	LMIC	247	591	220	141	188	1 387
South-East Asia Region[d]	LMIC	3 600	10 103	6 733	4 953	17 593	42 982
European Region	All	200	879	235	193	222	1 730
	HIC	11	68	29	36	39	184
	LMIC	190	811	206	157	183	1 546
Eastern Mediterranean Region	All	1 598	3 588	1 690	1 238	2 964	11 079
	HIC	26	9	9	2	1	48
	LMIC	1 572	3 579	1 680	1 236	2 963	11 031
Western Pacific Region	All	181	1 344	363	746	625	3 258
	HIC	1	40	46	25	21	134
	LMIC	179	1 304	317	720	604	3 124

TABLE A.1 *(CONTINUED)*

Fire-related burns

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Rate[e] per 100 000 population

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	8.4	6.1	2.5	1.3	1.6	3.0
	HIC	0.8	0.8	0.5	0.3	0.3	0.5
	LMIC	9.1	6.6	2.7	1.4	1.8	3.3
African Region[d]	LMIC	18.2	17.8	8.7	4.1	0.8	8.9
Region of the Americas	All	1.8	1.5	0.6	0.3	0.5	0.7
	HIC	0.6	1.4	1.0	0.4	0.4	0.7
	LMIC	2.3	1.5	0.4	0.3	0.5	0.7
South-East Asia Region[d]	LMIC	9.5	4.7	2.2	1.5	4.0	3.3
European Region	All	1.7	2.5	0.5	0.4	0.4	0.9
	HIC	0.2	0.3	0.1	0.2	0.2	0.2
	LMIC	2.7	4.1	0.8	0.5	0.5	1.3
Eastern Mediterranean Region	All	12.5	6.8	2.2	1.4	2.1	3.5
	HIC	7.2	0.4	0.3	0.1	0.1	0.6
	LMIC	12.8	7.1	2.3	1.5	2.2	3.6
Western Pacific Region	All	1.1	1.1	0.3	0.1	0.3	0.4
	HIC	0.0	0.6	0.5	0.2	0.2	0.3
	LMIC	1.2	1.2	0.3	0.1	0.3	0.4

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	12.0	7.6	2.7	2.4	6.0	4.9
	HIC	0.4	0.7	0.4	0.3	0.2	0.4
	LMIC	13.2	8.4	2.9	2.6	6.6	5.4
African Region[d]	LMIC	35.0	17.8	3.4	3.7	1.0	8.5
Region of the Americas	All	1.7	1.2	0.5	0.3	0.2	0.6
	HIC	0.6	1.2	0.6	0.4	0.2	0.6
	LMIC	2.2	1.2	0.4	0.2	0.2	0.6
South-East Asia Region[d]	LMIC	9.8	9.3	5.5	4.2	17.6	9.1
European Region	All	2.2	1.8	0.4	0.3	0.3	0.7
	HIC	0.3	0.5	0.1	0.2	0.1	0.2
	LMIC	3.5	2.9	0.6	0.4	0.4	1.0
Eastern Mediterranean Region	All	11.7	7.3	3.2	2.6	8.0	5.5
	HIC	0.1	0.2	0.3	0.1	0.0	0.1
	LMIC	12.4	7.7	3.4	2.7	8.4	5.8
Western Pacific Region	All	0.4	1.6	0.3	1.0	0.6	0.8
	HIC	0.2	0.4	0.4	0.3	0.2	0.3
	LMIC	0.4	1.7	0.3	1.1	0.6	0.8

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	10.1	6.8	2.6	1.8	3.7	3.9
	HIC	0.6	0.8	0.5	0.3	0.2	0.4
	LMIC	11.1	7.5	2.8	2.0	4.1	4.3
African Region[d]	LMIC	26.5	17.8	6.1	3.9	0.9	8.7
Region of the Americas	All	1.7	1.3	0.5	0.3	0.3	0.6
	HIC	0.6	1.3	0.8	0.4	0.3	0.7
	LMIC	2.2	1.3	0.4	0.3	0.4	0.6
South-East Asia Region[d]	LMIC	9.6	6.9	3.8	2.8	10.6	6.1
European Region	All	1.9	2.2	0.5	0.3	0.3	0.8
	HIC	0.3	0.4	0.1	0.2	0.2	0.2
	LMIC	3.1	3.5	0.7	0.4	0.4	1.1
Eastern Mediterranean Region	All	12.1	7.0	2.7	2.0	5.0	4.5
	HIC	3.7	0.3	0.3	0.1	0.0	0.4
	LMIC	12.6	7.4	2.8	2.1	5.2	4.7
Western Pacific Region	All	0.8	1.4	0.3	0.5	0.4	0.6
	HIC	0.1	0.5	0.4	0.2	0.2	0.3
	LMIC	0.8	1.4	0.3	0.6	0.4	0.6

TABLE A.1 *(CONTINUED)*

Falls

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Absolute numbers[c]

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	4 429	5 458	6 801	3 637	7 993	28 317
	HIC	141	123	81	72	326	744
	LMIC	4 285	5 325	6 716	3 560	7 659	27 546
African Region[d]	LMIC	741	697	1 723	281	257	3 699
Region of the Americas	All	135	235	177	225	440	1 211
	HIC	14	33	6	19	80	151
	LMIC	121	202	171	206	360	1 060
South-East Asia Region[d]	LMIC	1 912	2 302	2 077	1 828	2 793	10 911
European Region	All	102	305	151	233	359	1 150
	HIC	9	56	21	33	100	218
	LMIC	93	249	130	201	260	932
Eastern Mediterranean Region	All	833	1 143	1 127	541	805	4 448
	HIC	103	9	36	4	103	255
	LMIC	730	1 134	1 091	537	702	4 194
Western Pacific Region	All	705	767	1 541	525	3 332	6 870
	HIC	16	25	18	18	44	120
	LMIC	689	742	1 524	507	3 289	6 751

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	2 280	4 524	5 215	2 209	4 348	18 577
	HIC	32	53	35	35	64	219
	LMIC	2 247	4 464	5 174	2 173	4 247	18 304
African Region[d]	LMIC	355	233	1 142	190	180	2 100
Region of the Americas	All	62	160	79	66	82	449
	HIC	11	16	6	9	21	63
	LMIC	52	144	73	57	60	386
South-East Asia Region[d]	LMIC	993	2 480	1 952	1 030	1 759	8 213
European Region	All	92	161	73	74	97	497
	HIC	6	21	13	15	19	76
	LMIC	86	140	60	58	78	422
Eastern Mediterranean Region	All	418	796	772	293	387	2 665
	HIC	9	2	7	1	1	20
	LMIC	408	793	765	292	386	2 645
Western Pacific Region	All	359	687	1 191	555	1 807	4 599
	HIC	6	14	8	9	23	60
	LMIC	353	673	1 183	546	1 784	4 539

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	6 709	9 982	12 016	5 846	12 341	46 894
	HIC	174	177	115	107	390	963
	LMIC	6 532	9 789	11 890	5 733	11 907	45 851
African Region[d]	LMIC	1 096	930	2 865	471	437	5 799
Region of the Americas	All	197	395	256	291	521	1 660
	HIC	25	49	12	28	101	215
	LMIC	172	346	243	263	420	1 446
South-East Asia Region[d]	LMIC	2 904	4 782	4 029	2 857	4 552	19 125
European Region	All	194	466	224	307	457	1 647
	HIC	15	78	34	48	119	294
	LMIC	179	388	190	259	338	1 354
Eastern Mediterranean Region	All	1 250	1 939	1 899	834	1 191	7 113
	HIC	112	11	43	5	104	275
	LMIC	1 138	1 928	1 856	829	1 088	6 838
Western Pacific Region	All	1 064	1 454	2 732	1 080	5 139	11 469
	HIC	22	39	26	27	66	179
	LMIC	1 042	1 415	2 707	1 053	5 073	11 290

TABLE A.1 *(CONTINUED)*

Falls

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Rate[e] per 100 000 population

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	6.8	2.1	2.2	1.2	2.6	2.3
	HIC	2.4	0.5	0.3	0.2	1.0	0.6
	LMIC	7.2	2.3	2.4	1.3	2.8	2.4
African Region[d]	LMIC	5.6	1.5	3.3	0.6	0.6	1.8
Region of the Americas	All	1.7	0.7	0.5	0.6	1.1	0.8
	HIC	0.6	0.4	0.1	0.2	0.7	0.3
	LMIC	2.1	0.9	0.6	0.8	1.4	1.0
South-East Asia Region[d]	LMIC	9.9	3.0	2.2	2.0	3.2	3.0
European Region	All	1.9	1.5	0.6	0.8	1.1	1.0
	HIC	0.4	0.6	0.2	0.3	0.8	0.5
	LMIC	3.0	2.1	0.8	1.1	1.2	1.3
Eastern Mediterranean Region	All	12.3	4.4	3.5	1.7	2.6	3.5
	HIC	28.4	0.7	2.2	0.2	7.4	4.0
	LMIC	11.4	4.6	3.6	1.8	2.4	3.5
Western Pacific Region	All	5.6	1.5	2.2	0.7	4.2	2.4
	HIC	1.6	0.6	0.3	0.3	0.7	0.5
	LMIC	5.9	1.5	2.4	0.7	4.5	2.5

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	3.7	1.9	1.8	0.7	1.5	1.6
	HIC	0.6	0.2	0.1	0.1	0.2	0.2
	LMIC	4.0	2.1	1.9	0.8	1.6	1.7
African Region[d]	LMIC	2.7	0.5	2.2	0.4	0.4	1.1
Region of the Americas	All	0.8	0.5	0.2	0.2	0.2	0.3
	HIC	0.5	0.2	0.1	0.1	0.2	0.1
	LMIC	0.9	0.7	0.3	0.2	0.2	0.4
South-East Asia Region[d]	LMIC	5.5	3.5	2.3	1.2	2.2	2.4
European Region	All	1.8	0.8	0.3	0.3	0.3	0.5
	HIC	0.3	0.3	0.1	0.1	0.2	0.2
	LMIC	2.9	1.2	0.4	0.3	0.4	0.6
Eastern Mediterranean Region	All	6.5	3.2	2.5	1.0	1.3	2.2
	HIC	2.7	0.2	0.4	0.1	0.1	0.3
	LMIC	6.7	3.4	2.7	1.0	1.4	2.3
Western Pacific Region	All	3.2	1.5	1.9	0.8	2.5	1.8
	HIC	0.7	0.3	0.1	0.2	0.4	0.3
	LMIC	3.5	1.6	2.1	0.9	2.7	1.9

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	5.3	2.0	2.0	1.0	2.1	1.9
	HIC	1.5	0.4	0.2	0.2	0.6	0.4
	LMIC	5.7	2.2	2.2	1.0	2.2	2.1
African Region[d]	LMIC	4.2	1.0	2.8	0.5	0.5	1.5
Region of the Americas	All	1.2	0.6	0.3	0.4	0.7	0.5
	HIC	0.5	0.3	0.1	0.1	0.4	0.2
	LMIC	1.5	0.8	0.4	0.5	0.8	0.7
South-East Asia Region[d]	LMIC	7.8	3.3	2.2	1.6	2.7	2.7
European Region	All	1.9	1.2	0.4	0.5	0.7	0.7
	HIC	0.3	0.5	0.2	0.2	0.5	0.3
	LMIC	2.9	1.7	0.6	0.7	0.8	1.0
Eastern Mediterranean Region	All	9.5	3.8	3.0	1.3	2.0	2.9
	HIC	15.7	0.4	1.3	0.2	3.8	2.2
	LMIC	9.1	4.0	3.1	1.4	1.9	2.9
Western Pacific Region	All	4.5	1.5	2.1	0.8	3.4	2.1
	HIC	1.2	0.5	0.2	0.2	0.6	0.4
	LMIC	4.8	1.6	2.2	0.8	3.6	2.2

TABLE A.1 *(CONTINUED)*

Poisoning

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Absolute numbers[c]

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	3 556	7 382	4 057	3 580	6 606	25 181
	HIC	83	24	16	42	646	812
	LMIC	3 471	7 354	4 038	3 534	5 938	24 336
African Region[d]	LMIC	2 138	4 463	1 499	1 072	704	9 877
Region of the Americas	All	62	151	63	64	628	967
	HIC	5	15	4	29	514	567
	LMIC	56	136	59	35	115	400
South-East Asia Region[d]	LMIC	309	628	1 556	1 522	2 371	6 387
European Region	All	174	474	149	157	871	1 825
	HIC	2	8	8	9	107	134
	LMIC	172	467	141	148	764	1 691
Eastern Mediterranean Region	All	497	346	355	261	642	2 101
	HIC	76	0	2	0	1	80
	LMIC	420	346	353	261	641	2 021
Western Pacific Region	All	374	1 316	432	500	1 368	3 991
	HIC	0	1	2	3	25	31
	LMIC	374	1 315	430	497	1 343	3 960

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	2 273	4 761	3 448	3 672	5 717	19 870
	HIC	10	16	9	33	226	294
	LMIC	2 263	4 743	3 437	3 637	5 484	19 564
African Region[d]	LMIC	768	2 314	1 335	412	1 126	5 956
Region of the Americas	All	68	111	40	55	253	527
	HIC	9	7	5	21	154	196
	LMIC	59	105	35	33	98	331
South-East Asia Region[d]	LMIC	331	469	1 447	1 480	1 622	5 350
European Region	All	165	323	112	142	432	1 174
	HIC	0	6	3	11	48	68
	LMIC	165	317	110	131	384	1 106
Eastern Mediterranean Region	All	335	196	341	262	636	1 770
	HIC	0	1	0	1	0	2
	LMIC	335	195	341	261	636	1 768
Western Pacific Region	All	605	1 346	170	1 320	1 640	5 081
	HIC	1	2	1	0	23	28
	LMIC	604	1 344	169	1 320	1 617	5 053

