

Review article

The problem of children's injuries in low-income countries: a review

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Unintentional injuries are the cause of death and disability for millions of children every year in low-income countries. Challenging living conditions, heavy traffic, a lack of safe play space and an absence of child care options, together with a disproportionate vulnerability to injury, combine to put children at high risk. Inaccessible and unaffordable emergency services add to the number of resulting deaths and impairments. Yet this major public health problem receives relatively little attention. Because communicable disease and nutritional problems continue to rank higher as causes of child mortality and morbidity in most of the developing world, injury is perceived as a less serious problem. Existing research is scanty and is largely limited to hospital-based studies, which cannot present a comprehensive picture of either causes or outcomes. Development of preventive measures is hampered not only by limited health budgets, but by a tendency (not unique to low-income countries) to see injuries as random events, and hence as unpredictable and uncontrollable. There is an urgent need for more research that can contribute to effective analyses of the situation, and especially for locally-based research and record keeping, which is most likely to contribute to awareness and to practical and well-targeted prevention measures.

Key words: children, injury, developing countries, review, causes, prevention measures

Introduction

Extraordinary numbers of children around the world are killed or disabled every year as a result of preventable injuries that occur within their homes and neighbourhoods. In countries where other health problems are well controlled, unintentional injury ranks as the leading cause of death for children, accounting for almost 40% of all deaths in the age group from 1 to 14 years. In countries where communicable disease and nutritional problems still kill many children, the percentage of injury-related deaths is lower, and as a result the problem is generally regarded as less significant. This does not mean that the number of injuries per capita is lower in these countries. In fact, it is considerably higher, especially in the poorest communities. Open fires and exposed kerosene heaters, unprotected stairways and heights, flimsy construction, lack of safe storage for chemicals and poisons, piles of debris, heavy traffic and a scarcity of safe play space all expose children to high levels of risk. The lack of accessible, affordable emergency health services increases the number of deaths and long-term impairments.

This review of the literature on children's injuries in the developing world will look at research and reports on the distribution and extent of child injuries, their causes and the status of preventive measures. Literature on conditions and trends in high-income countries will be considered where it

contributes to an understanding of the situation in Asia, Africa and Latin America.

Global assessments of the problem

Injuries have historically been neglected as a public health issue. Some observers argue that this is due in large part to a pervasive view of injuries as random events (Tursz 1986; Zwi et al. 1996; Meyer 1998; Krug et al. 2000). As Tursz points out, the very word 'accident' embodies the idea of chance and inevitability, and contributes to a fatalistic tendency to accept unintentional injuries as an unavoidable evil.

Even in the world's high-income countries, injuries have only lately begun to receive focused attention as a public health problem. As recently as 1986, Romer and Manciaux described injury prevention as 'the poor relation' in the field of public health, pointing out as an illustration that although injuries were the most costly health burden in the USA, only 2% of the research budget of the National Institutes of Health (NIH) was devoted to this problem (Romer and Manciaux 1986). The situation has improved in recent decades; the proportion of NIH funding allocated to injuries, for instance, has doubled since 1986 (Gross et al. 1999), and in most of the world's higher income countries, an organized response has resulted in a marked decline in injury rates. Recent figures from UNICEF, drawn from 1999 World Health Organization

(WHO) data, indicate that child injury deaths in the 29 member countries of the Organization for Economic Cooperation and Development (OECD) dropped by 50% between 1970 and 1995 (UNICEF 2001).

This trend does not hold true for the rest of the world. Instead, it is generally acknowledged that the problem of injury is growing rapidly in poorer countries, not only in relative terms in response to the epidemiological transition away from infectious disease, but in absolute terms (Forjuoh and Gyebi-Ofusu 1993; Sharma et al. 1993; Zwi et al. 1996; Meyer 1998; Deen et al. 1999; Guastello 1999; Krug et al. 2000). This recognition may be due in part to improved reporting, but there is also no doubt that changes in the level of road traffic, increasing numbers of people living in crowded and unsafe urban settlements, and the availability on the open market of a range of products and drugs without restrictions, have contributed to injury rates far higher than those recorded in the world's rich nations.

In 1986, the *World Health Statistics Quarterly* published a special issue on accidents in children and young people, which included for the first time mortality and morbidity data from a number of developing countries (Manciaux and Romer 1986). Analysis of this information revealed alarmingly high injury rates, and highlighted the urgent need for preventive measures. Recent UNICEF estimates, based on 1998 global data from the WHO, indicate that 98% of all child deaths by injury occur in low- and middle-income countries, and that the rate of these deaths is five times higher than among higher income nations (specifically among the OECD countries, which produce most of the world's goods and services) (UNICEF 2001).

UNICEF acknowledges that these child deaths are only the tip of the iceberg. For every death, there are thousands of non-fatal injuries, and many result in serious impairment. Figures from the Global Burden of Disease Study (GBDS), based on 1990 data, make it possible to estimate the combined weight of death and disability through the use of disability adjusted life years (DALYs) (Murray and Lopez 1996). This unit of measurement, which takes into account both years of life lost (YLLs) and the estimated equivalent of years lost due to disability (YLDs), provides a basis for comparison of the burden represented by various health problems in different parts of the world, and allows for the analysis of injury as it compares with other problems. The study organizes data by age group, and includes categories for children of 0–4 and 5–14 years. Adolescents are unfortunately not considered as a distinct group, but are included in the 15–29 years category.

According to the GBDS 1990 figures, injury-related DALYs for children from 0–4 years made up 6.4% of their total burden of death and disease. This percentage rises dramatically for older children who are less vulnerable to disease: in the 5–14 years age group, injuries accounted for 30% of their burden of disease. Injury-related DALYs for all children under 15 years living outside the established market economies accounted for 98.3% of the burden of unintentional child injury worldwide. The estimated

distribution of the injury-related burden of death and disability combined, then, is roughly similar to the distribution of child injury deaths alone.

Although the GBDS offers a valuable indication of the scale and impact of the problem of injuries worldwide (Zwi 1996; Meyer 1998), it has been argued that for low-income countries this information is of highly questionable reliability, based as it is on estimates and extrapolations (Mohan 1997). This is especially the case for non-fatal injuries, many of which are never reported (Bangdiwala et al. 1990). While it is clear, then, that the rate and burden of unintentional child injuries is far higher in low-income