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	5 829	12 142	7 505	7 252	12 322	45 051
	HIC	93	40	26	75	873	1 106
	LMIC	5 733	12 098	7 475	7 172	11 422	43 899
African Region[d]	LMIC	2 906	6 778	2 835	1 484	1 830	15 833
Region of the Americas	All	129	262	103	118	881	1 494
	HIC	14	22	9	50	668	763
	LMIC	116	240	94	68	213	731
South-East Asia Region[d]	LMIC	641	1 097	3 003	3 002	3 994	11 737
European Region	All	339	797	261	299	1 303	2 999
	HIC	2	14	10	20	155	201
	LMIC	337	783	251	279	1 148	2 797
Eastern Mediterranean Region	All	832	542	696	523	1 278	3 871
	HIC	76	1	2	1	1	82
	LMIC	756	540	694	522	1 277	3 789
Western Pacific Region	All	979	2 662	602	1 821	3 008	9 072
	HIC	1	3	4	3	48	59
	LMIC	978	2 659	598	1 818	2 960	9 013

TABLE A.1 *(CONTINUED)*

Poisoning

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Rate[e] per 100 000 population

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	5.4	2.9	1.3	1.1	2.1	2.0
	HIC	1.4	0.1	0.1	0.1	2.0	0.7
	LMIC	5.8	3.2	1.4	1.3	2.1	2.1
African Region[d]	LMIC	16.0	9.3	2.9	2.3	1.7	4.9
Region of the Americas	All	0.8	0.5	0.2	0.2	1.6	0.6
	HIC	0.2	0.2	0.0	0.2	4.3	1.2
	LMIC	1.0	0.6	0.2	0.1	0.4	0.4
South-East Asia Region[d]	LMIC	1.6	0.8	1.7	1.7	2.8	1.7
European Region	All	3.2	2.3	0.6	0.5	2.6	1.6
	HIC	0.1	0.1	0.1	0.1	0.9	0.3
	LMIC	5.5	3.9	0.9	0.8	3.6	2.4
Eastern Mediterranean Region	All	7.4	1.3	1.1	0.8	2.1	1.7
	HIC	21.1	0.0	0.1	0.0	0.1	1.3
	LMIC	6.6	1.4	1.2	0.9	2.2	1.7
Western Pacific Region	All	3.0	2.5	0.6	0.7	1.7	1.4
	HIC	0.0	0.0	0.0	0.1	0.4	0.1
	LMIC	3.2	2.7	0.7	0.7	1.8	1.5

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	3.7	2.0	1.2	1.2	2.0	1.7
	HIC	0.2	0.1	0.0	0.1	0.7	0.3
	LMIC	4.1	2.2	1.3	1.4	2.1	1.8
African Region[d]	LMIC	5.9	4.9	2.6	0.9	2.8	3.0
Region of the Americas	All	0.9	0.4	0.1	0.1	0.7	0.4
	HIC	0.4	0.1	0.1	0.2	1.3	0.4
	LMIC	1.1	0.5	0.1	0.1	0.4	0.3
South-East Asia Region[d]	LMIC	1.8	0.7	1.7	1.7	2.0	1.6
European Region	All	3.2	1.6	0.4	0.5	1.3	1.1
	HIC	0.0	0.1	0.0	0.1	0.4	0.2
	LMIC	5.5	2.8	0.7	0.7	1.9	1.7
Eastern Mediterranean Region	All	5.2	0.8	1.1	0.9	2.2	1.5
	HIC	0.0	0.1	0.0	0.1	0.0	0.0
	LMIC	5.5	0.8	1.2	0.9	2.3	1.5
Western Pacific Region	All	5.4	2.9	0.3	1.9	2.3	1.9
	HIC	0.1	0.1	0.0	0.0	0.4	0.1
	LMIC	5.9	3.2	0.3	2.1	2.4	2.1

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	4.6	2.5	1.2	1.2	2.0	1.8
	HIC	0.8	0.1	0.0	0.1	1.4	0.5
	LMIC	5.0	2.7	1.4	1.3	2.1	2.0
African Region[d]	LMIC	11.0	7.1	2.7	1.6	2.3	4.0
Region of the Americas	All	0.8	0.4	0.1	0.2	1.2	0.5
	HIC	0.3	0.1	0.0	0.2	2.8	0.8
	LMIC	1.0	0.5	0.2	0.1	0.4	0.3
South-East Asia Region[d]	LMIC	1.7	0.8	1.7	1.7	2.4	1.7
European Region	All	3.2	2.0	0.5	0.5	2.0	1.3
	HIC	0.0	0.1	0.1	0.1	0.6	0.2
	LMIC	5.5	3.4	0.8	0.8	2.8	2.0
Eastern Mediterranean Region	All	6.3	1.1	1.1	0.8	2.1	1.6
	HIC	10.7	0.0	0.1	0.0	0.0	0.7
	LMIC	6.1	1.1	1.2	0.9	2.2	1.6
Western Pacific Region	All	4.1	2.7	0.5	1.3	2.0	1.7
	HIC	0.1	0.0	0.0	0.0	0.4	0.1
	LMIC	4.5	2.9	0.5	1.4	2.1	1.8

TABLE A.1 *(CONTINUED)*

Other unintentional injuries

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Absolute numbers[c]

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	36 662	37 124	34 927	23 097	38 522	170 333
	HIC	1 007	733	577	696	1 334	4 346
	LMIC	35 544	36 367	34 330	22 356	37 041	165 638
African Region[d]	LMIC	11 869	5 050	2 151	2 080	5 033	26 182
Region of the Americas	All	4 150	2 544	1 923	1 724	3 304	13 645
	HIC	506	298	155	277	515	1 751
	LMIC	3 644	2 246	1 767	1 447	2 790	11 894
South-East Asia Region[d]	LMIC	9 518	22 022	23 790	13 184	17 275	85 790
European Region	All	1 583	1 501	1 006	1 321	4 060	9 471
	HIC	93	149	117	156	398	914
	LMIC	1 489	1 351	889	1 165	3 661	8 557
Eastern Mediterranean Region	All	3 626	3 223	3 840	3 032	3 978	17 701
	HIC	293	200	255	215	303	1 267
	LMIC	3 333	3 023	3 585	2 818	3 675	16 434
Western Pacific Region	All	5 806	2 760	2 196	1 709	4 724	17 195
	HIC	115	85	49	48	117	415
	LMIC	5 691	2 675	2 147	1 661	4 607	16 780

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	38 011	40 575	31 635	20 259	24 165	154 646
	HIC	658	439	271	310	317	1 995
	LMIC	37 338	40 117	31 354	19 922	23 832	152 563
African Region[d]	LMIC	8 614	5 017	4 121	2 217	1 131	21 102
Region of the Americas	All	3 400	1 888	1 276	902	1 089	8 555
	HIC	373	154	80	81	99	787
	LMIC	3 027	1 734	1 196	821	990	7 768
South-East Asia Region[d]	LMIC	10 147	27 874	21 061	13 745	17 377	90 205
European Region	All	1 465	902	486	437	927	4 217
	HIC	91	110	65	61	101	428
	LMIC	1 374	793	421	375	826	3 789
Eastern Mediterranean Region	All	2 891	2 991	2 984	1 958	2 437	13 261
	HIC	63	122	97	139	84	506
	LMIC	2 829	2 869	2 886	1 819	2 353	12 756
Western Pacific Region	All	11 478	1 883	1 696	972	1 189	17 218
	HIC	131	53	28	28	34	274
	LMIC	11 347	1 829	1 668	944	1 154	16 944

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	74 673	77 700	66 562	43 356	62 687	324 979
	HIC	1 665	1 172	847	1 005	1 651	6 341
	LMIC	72 882	76 484	65 684	42 278	60 874	318 201
African Region[d]	LMIC	20 483	10 067	6 273	4 297	6 164	47 285
Region of the Americas	All	7 550	4 432	3 199	2 626	4 393	22 200
	HIC	879	452	236	358	613	2 538
	LMIC	6 671	3 981	2 963	2 268	3 780	19 662
South-East Asia Region[d]	LMIC	19 665	49 896	44 852	26 929	34 653	175 995
European Region	All	3 047	2 403	1 493	1 758	4 987	13 688
	HIC	184	259	183	217	499	1 342
	LMIC	2 863	2 144	1 310	1 541	4 487	12 345
Eastern Mediterranean Region	All	6 518	6 215	6 824	4 991	6 415	30 962
	HIC	356	323	353	354	387	1 772
	LMIC	6 162	5 892	6 471	4 637	6 028	29 190
Western Pacific Region	All	17 284	4 642	3 892	2 681	5 913	34 413
	HIC	246	138	77	76	152	688
	LMIC	17 038	4 504	3 815	2 605	5 761	33 724

TABLE A.1 *(CONTINUED)*

Other unintentional injuries

Estimated mortality by sex, age group,[a] WHO region and income level,[b] 2004

Rate[e] per 100 000 population

WHO region	Income level	Boys					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	55.9	14.5	11.1	7.3	12.4	13.5
	HIC	17.0	3.1	1.9	2.2	4.2	3.5
	LMIC	59.7	15.7	12.1	7.9	13.4	14.6
African Region[d]	LMIC	88.9	10.5	4.1	4.5	12.3	13.0
Region of the Americas	All	51.3	8.0	4.9	4.4	8.6	8.7
	HIC	21.5	3.3	1.4	2.23	4.3	3.7
	LMIC	63.5	9.9	6.3	5.3	10.5	10.8
South-East Asia Region[d]	LMIC	49.3	29.1	25.5	14.4	20.0	23.4
European Region	All	29.4	7.2	3.8	4.4	12.1	8.1
	HIC	4.1	1.7	1.0	1.3	3.2	2.0
	LMIC	47.4	11.4	5.7	6.3	17.3	12.2
Eastern Mediterranean Region	All	53.7	12.4	12.0	9.5	13.0	13.9
	HIC	81.0	14.4	15.4	13.6	21.8	19.9
	LMIC	52.2	12.3	11.8	9.3	12.6	13.6
Western Pacific Region	All	46.1	5.3	3.1	2.3	6.0	5.9
	HIC	11.9	2.0	0.9	0.8	1.9	1.8
	LMIC	48.9	5.6	3.3	2.4	6.3	6.3

WHO region	Income level	Girls					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	61.6	16.9	10.7	6.8	8.2	13.0
	HIC	11.7	2.0	1.0	1.0	1.0	1.7
	LMIC	66.9	18.5	11.8	7.5	9.1	14.3
African Region[d]	LMIC	65.8	10.6	8.0	4.8	2.8	10.6
Region of the Americas	All	43.9	6.2	3.4	2.4	2.9	5.6
	HIC	16.7	1.8	0.7	0.7	0.9	1.8
	LMIC	55.0	7.9	4.4	3.1	3.8	7.2
South-East Asia Region[d]	LMIC	56.3	39.6	24.4	16.2	21.6	26.5
European Region	All	28.7	4.6	1.9	1.5	2.9	3.8
	HIC	4.3	1.3	0.6	0.5	0.9	1.0
	LMIC	46.1	7.1	2.8	2.1	4.0	5.6
Eastern Mediterranean Region	All	44.8	12.0	9.8	6.4	8.3	10.9
	HIC	17.7	9.0	6.0	8.9	6.1	8.1
	LMIC	46.4	12.2	10.0	6.3	8.4	11.1
Western Pacific Region	All	103.0	4.1	2.7	1.4	1.6	6.6
	HIC	14.3	1.3	0.5	0.5	0.6	1.3
	LMIC	110.9	4.3	2.9	1.5	1.7	7.1

WHO region	Income level	Both sexes					
		<1 year	1–4 years	5–9 years	10–14 years	15–19 years	Under 20 years
World	All	58.7	15.7	10.9	7.1	10.4	13.3
	HIC	14.4	2.6	1.4	1.6	2.6	2.6
	LMIC	63.1	17.1	12.0	7.7	11.3	14.4
African Region[d]	LMIC	77.5	10.5	6.1	4.7	7.6	11.8
Region of the Americas	All	47.7	7.1	4.1	3.4	5.8	7.2
	HIC	19.2	2.6	1.1	1.5	2.6	2.8
	LMIC	59.3	8.9	5.4	4.2	7.2	9.0
South-East Asia Region[d]	LMIC	52.7	34.2	25.0	15.2	20.8	24.9
European Region	All	29.0	6.0	2.9	3.0	7.6	6.0
	HIC	4.2	1.5	0.8	0.9	2.1	1.5
	LMIC	46.8	9.3	4.3	4.3	10.8	9.0
Eastern Mediterranean Region	All	49.4	12.2	10.9	8.0	10.7	12.4
	HIC	49.7	11.8	10.7	11.3	14.0	14.0
	LMIC	49.4	12.2	10.9	7.8	10.6	12.4
Western Pacific Region	All	72.8	4.7	2.9	1.9	3.9	6.2
	HIC	13.1	1.7	0.7	0.7	1.3	1.5
	LMIC	77.9	5.0	3.1	2.0	4.1	6.7

[a] Data are for those under 20 years of age. [b] Income levels as per World Bank estimates of gross national income (GNI) per capita for the year 2004.

[c] Any apparent discrepancies in total sums are the result of rounding. [d] No high-income countries in the region. [e] Age-standardized.

HIC = High-income countries; LMIC = Low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

TABLE A.2

The 15 leading causes of mortality and DALYs among children under 15 years by sex and income level, 2004

All Member States

Both sexes

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	26.8	1	Perinatal causes	23.0
2	Lower respiratory infections	16.7	2	Lower respiratory infections	13.1
3	Diarrhoeal diseases	14.9	3	Diarrhoeal diseases	11.6
4	Malaria	7.8	4	Malaria	6.6
5	Measles	3.5	5	Congenital anomalies	4.4
6	Congenital anomalies	3.3	6	Protein–energy malnutrition	3.0
7	HIV/AIDS	2.5	7	Measles	2.7
8	Pertussis	2.1	8	Pertussis	2.0
9	Meningitis	1.9	9	HIV/AIDS	1.9
10	Protein–energy malnutrition	1.4	10	Road traffic injuries	1.7
11	Road traffic injuries	1.4	11	Meningitis	1.6
12	Tetanus	1.2	12	Asthma	1.2
13	Drowning	1.1	13	Falls	1.1
14	Tuberculosis	0.7	14	Iron-deficiency anaemia	1.1
15	Fire-related burns	0.6	15	Unipolar depressive disorders	1.0

Boys

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	26.9	1	Perinatal causes	22.8
2	Lower respiratory infections	16.5	2	Lower respiratory infections	13.1
3	Diarrhoeal diseases	14.9	3	Diarrhoeal diseases	11.7
4	Malaria	7.8	4	Malaria	6.5
5	Measles	3.5	5	Congenital anomalies	4.3
6	Congenital anomalies	3.2	6	Protein–energy malnutrition	3.0
7	HIV/AIDS	2.5	7	Measles	2.7
8	Pertussis	2.1	8	HIV/AIDS	1.9
9	Meningitis	1.7	9	Road traffic injuries	1.9
10	Road traffic injuries	1.6	10	Pertussis	1.8
11	Tetanus	1.5	11	Meningitis	1.5
12	Protein–energy malnutrition	1.4	12	Falls	1.2
13	Drowning	1.4	13	Tetanus	1.1
14	Tuberculosis	0.7	14	Asthma	1.1
15	Syphilis	0.5	15	Drowning	1.1

Girls

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	26.6	1	Perinatal causes	23.3
2	Lower respiratory infections	16.9	2	Lower respiratory infections	13.1
3	Diarrhoeal diseases	14.9	3	Diarrhoeal diseases	11.6
4	Malaria	7.9	4	Malaria	6.6
5	Measles	3.5	5	Congenital anomalies	4.5
6	Congenital anomalies	3.4	6	Protein–energy malnutrition	3.0
7	HIV/AIDS	2.6	7	Measles	2.7
8	Pertussis	2.2	8	HIV/AIDS	2.0
9	Meningitis	2.0	9	Pertussis	1.8
10	Protein–energy malnutrition	1.5	10	Meningitis	1.7
11	Road traffic injuries	1.1	11	Road traffic injuries	1.6
12	Tetanus	0.9	12	Asthma	1.2
13	Drowning	0.9	13	Falls	1.1
14	Fire-related burns	0.7	14	Unipolar depressive disorders	1.1
15	Tuberculosis	0.7	15	Iron-deficiency anaemia	1.1

TABLE A.2 *(CONTINUED)*

All Member States

High-income countries

Rank	Cause of death	Proportion of total (%)
1	Perinatal causes	36.3
2	Congenital anomalies	19.2
3	Road traffic injuries	5.7
4	Lower respiratory infections	3.4
5	Endocrine disorders	2.9
6	Diarrhoeal diseases	2.4
7	Drowning	2.0
8	Leukaemia	1.7
9	Violence	1.6
10	Fire-related burns	0.8
11	Meningitis	0.8
12	Inflammatory heart diseases	0.8
13	Falls	0.6
14	Self-inflicted injuries	0.6
15	Epilepsy	0.5

Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	17.8
2	Congenital anomalies	14.3
3	Asthma	8.1
4	Unipolar depressive disorders	5.6
5	Migraine	3.8
6	Endocrine disorders	3.3
7	Road traffic injuries	3.0
8	Refractive errors	3.0
9	Schizophrenia	2.5
10	Diarrhoeal diseases	2.1
11	Dental caries	2.0
12	Falls	2.0
13	Lower respiratory infections	1.4
14	Epilepsy	1.1
15	Otitis media	1.0

Low-income and middle-income countries

Rank	Cause of death	Proportion of total (%)
1	Perinatal causes	26.7
2	Lower respiratory infections	16.8
3	Diarrhoeal diseases	15.0
4	Malaria	7.9
5	Measles	3.6
6	Congenital anomalies	3.1
7	HIV/AIDS	2.6
8	Pertussis	2.2
9	Meningitis	1.9
10	Protein–energy malnutrition	1.5
11	Road traffic injuries	1.4
12	Tetanus	1.2
13	Drowning	1.1
14	Tuberculosis	0.7
15	Fire-related burns	0.6

Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	23.1
2	Lower respiratory infections	13.3
3	Diarrhoeal diseases	11.9
4	Malaria	6.6
5	Congenital anomalies	4.2
6	Protein–energy malnutrition	3.0
7	Measles	2.7
8	HIV/AIDS	2.0
9	Pertussis	1.8
10	Road traffic injuries	1.7
11	Meningitis	1.6
12	Falls	1.1
13	Iron-deficiency anaemia	1.1
14	Asthma	1.0
15	Unipolar depressive disorders	0.9

TABLE A.2 *(CONTINUED)*

African Region[a]

Both sexes

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Lower respiratory infections	20.0	1	Perinatal causes	17.7
2	Perinatal causes	18.8	2	Lower respiratory infections	17.2
3	Malaria	15.5	3	Malaria	14.3
4	Diarrhoeal diseases	15.4	4	Diarrhoeal diseases	13.3
5	HIV/AIDS	5.3	5	HIV/AIDS	4.4
6	Measles	3.5	6	Protein–energy malnutrition	3.1
7	Meningitis	2.1	7	Measles	3.0
8	Pertussis	2.0	8	Congenital anomalies	2.6
9	Congenital anomalies	1.8	9	Pertussis	2.0
10	Protein–energy malnutrition	1.7	10	Meningitis	1.9
11	Road traffic injuries	1.3	11	Road traffic injuries	1.5
12	Tetanus	1.3	12	Tetanus	1.1
13	Tuberculosis	0.9	13	Tuberculosis	0.9
14	Fire-related burns	0.7	14	Fire-related burns	0.8
15	Syphilis	0.6	15	Iron-deficiency anaemia	0.7

Boys

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Lower respiratory infections	10.2	1	Perinatal causes	17.9
2	Perinatal causes	10.2	2	Lower respiratory infections	17.0
3	Diarrhoeal diseases	8.1	3	Malaria	14.1
4	Malaria	8.0	4	Diarrhoeal diseases	13.3
5	HIV/AIDS	2.7	5	HIV/AIDS	4.3
6	Measles	1.8	6	Protein–energy malnutrition	3.0
7	Pertussis	1.0	7	Measles	2.9
8	Meningitis	1.0	8	Congenital anomalies	2.6
9	Congenital anomalies	0.9	9	Pertussis	1.7
10	Protein–energy malnutrition	0.9	10	Meningitis	1.7
11	Tetanus	0.8	11	Road traffic injuries	1.6
12	Road traffic injuries	0.8	12	Tetanus	1.3
13	Tuberculosis	0.5	13	Tuberculosis	0.9
14	Syphilis	0.3	14	Fire-related burns	0.8
15	Fire-related burns	0.3	15	Iron-deficiency anaemia	0.7

Girls

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Lower respiratory infections	9.7	1	Perinatal causes	17.6
2	Perinatal causes	8.6	2	Lower respiratory infections	17.4
3	Malaria	7.5	3	Malaria	14.6
4	Diarrhoeal diseases	7.4	4	Diarrhoeal diseases	13.3
5	HIV/AIDS	2.6	5	HIV/AIDS	4.6
6	Measles	1.7	6	Protein–energy malnutrition	3.2
7	Meningitis	1.1	7	Measles	3.0
8	Pertussis	1.0	8	Congenital anomalies	2.7
9	Protein–energy malnutrition	0.9	9	Meningitis	2.2
10	Congenital anomalies	0.8	10	Pertussis	1.8
11	Road traffic injuries	0.5	11	Road traffic injuries	1.4
12	Tetanus	0.5	12	Tuberculosis	0.8
13	Tuberculosis	0.4	13	Tetanus	0.8
14	Fire-related burns	0.3	14	Iron-deficiency anaemia	0.8
15	Syphilis	0.3	15	Fire-related burns	0.7

TABLE A.2 *(CONTINUED)*

Region of the Americas

Both sexes

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	33.0	1	Perinatal causes	21.5
2	Lower respiratory infections	11.7	2	Congenital anomalies	9.1
3	Diarrhoeal diseases	11.2	3	Lower respiratory infections	7.5
4	Congenital anomalies	9.2	4	Diarrhoeal diseases	7.2
5	Protein–energy malnutrition	3.7	5	Asthma	4.5
6	Road traffic injuries	2.4	6	Protein–energy malnutrition	3.3
7	Meningitis	1.6	7	Endocrine disorders	3.0
8	Endocrine disorders	1.5	8	Unipolar depressive disorders	2.4
9	Drowning	1.3	9	Dental caries	2.2
10	Leukaemia	1.0	10	Road traffic injuries	2.1
11	Pertussis	0.9	11	Migraine	2.0
12	Violence	0.9	12	Refractive errors	1.2
13	HIV/AIDS	0.8	13	Iron-deficiency anaemia	1.2
14	Iron-deficiency anaemia	0.6	14	Falls	1.1
15	Malaria	0.5	15	Epilepsy	1.0

Boys

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	33.4	1	Perinatal causes	21.9
2	Lower respiratory infections	11.5	2	Congenital anomalies	8.9
3	Diarrhoeal diseases	11.1	3	Lower respiratory infections	7.5
4	Congenital anomalies	8.9	4	Diarrhoeal diseases	7.2
5	Protein–energy malnutrition	3.6	5	Asthma	3.9
6	Road traffic injuries	2.7	6	Protein–energy malnutrition	3.2
7	Meningitis	1.6	7	Endocrine disorders	3.0
8	Drowning	1.6	8	Road traffic injuries	2.3
9	Endocrine disorders	1.5	9	Dental caries	2.1
10	Violence	1.0	10	Unipolar depressive disorders	2.1
11	Leukaemia	1.0	11	Violence	1.3
12	Pertussis	0.9	12	Falls	1.2
13	HIV/AIDS	0.7	13	Refractive errors	1.2
14	Iron-deficiency anaemia	0.6	14	Iron-deficiency anaemia	1.2
15	Nephritis and nephrosis	0.5	15	Migraine	1.2

Girls

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	32.4	1	Perinatal causes	20.9
2	Lower respiratory infections	12.0	2	Congenital anomalies	9.4
3	Diarrhoeal diseases	11.4	3	Lower respiratory infections	7.5
4	Congenital anomalies	9.5	4	Diarrhoeal diseases	7.1
5	Protein–energy malnutrition	3.8	5	Asthma	5.2
6	Road traffic injuries	2.1	6	Protein–energy malnutrition	3.3
7	Meningitis	1.6	7	Migraine	3.1
8	Endocrine disorders	1.5	8	Endocrine disorders	3.0
9	Leukaemia	1.0	9	Unipolar depressive disorders	2.8
10	Pertussis	1.0	10	Dental caries	2.3
11	Drowning	0.9	11	Road traffic injuries	1.9
12	HIV/AIDS	0.8	12	Refractive errors	1.3
13	Violence	0.8	13	Iron-deficiency anaemia	1.3
14	Iron-deficiency anaemia	0.6	14	Epilepsy	1.1
15	Malaria	0.5	15	Meningitis	1.0

TABLE A.2 ***(CONTINUED)***

Region of the Americas

High-income countries

Rank	Cause of death	Proportion of total (%)
1	Perinatal causes	41.7
2	Congenital anomalies	19.0
3	Road traffic injuries	5.7
4	Violence	2.6
5	Endocrine disorders	2.1
6	Drowning	1.9
7	Lower respiratory infections	1.6
8	Fire-related burns	1.3
9	Leukaemia	1.3
10	Inflammatory heart diseases	0.8
11	Self-inflicted injuries	0.8
12	Cerebrovascular disease	0.6
13	Meningitis	0.5
14	Nephritis and nephrosis	0.4
15	Asthma	0.4

Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	20.7
2	Congenital anomalies	15.4
3	Asthma	9.6
4	Unipolar depressive disorders	5.5
5	Migraine	4.9
6	Road traffic injuries	3.1
7	Refractive errors	2.9
8	Endocrine disorders	2.2
9	Dental caries	1.9
10	Schizophrenia	1.7
11	Falls	1.4
12	Violence	1.3
13	Epilepsy	1.1
14	Diarrhoeal diseases	1.1
15	Otitis media	0.9

Low-income and middle-income countries

Rank	Cause of death	Proportion of total (%)
1	Perinatal causes	32.1
2	Lower respiratory infections	12.7
3	Diarrhoeal diseases	12.3
4	Congenital anomalies	8.2
5	Protein–energy malnutrition	4.0
6	Road traffic injuries	2.1
7	Meningitis	1.7
8	Endocrine disorders	1.4
9	Drowning	1.2
10	Pertussis	1.0
11	Leukaemia	1.0
12	HIV/AIDS	0.8
13	Violence	0.7
14	Iron-deficiency anaemia	0.7
15	Malaria	0.6

Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	21.4
2	Lower respiratory infections	8.4
3	Congenital anomalies	8.2
4	Diarrhoeal diseases	8.0
5	Asthma	3.7
6	Protein–energy malnutrition	3.6
7	Endocrine disorders	3.0
8	Dental caries	2.2
9	Unipolar depressive disorders	1.9
10	Road traffic injuries	1.9
11	Migraine	1.6
12	Meningitis	1.4
13	Iron-deficiency anaemia	1.3
14	Pertussis	1.2
15	Epilepsy	1.0

TABLE A.2 *(CONTINUED)*

South-East Asia Region[a]

Both sexes

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	33.1	1	Perinatal causes	27.8
2	Diarrhoeal diseases	16.2	2	Diarrhoeal diseases	12.5
3	Lower respiratory infections	13.4	3	Lower respiratory infections	10.6
4	Measles	5.2	4	Congenital anomalies	4.4
5	Pertussis	3.2	5	Measles	3.9
6	Congenital anomalies	3.2	6	Protein–energy malnutrition	3.1
7	Malaria	2.0	7	Pertussis	2.8
8	Meningitis	1.5	8	Malaria	1.8
9	Tetanus	1.3	9	Falls	1.7
10	Protein–energy malnutrition	1.0	10	Road traffic injuries	1.5
11	Drowning	0.9	11	Meningitis	1.4
12	Road traffic injuries	0.9	12	Iron-deficiency anaemia	1.4
13	Fire-related burns	0.7	13	Unipolar depressive disorders	1.2
14	Cirrhosis of the liver	0.6	14	Fire-related burns	1.2
15	Tuberculosis	0.5	15	Tetanus	1.0

Boys

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	32.9	1	Perinatal causes	27.4
2	Diarrhoeal diseases	16.5	2	Diarrhoeal diseases	12.9
3	Lower respiratory infections	13.7	3	Lower respiratory infections	10.9
4	Measles	5.4	4	Congenital anomalies	4.3
5	Pertussis	3.2	5	Measles	4.1
6	Congenital anomalies	2.9	6	Protein–energy malnutrition	3.2
7	Malaria	2.0	7	Pertussis	2.7
8	Tetanus	1.7	8	Malaria	1.8
9	Meningitis	1.5	9	Falls	1.7
10	Road traffic injuries	1.0	10	Road traffic injuries	1.6
11	Drowning	1.0	11	Meningitis	1.4
12	Protein–energy malnutrition	0.9	12	Iron-deficiency anaemia	1.4
13	Fire-related burns	0.5	13	Tetanus	1.2
14	Tuberculosis	0.4	14	Unipolar depressive disorders	1.2
15	Falls	0.4	15	Lymphatic filariasis	1.1

Girls

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	33.3	1	Perinatal causes	28.2
2	Diarrhoeal diseases	15.8	2	Diarrhoeal diseases	12.2
3	Lower respiratory infections	13.2	3	Lower respiratory infections	10.4
4	Measles	5.0	4	Congenital anomalies	4.5
5	Congenital anomalies	3.4	5	Measles	3.8
6	Pertussis	3.2	6	Protein–energy malnutrition	3.1
7	Malaria	1.9	7	Pertussis	2.7
8	Meningitis	1.5	8	Falls	1.8
9	Protein–energy malnutrition	1.0	9	Malaria	1.7
10	Fire-related burns	0.9	10	Fire-related burns	1.6
11	Tetanus	0.9	11	Road traffic injuries	1.5
12	Drowning	0.8	12	Meningitis	1.4
13	Road traffic injuries	0.7	13	Iron-deficiency anaemia	1.3
14	Cirrhosis of the liver	0.7	14	Migraine	1.3
15	Epilepsy	0.5	15	Unipolar depressive disorders	1.2

TABLE A.2 *(CONTINUED)*

European Region

Both sexes

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	33.2	1	Perinatal causes	21.6
2	Lower respiratory infections	13.8	2	Congenital anomalies	9.8
3	Diarrhoeal diseases	12.4	3	Lower respiratory infections	7.5
4	Congenital anomalies	10.3	4	Diarrhoeal diseases	7.1
5	Road traffic injuries	2.2	5	Iodine deficiency	4.0
6	Meningitis	2.2	6	Unipolar depressive disorders	3.1
7	Drowning	1.9	7	Asthma	2.7
8	Upper respiratory infections	1.3	8	Falls	2.2
9	Leukaemia	1.0	9	Road traffic injuries	1.9
10	Endocrine disorders	0.8	10	Refractive errors	1.7
11	HIV/AIDS	0.7	11	Migraine	1.7
12	Poisoning	0.6	12	Endocrine disorders	1.5
13	Fire-related burns	0.6	13	Schizophrenia	1.4
14	Epilepsy	0.5	14	Meningitis	1.4
15	Violence	0.5	15	Iron-deficiency anaemia	1.3

Boys

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	33.5	1	Perinatal causes	21.8
2	Lower respiratory infections	13.4	2	Congenital anomalies	9.7
3	Diarrhoeal diseases	11.9	3	Lower respiratory infections	7.5
4	Congenital anomalies	10.1	4	Diarrhoeal diseases	7.0
5	Road traffic injuries	2.5	5	Iodine deficiency	3.5
6	Drowning	2.2	6	Falls	2.7
7	Meningitis	2.0	7	Unipolar depressive disorders	2.6
8	Upper respiratory infections	1.2	8	Asthma	2.3
9	Leukaemia	1.0	9	Road traffic injuries	2.0
10	Endocrine disorders	0.8	10	Refractive errors	1.6
11	Poisoning	0.6	11	Schizophrenia	1.5
12	HIV/AIDS	0.6	12	Endocrine disorders	1.4
13	Fire-related burns	0.6	13	Meningitis	1.3
14	Self-inflicted injuries	0.5	14	Drowning	1.3
15	Epilepsy	0.5	15	Iron-deficiency anaemia	1.2

Girls

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	32.8	1	Perinatal causes	21.2
2	Lower respiratory infections	14.3	2	Congenital anomalies	10.0
3	Diarrhoeal diseases	12.9	3	Lower respiratory infections	7.5
4	Congenital anomalies	10.6	4	Diarrhoeal diseases	7.2
5	Meningitis	2.4	5	Iodine deficiency	4.6
6	Road traffic injuries	1.9	6	Unipolar depressive disorders	3.7
7	Upper respiratory infections	1.4	7	Asthma	3.1
8	Drowning	1.3	8	Migraine	2.3
9	Leukaemia	1.0	9	Refractive errors	1.9
10	Endocrine disorders	0.9	10	Road traffic injuries	1.7
11	HIV/AIDS	0.8	11	Endocrine disorders	1.6
12	Poisoning	0.7	12	Falls	1.4
13	Fire-related burns	0.6	13	Iron-deficiency anaemia	1.4
14	Epilepsy	0.5	14	Meningitis	1.4
15	Violence	0.5	15	Schizophrenia	1.3

TABLE A.2 *(CONTINUED)*

European Region

High-income countries

Rank	Cause of death	Proportion of total (%)
1	Perinatal causes	38.4
2	Congenital anomalies	23.0
3	Road traffic injuries	4.1
4	Endocrine disorders	3.6
5	Leukaemia	2.3
6	Lower respiratory infections	1.4
7	Meningitis	1.3
8	Drowning	1.3
9	Violence	1.0
10	Inflammatory heart diseases	0.9
11	Epilepsy	0.9
12	Falls	0.6
13	Cerebrovascular disease	0.6
14	Fire-related burns	0.5
15	Self-inflicted injuries	0.4

Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	16.7
2	Congenital anomalies	15.1
3	Asthma	8.0
4	Unipolar depressive disorders	7.3
5	Endocrine disorders	4.3
6	Schizophrenia	3.6
7	Refractive errors	3.6
8	Migraine	3.3
9	Dental caries	2.4
10	Falls	2.1
11	Road traffic injuries	2.0
12	Diarrhoeal diseases	1.4
13	Otitis media	1.1
14	Iron-deficiency anaemia	1.1
15	Epilepsy	1.1

Low-income and middle-income countries

Rank	Cause of death	Proportion of total (%)
1	Perinatal causes	32.6
2	Lower respiratory infections	15.2
3	Diarrhoeal diseases	13.7
4	Congenital anomalies	8.8
5	Meningitis	2.3
6	Road traffic injuries	2.0
7	Drowning	1.9
8	Upper respiratory infections	1.4
9	Leukaemia	0.9
10	HIV/AIDS	0.7
11	Poisoning	0.7
12	Fire-related burns	0.6
13	Endocrine disorders	0.5
14	Self-inflicted injuries	0.5
15	Epilepsy	0.5

Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	22.5
2	Lower respiratory infections	9.0
3	Congenital anomalies	8.6
4	Diarrhoeal diseases	8.3
5	Iodine deficiency	4.9
6	Falls	2.2
7	Unipolar depressive disorders	2.1
8	Road traffic injuries	1.8
9	Asthma	1.5
10	Meningitis	1.4
11	Iron-deficiency anaemia	1.4
12	Migraine	1.4
13	Refractive errors	1.3
14	Protein-energy malnutrition	1.3
15	Drowning	1.2

TABLE A.2 *(CONTINUED)*

Eastern Mediterranean Region

Both sexes

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	28.6	1	Perinatal causes	25.4
2	Lower respiratory infections	19.4	2	Lower respiratory infections	15.3
3	Diarrhoeal diseases	14.6	3	Diarrhoeal diseases	11.4
4	Congenital anomalies	4.5	4	Congenital anomalies	5.4
5	Measles	3.0	5	Protein–energy malnutrition	2.9
6	Malaria	2.8	6	Road traffic injuries	2.5
7	Road traffic injuries	2.2	7	Measles	2.3
8	Pertussis	2.1	8	Malaria	2.2
9	Meningitis	1.7	9	Pertussis	1.7
10	Protein–energy malnutrition	1.6	10	Meningitis	1.4
11	Tetanus	1.5	11	Falls	1.4
12	War and conflict	0.9	12	Tetanus	1.1
13	Syphilis	0.9	13	Iodine deficiency	1.1
14	Drowning	0.9	14	Iron-deficiency anaemia	0.9
15	Tuberculosis	0.7	15	Fire-related burns	0.8

Boys

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	28.9	1	Perinatal causes	25.1
2	Lower respiratory infections	18.8	2	Lower respiratory infections	15.0
3	Diarrhoeal diseases	14.4	3	Diarrhoeal diseases	11.3
4	Congenital anomalies	4.5	4	Congenital anomalies	5.5
5	Measles	2.9	5	Protein–energy malnutrition	2.8
6	Malaria	2.7	6	Road traffic injuries	2.8
7	Road traffic injuries	2.6	7	Measles	2.3
8	Pertussis	2.1	8	Malaria	2.1
9	Tetanus	1.8	9	Pertussis	1.7
10	Meningitis	1.7	10	Meningitis	1.4
11	Protein–energy malnutrition	1.5	11	Falls	1.4
12	Drowning	1.1	12	Tetanus	1.3
13	War and conflict	1.0	13	Iodine deficiency	1.0
14	Syphilis	0.9	14	War and conflict	0.9
15	Tuberculosis	0.7	15	Iron-deficiency anaemia	0.9

Girls

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	28.3	1	Perinatal causes	25.6
2	Lower respiratory infections	20.1	2	Lower respiratory infections	15.7
3	Diarrhoeal diseases	14.9	3	Diarrhoeal diseases	11.5
4	Congenital anomalies	4.5	4	Congenital anomalies	5.4
5	Measles	3.1	5	Protein–energy malnutrition	2.9
6	Malaria	2.9	6	Measles	2.3
7	Pertussis	2.2	7	Malaria	2.3
8	Road traffic injuries	1.7	8	Road traffic injuries	2.1
9	Meningitis	1.7	9	Pertussis	1.8
10	Protein–energy malnutrition	1.6	10	Meningitis	1.4
11	Tetanus	1.1	11	Falls	1.3
12	Syphilis	0.9	12	Iodine deficiency	1.1
13	War and conflict	0.8	13	Iron-deficiency anaemia	1.0
14	Tuberculosis	0.7	14	Fire-related burns	1.0
15	Drowning	0.6	15	Migraine	1.0

TABLE A.2 *(CONTINUED)*

Eastern Mediterranean Region

High-income countries

Rank	Cause of death	Proportion of total (%)
1	Perinatal conditions	27.0
2	Congenital anomalies	13.0
3	Diarrhoeal diseases	10.8
4	Lower respiratory infections	9.4
5	Road traffic injuries	8.4
6	Endocrine disorders	4.0
7	Drowning	2.4
8	Tuberculosis	1.2
9	Leukaemia	1.1
10	Meningitis	0.9
11	Falls	0.9
12	Nephritis and nephrosis	0.8
13	Dengue	0.7
14	Violence	0.5
15	Epilepsy	0.5

Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal conditions	19.2
2	Congenital anomalies	10.8
3	Diarrhoeal diseases	6.6
4	Road traffic injuries	5.8
5	Lower respiratory infections	5.5
6	Endocrine disorders	5.0
7	Protein–energy malnutrition	2.5
8	Falls	2.5
9	Asthma	2.1
10	Migraine	1.8
11	Unipolar depressive disorders	1.8
12	Malaria	1.8
13	Dental caries	1.3
14	Drowning	1.3
15	Iron-deficiency anaemia	1.1

Low-income and middle-income countries

Rank	Cause of death	Proportion of total (%)
1	Perinatal causes	28.7
2	Lower respiratory infections	19.5
3	Diarrhoeal diseases	14.6
4	Congenital anomalies	4.4
5	Measles	3.0
6	Malaria	2.8
7	Pertussis	2.1
8	Road traffic injuries	2.1
9	Meningitis	1.7
10	Protein–energy malnutrition	1.6
11	Tetanus	1.5
12	War and conflict	0.9
13	Syphilis	0.9
14	Drowning	0.9
15	Tuberculosis	0.7

Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	25.4
2	Lower respiratory infections	15.4
3	Diarrhoeal diseases	11.4
4	Congenital anomalies	5.3
5	Protein–energy malnutrition	2.9
6	Malaria	2.6
7	Road traffic injuries	2.4
8	Measles	2.3
9	Pertussis	1.9
10	Meningitis	1.4
11	Falls	1.4
12	Tetanus	1.1
13	Iodine deficiency	1.1
14	Iron-deficiency anaemia	0.9
15	Fire-related burns	0.9

TABLE A.2 *(CONTINUED)*

Western Pacific Region

Both sexes

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	39.4	1	Perinatal causes	28.0
2	Diarrhoeal diseases	10.0	2	Diarrhoeal diseases	6.8
3	Lower respiratory infections	9.4	3	Lower respiratory infections	6.2
4	Drowning	6.3	4	Congenital anomalies	5.7
5	Congenital anomalies	5.6	5	Drowning	4.0
6	Meningitis	2.0	6	Refractive errors	3.8
7	Road traffic injuries	1.9	7	Protein–energy malnutrition	2.6
8	Endocrine disorders	1.5	8	Asthma	2.5
9	Malaria	1.3	9	Falls	2.4
10	Leukaemia	1.1	10	Unipolar depressive disorders	2.3
11	Tetanus	1.0	11	Road traffic injuries	2.0
12	Upper respiratory infections	0.9	12	Meningitis	1.4
13	Measles	0.8	13	Iron-deficiency anaemia	1.3
14	Protein–energy malnutrition	0.7	14	Intestinal nematode infections	1.2
15	Falls	0.7	15	Endocrine disorders	1.2

Boys

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	37.9	1	Perinatal causes	26.7
2	Diarrhoeal diseases	9.8	2	Diarrhoeal diseases	6.6
3	Lower respiratory infections	9.3	3	Lower respiratory infections	6.1
4	Drowning	8.0	4	Congenital anomalies	5.4
5	Congenital anomalies	5.2	5	Drowning	4.9
6	Road traffic injuries	2.4	6	Refractive errors	3.9
7	Meningitis	2.0	7	Protein–energy malnutrition	2.7
8	Endocrine disorders	1.6	8	Falls	2.4
9	Malaria	1.4	9	Asthma	2.3
10	Tetanus	1.3	10	Road traffic injuries	2.3
11	Leukaemia	1.1	11	Unipolar depressive disorders	2.2
12	Upper respiratory infections	0.8	12	Schizophrenia	1.6
13	Falls	0.8	13	Alcohol use disorders	1.5
14	Protein–energy malnutrition	0.8	14	Meningitis	1.4
15	Measles	0.8	15	Iron-deficiency anaemia	1.4

Girls

Rank	Cause of death	Proportion of total (%)	Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	41.0	1	Perinatal causes	29.5
2	Diarrhoeal diseases	10.2	2	Diarrhoeal diseases	7.0
3	Lower respiratory infections	9.5	3	Lower respiratory infections	6.4
4	Congenital anomalies	6.0	4	Congenital anomalies	6.1
5	Drowning	4.7	5	Refractive errors	3.7
6	Meningitis	1.9	6	Drowning	3.0
7	Endocrine disorders	1.5	7	Asthma	2.7
8	Road traffic injuries	1.4	8	Protein–energy malnutrition	2.5
9	Malaria	1.2	9	Unipolar depressive disorders	2.4
10	Leukaemia	1.1	10	Falls	2.4
11	Upper respiratory infections	0.9	11	Road traffic injuries	1.7
12	Measles	0.8	12	Meningitis	1.4
13	Poisoning	0.8	13	Iron-deficiency anaemia	1.3
14	Tetanus	0.7	14	Endocrine disorders	1.3
15	Protein–energy malnutrition	0.7	15	Intestinal nematode infections	1.2

TABLE A.2 *(CONTINUED)*

Western Pacific Region

High-income countries

Rank	Cause of death	Proportion of total (%)
1	Perinatal conditions	28.1
2	Congenital anomalies	23.3
3	Road traffic injuries	6.0
4	Drowning	3.3
5	Leukaemia	2.9
6	Lower respiratory infections	2.9
7	Endocrine disorders	2.3
8	Violence	1.8
9	Inflammatory heart diseases	1.2
10	Self-inflicted injuries	1.1
11	Epilepsy	1.0
12	Falls	1.0
13	Fire-related burns	1.0
14	Cerebrovascular disease	0.8
15	Meningitis	0.5

Rank	Cause of DALYs	Proportion of total (%)
1	Congenital anomalies	13.2
2	Perinatal conditions	10.9
3	Asthma	10.0
4	Unipolar depressive disorders	6.2
5	Schizophrenia	4.6
6	Refractive errors	4.2
7	Migraine	3.8
8	Falls	2.8
9	Road traffic injuries	2.5
10	Endocrine disorders	2.3
11	Dental caries	2.3
12	Diarrhoeal diseases	1.8
13	Iron-deficiency anaemia	1.6
14	Alcohol use disorders	1.4
15	Self-inflicted injuries	1.3

Low-income and middle-income countries

Rank	Cause of death	Proportion of total (%)
1	Perinatal causes	39.6
2	Diarrhoeal diseases	10.2
3	Lower respiratory infections	9.5
4	Drowning	6.4
5	Congenital anomalies	5.4
6	Meningitis	2.0
7	Road traffic injuries	1.9
8	Endocrine disorders	1.5
9	Malaria	1.3
10	Leukaemia	1.1
11	Tetanus	1.0
12	Upper respiratory infections	0.9
13	Measles	0.8
14	Protein–energy malnutrition	0.7
15	Falls	0.7

Rank	Cause of DALYs	Proportion of total (%)
1	Perinatal causes	28.4
2	Diarrhoeal diseases	6.9
3	Lower respiratory infections	6.4
4	Congenital anomalies	5.5
5	Drowning	4.0
6	Refractive errors	3.7
7	Protein–energy malnutrition	2.6
8	Falls	2.3
9	Asthma	2.2
10	Unipolar depressive disorders	2.2
11	Road traffic injuries	2.0
12	Meningitis	1.4
13	Iron-deficiency anaemia	1.3
14	Intestinal nematode infections	1.2
15	Endocrine disorders	1.2

[a] No high-income countries in the region.

DALYs = disability-adjusted life years lost.

Source: WHO (2008), Global Burden of Disease: 2004 update.

TABLE A.3

Unintentional injuries reported by 13–15-year-olds included in the Global School Health Survey

Country	Botswana		Cayman Islands[a]		Chile (Metropolitan)		China (Beijing)		Djibouti	
Year	2005		2007		2004		2003		2007	
Overall response rate	95.0%		79.0%		85.0%		99.0%		83.0%	
Number of schools	25		8		25		25		11	
All students	2197		1299		2111		2348		1777	
Sample	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Students 13–15 yrs	1375	63.4	935	73.3	1766	81.1	1936	81.6	923	52.7
Sex	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Male	581	46.4	474	53.9	812	50.9	922	49.8	535	60.1
Female	788	53.6	457	46.1	951	49.1	1014	50.2	387	39.9
Injuries	**%**	**95% CI**	**%**		**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
Any injury	65.8	62.4–69.1	50.2	–	36.4	33.9–39.0	16.4	14.5–18.4	60.6	56.1–65.0
Unintentional injury	56.0	50.6–61.4	86.0	–	83.6	80.3–86.9	83.6	78.5–88.8	57.3	49.4–65.1
Cause of injury	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Road traffic injury	41	12.3	16	5.8	13	3.5	7	3.1	9	6.9
Fall	114	34.8	79	26.6	208	46.6	84	40.0	64	45.9
Burn	27	7.7	11	3.3	4	1.0	7	3.2	1	0.7
Struck by an object	51	15.2	24	9.1	25	5.9	35	16.4	16	11.3
Other	99	30.0	154	55.1	200	43.1	80	37.2	48	35.2
Total	*332*	*100.0*	*284*	*100.0*	*450*	*100.0*	*213*	*100.0*	*138*	*100.0*
Activity	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Playing a sport	107	32.8	105	37.9	232	52.1	43	20.4	51	40.4
Walking/running	47	14.4	27	8.7	55	12.9	42	19.7	8	6.1
Riding a two-wheeler	70	21.5	75	26.2	41	9.2	29	14.3	18	14.7
Driving motor vehicle	18	5.5	6	2.4	7	1.6	5	2.3	8	6.2
Doing work	40	11.3	11	3.2	12	2.3	12	5.5	3	2.1
Nothing	25	7.2	12	3.8	13	2.7	31	14.3	16	12.5
Something else	22	7.3	52	17.7	90	19.2	51	23.6	22	18.1
Total	*329*	*100.0*	*288*	*100.0*	*450*	*100.0*	*213*	*100.0*	*126*	*100.0*
Nature of injury	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Fracture or dislocation	78	23.7	71	27.8	214	48.3	60	28.4	17	13.5
Penetrating injury	108	33.7	67	23.7	24	5.5	30	14.1	17	12.7
Head injury	33	9.4	17	6.8	29	6.5	6	2.8	29	21.8
Gunshot wound	11	3.4	10	3.7	1	0.3	0	0.0	25	18.7
Burn	45	12.9	19	7.0	6	1.4	3	1.4	6	4.5
Amputation	11	3.3	1	0.3	4	0.8	2	0.9	5	3.7
Other	46	13.6	84	30.7	173	37.2	111	52.4	32	25.1
Total	*332*	*100.0*	*269*	*100.0*	*451*	*100.0*	*212*	*100.0*	*131*	*100.0*

TABLE A.3 *(CONTINUED)*

Country	Egypt		Guatemala (Capital City)		Guyana		Jordan			
Year	2006		2006		2004		2004		2007	
Overall response rate	87.0%		41.0%		80.0%		95.0%		99.8%	
Number of schools	51		19		25		26		25	
All students	5249		898		1212		2457		2197	
Sample	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Students 13–15 yrs	3910	75.4	690	78.2	1052	86.6	1844	74.0	1631	73.9
Sex	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Male	2082	54.1	275	44.8	415	47.0	820	48.4	916	47.5
Female	1795	45.9	412	55.2	626	53.0	1004	51.6	711	52.5
Injuries	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
Any injury	38.5	33.4–43.6	33.0	28.3–37.8	33.3	29.1–37.6	36.1	33.0–39.3	43.5	36.5–50.5
Unintentional injury	83.5	78.9–88.2	72.3	66.2–78.3	68.4	61.9–75.0	80.9	76.8–85.0	77.4	72.0–82.8
Cause of injury	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Road traffic injury	126	28.3	9	8.7	14	8.8	17	4.8	17	4.6
Fall	100	23.7	59	52.0	55	35.7	91	23.6	91	26.9
Burn	8	1.6	0	0.0	3	1.5	7	1.8	7	2.2
Struck by an object	59	14.9	11	7.7	17	12.0	63	16.8	72	22.0
Other	121	31.5	32	31.6	68	42.0	206	52.9	140	40.9
Total	*414*	*100.0*	*111*	*100.0*	*157*	*100.0*	*384*	*100.0*	*327*	*100.0*
Activity	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Playing a sport	203	47.1	72	62.9	27	19.9	101	27.2	105	30.7
Walking/running	108	24.4	11	10.1	27	17.4	59	15.0	42	13.8
Riding a two-wheeler	33	7.9	4	2.3	18	11.7	20	5.3	18	5.2
Driving motor vehicle	15	3.1	3	3.7	6	4.4	14	3.9	9	2.7
Doing work	18	4.7	9	7.3	18	10.6	21	5.9	22	7.6
Nothing	31	8.1	2	0.9	20	11.8	78	19.3	46	15.4
Something else	22	4.7	14	12.9	39	24.2	91	23.4	74	24.5
Total	*430*	*100.0*	*115*	*100.0*	*155*	*100.0*	*384*	*100.0*	*316*	*100.0*
Nature of injury	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Fracture or dislocation	170	36.3	54	46.6	34	22.3	103	27.0	91	28.2
Penetrating injury	146	37.5	0	0.0	48	31.7	73	20.1	56	16.7
Head injury	27	6.9	6	4.5	6	3.7	23	6.1	34	10.7
Gunshot wound	9	2.3	1	1.0	1	0.6	1	0.4	4	1.2
Burn	8	2.0	3	2.4	9	5.7	13	3.3	6	2.1
Amputation	5	1.2	0	0.0	2	1.1	1	0.2	2	0.5
Other	51	13.8	45	45.5	57	35.0	168	43.0	120	40.6
Total	*416*	*100.0*	*109*	*100.0*	*157*	*100.0*	*382*	*100.0*	*313*	*100.0*

TABLE A.3 *(CONTINUED)*

Country	Kenya		Lebanon		Libyan Arab Jamahiriya		Morocco[b]		Namibia[c]	
Year	2003		2005		2007		2006		2004	
Overall response rate	84.0%		88.0%		98.0%		84.0%		82.0%	
Number of schools	50		92		50		25		95	
All students	3691		5115		2242		2670		6367	
Sample	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Students 13–15 yrs	2758	75.1	3754	73.4	1492	69.3	1866	72.8	4251	63.4
Sex	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Male	1280	47.7	1743	48.3	646	51.1	888	53.3	1852	42.7
Female	1462	52.3	2009	51.7	828	48.9	953	46.7	2370	57.3
Injuries	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
Any injury	71.0	66.4–75.6	31.1	29.1–33.1	40.3	36.7–43.9	44.7	40.6–48.8	60.2	55.8–64.6
Unintentional injury	64.1	60.7–67.5	85.8	83.4–88.2	74.2	68.3–80.1	65.7	60.1–71.3	60.0	56.4–63.5
Cause of injury	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Road traffic injury	107	15.5	50	7.0	20	12.3	41	13.8	105	14.0
Fall	231	30.1	204	28.9	28	17.6	135	46.0	237	21.7
Burn	58	7.7	23	3.1	7	3.8	9	2.6	65	8.7
Struck by an object	165	21.7	159	22.8	22	12.4	29	10.4	128	15.0
Other	203	24.9	273	38.2	89	53.9	80	27.1	351	40.5
Total	*764*	*100.0*	*709*	*100.0*	*166*	*100.0*	*294*	*100.0*	*886*	*100.0*
Activity	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**		
Playing a sport	224	30.9	234	33.4	74	47.1	123	44.6		
Walking/running	215	27.8	89	12.5	31	16.4	25	9.1		
Riding a two-wheeler	162	20.3	88	12.4	11	6.3	33	11.3		
Driving motor vehicle	25	3.2	33	4.9	9	4.6	14	5.5		
Doing work	59	7.2	41	5.9	13	6.7	11	4.4		
Nothing	60	7.5	81	11.0	16	7.6	33	12.0		
Something else	23	3.2	144	20.0	22	11.3	38	13.1		
Total	*768*	*100.0*	*710*	*100.0*	*176*	*100.0*	*277*	*100.0*		
Nature of injury	***n***	**%**	***n***	**%**	***n***	**%**			***n***	**%**
Fracture or dislocation	234	30.4	262	37.5	42	24.7			209	21.3
Penetrating injury	290	38.9	166	23.2	50	30.9			176	19.0
Head injury	69	9.5	83	11.7	15	9.9			74	9.5
Gunshot wound	23	3.3	9	1.4	3	1.7			24	2.6
Burn	36	4.5	26	3.6	5	2.6			56	7.6
Amputation	21	3.3	6	0.9	1	0.5			54	6.6
Other	87	10.1	157	21.7	56	29.8			296	33.3
Total	*760*	*100.0*	*709*	*100.0*	*172*	*100.0*			*889*	*100.0*

TABLE A.3 *(CONTINUED)*

Country	Oman		Philippines				Saint Lucia		Saint Vincent and the Grenadines	
Year	2005		2003		2007		2007		2007	
Overall response rate	97.0%		84.0%		81.0%		82.0%		84.0%	
Number of schools	51		148		73		20		26	
All students	2979		7338		5657		1276		1333	
Sample	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Students 13–15 yrs	2280	77.7	4160	69.9	3433	61.1	864	69.4	1029	74.7
Sex	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Male	1109	52.6	1643	40.9	1383	49.4	371	45.3	473	47.5
Female	1146	47.4	2495	59.1	2047	50.6	492	54.7	554	52.5
Injuries	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
Any injury	26.6	22.5–30.7	29.9	26.2–33.6	46.0	43.0–49.0	47.8	43.4–52.3	48.4	41.0–55.7
Unintentional injury	83.2	79.3–87.1	77.9	74.0–81.8	81.9	78.7–85.0	77.9	72.3–83.6	67.7	60.1–75.3
Cause of injury	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Road traffic injury	23	7.4	91	11.7	78	14.1	13	5.7	12	6.5
Fall	109	33.3	128	24.6	136	23.9	100	41.8	79	40.7
Burn	2	0.6	25	4.4	6	1.1	1	0.4	6	3.1
Struck by an object	32	9.8	63	9.3	91	17.7	15	6.6	18	8.5
Other	159	49.0	278	47.4	256	43.3	109	45.6	86	41.3
Total	*325*	*100.0*	*585*	*100.0*	*567*	*100.0*	*238*	*100.0*	*201*	*100.0*
Activity	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Playing a sport	115	36.7	158	28.8	163	30.0	64	28.5	43	21.6
Walking/running	43	13.1	108	17.5	114	19.0	33	13.4	45	24.9
Riding a two-wheeler	16	5.3	49	6.5	68	10.9	30	13.9	23	11.9
Driving motor vehicle	10	3.1	18	2.8	14	2.2	5	1.9	6	2.8
Doing work	14	4.3	90	15.7	81	12.1	19	8.1	26	12.0
Nothing	75	22.9	78	14.5	85	14.2	12	4.7	16	7.9
Something else	48	14.5	71	14.1	69	11.7	72	29.4	37	19.0
Total	*321*	*100.0*	*572*	*100.0*	*594*	*100.0*	*235*	*100.0*	*196*	*100.0*
Nature of injury	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Fracture or dislocation	73	22.8	118	18.9	115	23.1	59	28.1	53	28.5
Penetrating injury	93	29.1	116	20.9	88	19.1	65	26.3	67	33.3
Head injury	14	4.4	66	13.1	65	12.9	11	5.0	5	2.9
Gunshot wound	5	1.6	5	1.0	5	1.4	2	0.8	2	1.4
Burn	14	4.4	13	1.5	2	0.5	9	3.4	11	5.7
Amputation	125	37.4	2	0.4	5	0.8	0	0.0	0	0.0
Other	1	0.3	259	44.3	230	42.2	86	36.4	59	28.1
Total	*325*	*100.0*	*579*	*100.0*	*510*	*100.0*	*232*	*100.0*	*197*	*100.0*

TABLE A.3 *(CONTINUED)*

Country	Swaziland		Tajikistan		Trinidad and Tobago		Uganda		United Republic of Tanzania (Dar es Salaam)	
Year	2003		2006		2007		2003		2006	
Overall response rate	96.0%		80.0%		78.0%		69.0%		87.0%	
Number of schools	97		99		32		45		25	
All students	7341		9714		2969		3215		2176	
Sample	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Students 13–15 yrs	6784	95.4	7395	76.3	2095	69.1	1878	60.5	1217	49.6
Sex	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Male	2341	35.6	3629	54.1	1018	50.1	880	47.6	649	51.4
Female	4240	64.4	3694	45.9	1063	49.9	963	52.4	560	48.6
Injuries	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
Any injury	38.6	36.7–40.4	17.6	14.1–21.1	46.5	43.1–49.8	63.4	58.5–68.4	39.9	36.1–43.7
Unintentional injury	58.4	56.0–60.9	82.0	75.4–88.6	75.4	71.5–79.2	71.6	67.7–75.7	89.6	86.3–92.8
Cause of injury	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Road traffic injury	121	11.6	29	12.6	24	7.6	84	14.0	17	5.2
Fall	366	35.5	117	57.0	173	38.3	227	38.8	133	50.7
Burn	73	6.8	2	0.9	2	0.3	46	7.8	23	8.6
Struck by an object	126	11.7	14	6.5	66	13.9	98	16.7	39	13.4
Other	367	34.4	33	23.0	182	38.9	142	22.7	67	22.1
Total	*1053*	*100.0*	*195*	*100.0*	*447*	*100.0*	*597*	*100.0*	*279*	*100.0*
Activity	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Playing a sport	342	32.6	135	58.6	176	37.4	233	38.5	100	38.9
Walking/running	157	14.7	33	13.4	38	8.3	117	19.4	41	17.9
Riding a two-wheeler	119	11.7	28	19.0	55	12.4	97	17.1	38	13.8
Driving motor vehicle	52	5.2	3	1.1	15	4.1	17	2.6	5	1.5
Doing work	141	13.2	13	4.4	35	5.8	54	9.2	8	3.3
Nothing	93	8.7	4	2.2	21	5.4	41	7.1	46	19.2
Something else	146	13.9	4	1.3	112	26.6	39	6.1	14	5.5
Total	*1050*	*100.0*	*220*	*100.0*	*452*	*100.0*	*598*	*100.0*	*252*	*100.0*
Nature of injury	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Fracture or dislocation	314	30.0	92	47.5	102	24.1	186	30.3	61	23.4
Penetrating injury	310	30.1	39	20.0	124	24.8	238	40.2	60	20.8
Head injury	62	6.0	27	14.4	21	5.0	45	7.7	42	15.5
Gunshot wound	7	0.7	0	0.0	4	0.7	8	1.5	4	2.1
Burn	89	8.8	12	4.9	20	5.7	35	5.7	33	13.9
Amputation	24	2.6	3	2.1	2	0.0	21	3.6	6	3.5
Other	237	21.9	21	11.1	165	39.8	64	11.0	47	20.9
Total	*1043*	*100.0*	*194*	*100.0*	*438*	*100.0*	*597*	*100.0*	*253*	*100.0*

TABLE A.3 *(CONTINUED)*

Country	Uruguay		Zambia		Zimbabwe (Harare)	
Year	2006		2004		2003	
Overall response rate	71.0%		70.0%		84.0%	
Number of schools	95		47		25	
All students	3406		2257		1997	
Sample	***n***	**%**	***n***	**%**	***n***	**%**
Students 13–15 yrs	2372	70.4	1241	58.9	1435	72.8
Sex	***n***	**%**	***n***	**%**	***n***	**%**
Male	1070	45.1	553	51.5	604	47.8
Female	1296	54.9	651	48.5	823	52.2
Injuries	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
Any injury	25.5	23.7–27.3	71.5	65.5–77.4	57.1	49.7–64.5
Unintentional injury	86.3	82.9–89.7	61.7	55.6–67.8	68.6	64.0–73.3
Cause of injury	***n***	**%**	***n***	**%**	***n***	**%**
Road traffic injury	38	10.5	54	26.5	49	12.5
Fall	152	37.3	43	20.2	143	36.6
Burn	3	0.6	18	9.4	33	8.1
Struck by an object	47	11.1	43	21.5	62	14.9
Other	164	40.5	51	22.5	107	27.9
Total	*404*	*100.0*	*209*	*100.0*	*394*	*100.0*
Activity	***n***	**%**	***n***	**%**	***n***	**%**
Playing a sport	223	54.2	79	38.8	123	32.2
Walking/running	26	6.6	40	18.8	68	17.3
Riding a two-wheeler	53	13.7	20	8.7	65	16.4
Driving motor vehicle	22	5.7	6	2.8	15	3.6
Doing work	11	2.9	29	15.2	63	14.8
Nothing	6	1.7	25	11.7	24	6.8
Something else	62	15.2	9	3.9	38	8.9
Total	*403*	*100.0*	*208*	*100.0*	*396*	*100.0*
Nature of injury	***n***	**%**	***n***	**%**	***n***	**%**
Fracture or dislocation	145	36.2	52	23.4	146	38.3
Penetrating injury	29	7.7	40	19.2	90	23.2
Head injury	24	6.2	32	16.7	49	12.4
Gunshot wound	0	0.0	8	4.0	6	1.5
Burn	9	2.1	20	10.5	28	6.6
Amputation	0	0.0	16	6.6	13	3.7
Other	187	47.8	41	19.5	58	14.2
Total	*394*	*100.0*	*209*	*100.0*	*390*	*100.0*

CI = Confidence interval.

[a] No confidence intervals available.

[b] Did not collect information about the nature of injury.

[c] Did not collect information about activity.

Source: WHO Global School Health Survey (http://www.who.int/chp/gshs/en/, accessed 18 July 2008).

TABLE B.1

Child mortality and injury in Asia

All countries surveyed						
	Both sexes (age in years)					
	<1	1–4	5–9	10–14	15–17	Under 18
Percentage (%) distribution of mortality by cause, age group and sex						
Injury	3	33	56	58	57	20
Communicable diseases	39	42	23	20	10	36
Noncommunicable diseases[a]	48	16	13	10	20	34
Undetermined	10	9	8	12	12	10
Injury mortality rate (per 100 000 children) by cause, age group and sex						
Road traffic injuries	10.0	4.3	7.8	10.0	14.3	8.9
Burns	5.5	0.7	0.2	–	–	0.4
Drowning	32.8	65.3	36.9	12.7	6.7	30.1
Falls	11.7	4.9	1.5	2.2	–	2.6
Poisoning	2.3	1.1	2.1	–	–	0.8
Suffocation	33.3	–	3.0	2.0	–	3.2
Other unintentional						10.6
Ratio of injury to death by severity level (frequency per each injury death)						
Missed work, school or sought treatment						34.4
Hospitalization <10 days						7.7
Hospitalization ≥10 days						3.1
Permanent disability						1.2
Death						1
Fatal injury rate (per 100 000 children) for children 0–17 years by survey location						
	Bangladesh	**Beijing, China**	**Jiangxi, China**	**Thailand**	**Philippines**	**Viet Nam**
	49.7	23.0	58.0	39.0	59.4	78.0
Fatal injury rate (per 100 000 children) for children 0–17 years by urban/rural area						
Urban	150.9		65.2	229.4		104.0
Rural	651.9	75.4	194.4	146.6		196.4
Fatal injury rate (per 100 000 children) for children 0–17 years by sex						
Boys	56.0	29.1	75.9	46.6	38.8	99.3
Girls	43.3	16.2	41.9	30.1	20.6	57.2

TABLE B.1 *(CONTINUED)*

Bangladesh												
	Boys (age in years)						Girls (age in years)					
	<1	1–4	5–9	10–14	15–17	Under 18	<1	1–4	5–9	10–14	15–17	Under 18
Percentage (%) distribution of mortality by cause, age group and sex												
Injury	1.5	25.8	42.4	55.6	48.7	12.9	1.5	25.4	37.3	17.1	52.2	11.1
Communicable diseases	43.6	51.5	38.1	17.8	24.2	42.8	41.5	42.9	35.9	32.3	8.3	40.2
Noncommunicable diseases[a]	45.5	11.3	5.3	5.7	11.8	33.5	44.1	21.6	9.5	17.8	9.7	34.9
Undetermined	9.4	11.4	14.2	20.8	15.3	10.8	13.0	10.1	17.4	32.8	29.7	13.8
Injury mortality rate (per 100 000 children) by cause, age group and sex												
All unintentional	94.6	91.7	51.2	32.7	25.9	52.8	82.5	99.0	36.6	5.1	4.5	37.7
Road traffic injuries			4.1	12.2	10.2	6.3		7.4	9.5	2.9		0.3
Burns	17.3	1.8				1.2		0.7	0.5			0.3
Drowning	19.9	89.9	31.2	6.6	2.7	31.8	9.7	83.6	21.9			24.6
Falls	8.4		2.0	4.9		2.4	36.0	3.3		2.2		3.0
Poisoning[b]												
Suffocation	31.6		2.1			2.1	24.0					1.1
Other unintentional	17.3		11.8	9.1	13.0	8.9	12.8	4.0	4.7		4.5	3.5
All intentional				1.4	19.1	3.2		0.8		2.8	31.7	5.6
Total	*94.6*	*91.7*	*51.2*	*34.1*	*45.1*	*56.0*	*82.5*	*99.8*	*36.6*	*7.9*	*36.1*	*43.3*

Severity rate (per 100 000 children) for unintentional injuries in children aged 0–17 years, both sexes						
	Road traffic injuries	Drowning	Burns	Falls	Poisoning[b]	Other unintentional
Missed work, school or sought treatment	147.1	9.3	14.2	38.3		16.0
Hospitalization <10 days	22.6		7.3	12.6		10.2
Hospitalization ≥10 days	13.8		5.2	7.7		6.7
Permanent disability	5.8	104.8	256.4	379.9		388.8
Death		28.3	0.7	2.7		7.8

Beijing, China												
	Boys (age in years)						Girls (age in years)					
	<1	1–4	5–9	10–14	15–17	Under 18	<1	1–4	5–9	10–14	15–17	Under 18
Percentage (%) distribution of mortality by cause, age group and sex												
Injury		100			50.0	66.7					100	25.0
Communicable diseases												
Noncommunicable diseases[a]							50.0			100		50.0
Undetermined					50.0	33.3	50.0					25.0
Injury mortality rate (per 100 000 children) by cause, age group and sex												
All unintentional		88.9			61.3	29.1					69.9	16.2
Road traffic injuries		88.9				14.6					69.9	16.2
Burns[b]												
Drowning					61.3	14.6						
Falls[b]												
Poisoning[b]												
Suffocation[b]												
Other unintentional[b]												
All intentional[b]												
Total		*88.9*			*61.3*	*29.1*					*69.9*	*16.2*

Severity rate (per 100 000 children) for unintentional injuries in children aged 0–17 years, both sexes						
	Road traffic injuries	Drowning	Burns	Falls	Poisoning	Other unintentional
Missed work, school or sought treatment	176.2		99.6	566.7	46.0	850.1
Hospitalization <10 days	30.6		30.6	84.2	7.7	114.9
Hospitalization ≥10 days	53.6		23.0	38.3		15.3
Permanent disability	7.7					7.7
Death	32.6	32.6				

TABLE B.1 *(CONTINUED)*

Jiangxi, China												
	Boys (age in years)						Girls (age in years)					
	<1	1–4	5–9	10–14	15–17	Under 18	<1	1–4	5–9	10–14	15–17	Under 18
Percentage (%) distribution of mortality by cause, age group and sex												
Injury	9.8	79.0	85.7	100	50.0	42.0	5.0	50.0	62.5	100		22.1
Communicable diseases	2.4		7.1		16.7	3.3	1.7	7.1	12.5			3.8
Noncommunicable diseases[a]	86.4	21.1	7.1		33.3	53.9	92.8	21.4	25.0		100	69.7
Undetermined	1.5					0.8	0.6	21.4				4.4
Injury mortality rate (per 100 000 children) by cause, age group and sex												
All unintentional	169.3	114.8	76.1	45.1	25.5	74.7	115.6	77.4	40.5	7.6		35.9
Road traffic injuries		7.7	19.0	19.3	12.7	14.4		22.1				4.7
Burns	10.6					0.6	14.5					0.7
Drowning	21.2	99.5	50.7	19.3	12.7	46.4	14.5	55.3	32.4			21.6
Falls	10.6	7.7	6.3			4.2	14.5		8.1	7.6		5.4
Poisoning	21.2					1.2						
Suffocation	105.8					6.0	72.3					3.5
Other unintentional				6.4								
All intentional					12.7	1.8				7.6		2.3
Total	*169.3*	*114.8*	*76.1*	*45.1*	*38.2*	*76.5*	*115.6*	*77.4*	*40.5*	*15.3*		*38.2*

Severity rate (per 100 000 children) for unintentional injuries in children aged 0–17 years, both sexes						
	Road traffic injuries	Drowning	Burns	Falls	Poisoning	Other unintentional
Missed work, school or sought treatment	561.3	21.4	289.8	244.5	7.8	314.4
Hospitalization <10 days	103.7	4.1	27.5	123.4		62.0
Hospitalization ≥10 days	58.0	1.0	20.3	16.8		5.3
Permanent disability	17.3		2.0	2.4		2.3
Death	10.2	35.4	0.6	0.5		4.7

Thailand												
	Boys (age in years)						Girls (age in years)					
	<1	1–4	5–9	10–14	15–17	Under 18	<1	1–4	5–9	10–14	15–17	Under 18
Percentage (%) distribution of mortality by cause, age group and sex												
Injury		61.2	47.3	84.3	88.1	27.3	4.2	41.6	64.5	65.2	55.0	16.7
Communicable diseases	36.3	25.1	21.3	1.0	8.0	28.1	38.8	51.8	36.5	18.3	10.8	37.9
Noncommunicable diseases[a]	64.7	10.0	25.0	12.2	2.7	43.3	57.1	6.6		16.5	7.4	44.7
Undetermined		3.8	6.4	2.5	1.3	1.4					26.8	0.7
Injury mortality rate (per 100 000 children) by cause, age group and sex												
All unintentional		55.5	30.4	25.8	114.6	45.7	91.2	35.2	29.9	22.4	10.7	29.2
Road traffic injuries			2.6	19.2	114.6	24.2			15.1	5.4	10.7	7.4
Burns									2.0			0.5
Drowning		55.5	24.0	1.0		18.8		24.0	12.7	17.0		13.4
Falls			1.9	1.7		1.0						
Poisoning												
Suffocation							91.2					5.6
Other unintentional			1.9	3.9		1.7		11.2				2.3
All intentional					12.4	1.9					5.1	0.9
Total		*55.5*	*30.4*	*25.8*	*127.0*	*47.6*	*91.2*	*35.2*	*29.9*	*22.4*	*15.8*	*30.1*

Severity rate (per 100 000 children) for unintentional injuries in children aged 0–17 years, both sexes						
	Road traffic injuries	Drowning	Burns	Falls	Poisoning	Other unintentional
Missed work, school or sought treatment	212.1	11.4	66.8	244.5	7.8	314.4
Hospitalization <10 days	160.5	5.6	6.6	123.4		62.0
Hospitalization ≥10 days	66.9	1.3	4.0	16.8		5.3
Permanent disability	4.3			2.4		2.3
Death	15.6	16.1	0.3	0.5		4.7

TABLE B.1 *(CONTINUED)*

Philippines

	Both sexes (age in years)[c]					
	<1	**1–4**	**5–9**	**10–14**	**15–17**	**Under 18**
Percentage (%) distribution of mortality by cause and age group						
Injury	8.1	16.7	19.9	24.9	25.6	13.5
Communicable diseases	41.9	52.6	46.9	19.7	25.4	39.1
Noncommunicable diseases[a]	13.4	11.7	11.9	23.3	21.5	16.4
Undetermined	29.7	5.7	6.4	6.9	7.9	19.8

Injury mortality rate (per 100 000 children) by cause, age group and sex

	Boys (age in years)						Girls (age in years)					
	<1	**1–4**	**5–9**	**10–14**	**15–17**	**Under 18**	**<1**	**1–4**	**5–9**	**10–14**	**15–17**	**Under 18**
All unintentional	227.4	74.7	33.8	40.3	35.2	57.2	250.8	81.5	11.4	30.5	20.7	49.5
Road traffic injuries		6.8	23.6	15.1	13.2	15.3			5.7			
Burns	41.4					2.4		9.1			6.9	5.5
Drowning		27.2		10.1	4.4	7.1		27.2		12.2	6.9	12.4
Falls		6.8	3.4	5.1		3.5						
Poisoning		6.8			4.4	2.4						
Suffocation	165.4					9.4	188.1			6.1		9.2
Other unintentional		27.2	6.8	5.1	17.6	17.2	62.7	45.3	5.7	12.2	6.9	32.4
All intentional	20.7	20.4		5.1	4.4	8.2					6.9	1.8
Total	*248.1*	*95.1*	*33.8*	*45.4*	*39.6*	*65.4*	*250.8*	*81.5*	*11.4*	*30.5*	*27.5*	*51.3*

Severity rate (per 100 000 children) for unintentional injuries in children aged 0–17 years, both sexes

	Road traffic injuries	**Drowning**	**Burns**	**Falls**	**Poisoning**	**Other unintentional**
Missed work, school or sought treatment	216.8	12.8	438.8	210.9	26.4	
Hospitalization <10 days	98.6	6.3	368.2	92.3	26.9	
Hospitalization ≥10 days	39.4	6.8	23.2	52.7		
Permanent disability	72.2		52.3	65.9		
Death	9.4	9.4	3.6	2.2	1.5	33.3

Viet Nam

	Boys (age in years)						Girls (age in years)					
	<1	**1–4**	**5–9**	**10–14**	**15–17**	**Under 18**	**<1**	**1–4**	**5–9**	**10–14**	**15–17**	**Under 18**
Percentage (%) distribution of mortality by cause, age group and sex												
Injury	67.6	44.2	54.7	50.4	69.1	56.2		44.6	78.1	100		56.1
Communicable diseases	24.7	29.5		19.9		13.2						
Noncommunicable diseases[a]			30.3	10.5	30.9	16.5	40.9				100	13.7
Undetermined	7.7	25.9	14.9	19.2		14.2	59.1	55.4	21.9			30.2
Injury mortality rate (per 100 000 children) by cause, age group and sex												
All unintentional	375.1	52.8	93.1	90.9	100.2	98.7		36.4	130.9	47.4		56.9
Road traffic injuries	94.5			11.7	12.5	10.2			17.6	16.0		10.0
Burns										19.1		
Drowning	220.1	42.4	71.3	49.3	30.1	57.3			71.6			25.6
Falls								36.4				6.1
Poisoning		10.4				1.8			19.3			5.2
Suffocation			21.8	15.8		10.9						
Other unintentional	60.5			14.1	57.6	18.6			22.4	12.3		10.1
All intentional[b]												
Total	*375.1*	*52.8*	*93.1*	*90.9*	*100.2*	*98.7*		*36.4*	*130.9*	*47.4*		*56.9*

Severity rate (per 100 000 children) for unintentional injuries in children aged 0–17 years, both sexes

	Road traffic injuries	**Drowning**	**Burns**	**Falls**	**Poisoning**	**Other unintentional**
Missed work, school or sought treatment	236.0	9.6	77.6	470.2	28.3	645.6
Hospitalization <10 days	184.5	8.6	29.5	334.8	47.7	167.6
Hospitalization ≥10 days	80.4		18.5	130.8	9.5	41.0
Permanent disability	23.7		6.4	58.2		68.1
Death	10.1	41.9		3.0	3.5	20.1

[a] Includes congenital causes of death, perinatal causes and other causes related to the pregnancy and birth process.
[b] None recorded.
[c] Not disaggregated by sex.

Source: UNICEF/TASC injury surveys in six Asian locations, 2008.

TABLE C.1

Unintentional injuries among children[a] presenting to emergency departments in four low-income countries,[b] 2007

		Road traffic injuries (*n*=350)		Drowning (*n*=20)		Burns (*n*=210)	
		n	%	*n*	%	*n*	%
Sex	Boys	247	70.6	11	55.0	111	52.9
	Girls	103	29.4	9	45.0	99	47.1
Age	0–12 months	2	0.6	1	5.0	8	3.8
	1–4 years	76	21.7	8	40.0	110	52.4
	≥5 years	272	77.7	11	55.0	92	43.8
Time of injury	Morning (06:01–12:00)	128	36.6	6	30.0	80	38.1
	Lunchtime (12:01–14:30)	71	20.3	4	20.0	40	19.0
	Afternoon (14:31–17:00)	39	11.1	0	0	39	18.6
	Evening (17:01–20:00)	53	15.1	4	20.0	26	12.4
	Night (20:01–06:00)	59	16.9	6	30.0	25	11.9
Mode of transport to hospital	Private car	86	24.6	11	55.0	44	21.0
	Public ambulance	59	16.9	0	0	14	6.7
	Private ambulance	48	13.7	1	5.0	19	9.0
	Motorcycle	17	4.9	1	5.0	1	0.5
	Bicycle	3	0.9	0	0	1	0.5
	Walking	31	8.9	2	10.0	18	8.6
	Taxi	80	22.9	5	25.0	109	51.9
	Other	26	7.4	0	0	4	1.9
Who brought child to hospital?	Mother	111	31.7	6	30.0	78	37.1
	Father	159	45.4	9	45.0	108	51.4
	Other family member	51	14.6	5	25.0	22	10.5
	Friend	5	1.4	0	0	2	1.0
	Teacher	2	0.6	0	0	0	0
	Other	22	6.3	0	0	0	0
Activity at time of injury	Sports	11	3.1	0	0	1	0.5
	Leisure/play	104	29.7	17	85.0	145	69.0
	Travelling	156	44.6	0	0	1	0.5
	Work (paid and unpaid)	19	5.4	0	0	15	7.1
	Educational activity	19	5.4	0	0	2	1.0
	Daily living	26	7.4	1	5.0	22	10.5
	Other/unknown/refused to answer	15	4.3	2	10.0	24	11.4
Where did injury occur?	Home (inside)	5	1.4	4	20.0	142	67.6
	Home (outside)	57	16.3	7	35.0	19	9.0
	Road/street/highway	249	71.1	2	10.0	2	1.0
	Countryside/farm/marketplace	2	0.6	1	5.0	1	0.5
	Other public building	2	0.6	6	30.0	44	21.0
	School/sports/play area	3	0.9	0	0	2	1.0
	Other/unknown	5	1.4	4	20.0	142	67.6
Nature of most severe injury	Concussion	80	26.0	3	15.0	1	0.5
	Cut/bite/open wound	78	25.3	7	35.0	0	0
	Fracture	65	21.1	1	5.0	0	0
	Sprain	33	10.7	1	5.0	0	0
	Bruise	42	13.6	3	15.0	2	1.0
	Burn	2	0.6	1	5.0	191	96.0
	Organ system	3	1.0	4	20.0	1	0.5
	Other/unknown	5	1.6	0	0	4	2.0
Outcome after injury	Treated and discharged home	173	55.1	11	55.0	41	19.7
	Admitted to a ward/intensive care unit/burn unit	100	31.8	4	20.0	164	78.8
	Admitted for emergency surgery	20	6.4	0	0	0	0
	Died in emergency room	2	0.6	2	10.0	0	0
	Referred to another centre	9	2.9	3	15.0	2	1.0
	Left before treatment completed	3	1.0	0	0	1	0.5
	Other/unknown	7	2.2	0	0	0	0
Estimated long-term effect of injury	No significant disability	119	34.0	13	65.0	108	51.4
	Short-term temporary disability (<6 weeks)	135	38.6	4	20.0	51	24.3
	Long-term temporary disability (≥6 weeks)	52	14.9	1	5.0	35	16.7
	Permanent disability	8	2.3	2	10.0	16	7.6

TABLE C.1 *(CONTINUED)*

		Falls (*n*=913)		Poisoning (*n*=66)		Total (*n*=1559)	
		n	***%***	***n***	***%***	***n***	***%***
Sex	Boys	598	65.5	43	65.2	1010	64.8
	Girls	315	34.5	23	34.8	549	35.2
Age	0–12 months	20	2.2	1	1.5	32	2.1
	1–4 years	355	38.9	37	56.1	586	37.6
	≥5 years	538	58.9	28	42.4	941	60.4
Time of injury	Morning (06:01–12:00)	294	32.2	27	40.9	535	34.3
	Lunchtime (12:01–14:30)	203	22.2	13	19.7	331	21.2
	Afternoon (14:31–17:00)	136	14.9	9	13.6	223	14.3
	Evening (17:01–20:00)	112	12.3	7	10.6	202	13.0
	Night (20:01–06:00)	168	18.4	10	15.2	268	17.2
Mode of transport to hospital	Private car	263	28.8	27	40.9	431	27.6
	Public ambulance	77	8.4	6	9.1	156	10.0
	Private ambulance	33	3.6	3	4.5	104	6.7
	Motorcycle	26	2.8	4	6.1	49	3.1
	Bicycle	3	0.3	0	0	7	0.4
	Walking	123	13.5	7	10.6	181	11.6
	Taxi	303	33.2	10	15.2	507	32.5
	Other	85	9.3	9	13.6	124	8.0
Who brought child to hospital?	Mother	376	41.2	35	53.0	606	38.9
	Father	412	45.1	25	37.9	713	45.7
	Other family member	92	10.1	6	9.1	176	11.3
	Friend	9	1.0	0	0	16	1.0
	Teacher	12	1.3	0	0	14	0.9
	Other	12	1.3	0	0	34	2.2
Activity at time of injury	Sports	42	4.6	2	3.0	56	3.6
	Leisure/play	684	74.9	36	54.5	986	63.2
	Travelling	16	1.8	1	1.5	174	11.2
	Work (paid or unpaid)	37	4.1	1	1.5	72	4.6
	Educational activity	23	2.5	1	1.5	45	2.9
	Daily living	80	8.8	18	27.3	147	9.4
	Other/unknown/refused to answer	31	3.4	7	10.6	79	5.1
Where did injury occur?	Home (inside)	351	38.4	41	62.1	543	34.8
	Home (outside)	237	26.0	9	13.6	329	21.1
	Road/street/highway	44	4.8	1	1.5	328	21.0
	Countryside/farm/marketplace	9	1.0	0	0	12	0.8
	Other public building	157	17.2	13	19.7	222	14.2
	School/sports/play area	96	10.5	2	3.0	103	6.6
	Other/unknown	19	2.1	0	0	21	1.3
Nature of most severe injury	Concussion	134	17.0	0	0	218	16.0
	Cut/bite/open wound	200	25.3	1	2.1	286	21.0
	Fracture	195	24.7	1	2.1	262	19.2
	Sprain	93	11.8	1	2.1	128	9.4
	Bruise	152	19.2	0	0	199	14.6
	Burn	4	0.5	6	12.8	204	15.0
	Organ system	1	0.1	27	57.4	36	2.6
	Other/unknown	11	1.4	11	23.4	31	2.3
Outcome after injury	Treated and discharged home	717	79.0	52	78.8	994	65.6
	Admitted to a ward/intensive care unit/burn unit	136	15.0	10	15.2	414	27.3
	Admitted for emergency surgery	15	1.7	1	1.5	36	2.4
	Died in emergency room	2	0.2	0	0	6	0.4
	Referred to another centre	14	1.5	1	1.5	29	1.9
	Left before treatment completed	4	0.4	2	3.0	10	0.7
	Other/unknown	20	2.2	0	0	27	1.8
Estimated long-term effect of injury	No significant disability	483	53.0	53	80.3	776	51.0
	Short-term temporary disability (<6 weeks)	354	38.8	8	12.1	552	36.3
	Long-term temporary disability (≥6 weeks)	70	7.7	5	7.6	163	10.7
	Permanent disability	5	0.5	0	0	31	2.0

[a] Children aged under 12 years.
[b] Bangladesh, Colombia, Egypt and Pakistan.

Source: Global Childhood Unintentional Injury Surveillance pilot study.

TABLE D.1

WHO regions and countries (in 2004)

African Region	Region of the Americas	South-East Asia Region	European Region	Eastern Mediterranean Region	Western Pacific Region
46 Member States	**35 Member States**	**11 Member States**	**51 Member States**	**22 Member States**	**27 Member States**
Low-income and middle-income	**High-income**	**Low-income and middle-income**	**High-income**	**High-income**	**High-income**
Algeria	Antigua and Barbuda	Bangladesh	Andorra	Bahrain	Australia
Angola	Bahamas	Bhutan	Austria	Cyprus	Brunei Darussalam
Benin	Barbados	Democratic People's Republic of Korea	Belgium	Kuwait	Japan
Botswana	Canada	India	Denmark	Qatar	New Zealand
Burkina Faso	United States of America	Indonesia	Finland	United Arab Emirates	Republic of Korea
Burundi	**Low-income and middle-income**	Maldives	France	**Low-income and middle-income**	Singapore
Cameroon	Argentina	Myanmar	Germany	Afghanistan	**Low-income and middle-income**
Cape Verde	Belize	Nepal	Greece	Djibouti	Cambodia
Central African Republic	Bolivia	Sri Lanka	Iceland	Egypt	China
Chad	Brazil	Thailand	Ireland	Iraq	Cook Islands
Comoros	Chile	Timor-Leste	Israel	Islamic Republic of Iran	Federated States of Micronesia
Congo	Colombia		Italy	Jordan	Fiji
Côte d'Ivoire	Costa Rica		Luxembourg	Lebanon	Kiribati
Democratic Republic of the Congo	Cuba		Malta	Libyan Arab Jamahiriya	Lao People's Democratic Republic
Equatorial Guinea	Dominica		Monaco	Morocco	Malaysia
Eritrea	Dominican Republic		Netherlands	Oman	Marshall Islands
Ethiopia	Ecuador		Norway	Pakistan	Mongolia
Gabon	El Salvador		Portugal	Saudi Arabia	Nauru
Gambia	Grenada		San Marino	Somalia	Niue
Ghana	Guatemala		Slovenia	Sudan	Palau
Guinea	Guyana		Spain	Syrian Arab Republic	Papua New Guinea
Guinea-Bissau	Haiti		Sweden	Tunisia	Philippines
Kenya	Honduras		Switzerland	Yemen	Samoa
Lesotho	Jamaica		United Kingdom		Solomon Islands
Liberia	Mexico		**Low-income and middle-income**		Tonga
Madagascar	Nicaragua		Albania		Tuvalu
Malawi	Panama		Armenia		Vanuatu
Mali	Paraguay		Azerbaijan		Viet Nam
Mauritania	Peru		Belarus		
Mauritius	Saint Kitts and Nevis		Bosnia and Herzegovina		
Mozambique	Saint Lucia		Bulgaria		
Namibia	Saint Vincent and the Grenadines		Croatia		
Niger	Suriname		Czech Republic		
Nigeria	Trinidad and Tobago		Estonia		
Rwanda	Uruguay		Georgia		
Sao Tome and Principe	Venezuela		Hungary		
Senegal			Kazakhstan		
Seychelles			Kyrgyzstan		
Sierra Leone			Latvia		
South Africa			Lithuania		
Swaziland			Moldova		
Togo			Poland		
Uganda			Romania		
United Republic of Tanzania			Russian Federation		
Zambia			Serbia and Montenegro		
Zimbabwe			Slovakia		
			Tajikistan		
			The former Yugoslav Republic of Macedonia		
			Turkey		
			Turkmenistan		
			Ukraine		
			Uzbekistan		

Index

Keeping children safe is a universal priority. Yet each year millions of children are affected by unintentional injuries, which can result in disability, hospitalization, and even death. CDC's Injury Center is committed to raising awareness about what research shows – that there are steps governments, organizations, communities, and individuals can take to reduce the enormous burden of childhood injury. By keeping our children safe and secure, we can help them live to their fullest potential.

— Ileana Arias, Director, National Center for Injury Prevention and Control, US Centers for Disease Control and Prevention

We have long known that injury is not well counted outside high-income countries with their well-developed death registration and certification systems. This report makes it clear that we need to count these events better, as they are the leading cause of child death after infancy and equally important, we need to work to prevent them with the same intensity and commitment as other causes of child death and disability.

— "Pete" Petersen, Co-Founder, The Alliance for Safe Children

The World Report on Child Injury Prevention highlights the urgent need to address gaps in our knowledge base to understand, control, and prevent child and adolescent injuries. Research that examines ways to decrease exposure, mitigate risks, and promote safer interventions is needed worldwide, and especially in low- and middle-income countries. Paediatric injury research is a global imperative and we hope that this report will inspire a new era of support, capacity development and utilization of research findings.

— Adnan Hyder, President, International Society for Child and Adolescent Injury Prevention

The European Child Safety Alliance fully supports the recommendations of the World Report on Child Injury Prevention, as Europe is a region that has some of the world's highest and lowest child injury rates. This report reflects the goals that the Alliance, as a growing network of 32 countries, is striving to achieve through joint work to advocate for the adoption, implementation and evaluation of proven good practices in child injury prevention in the European setting. It is hoped that the work in Europe will also support efforts in other parts of the world.

— Joanne Vincenten, Director, European Child Safety Alliance

Childhood injury is one of the greatest challenges in present and future global health care, particularly in Africa; this timely publication of the World Report on Child Injury Prevention makes a significant contribution to promoting child safety and mitigating child trauma.

— Sebastian van As, President, Childsafe South Africa

The WHO World Report on Child Injury Prevention provides a call to action to prevent injury to children worldwide. The solutions are low cost and require simple technology. We must act now to eliminate death to children from preventable injury in all nations. Safe Kids Worldwide is committed to this global initiative to save the lives of children.

— Martin Eichelberger, Founder and Director, Safe Kids Worldwide

IMPLEMENTING PROVEN CHILD INJURY prevention interventions could save more than a thousand children's lives a day.

— Dr Margaret Chan,
Director-General, WHO
and Mrs Ann Veneman,
Executive Director, UNICEF

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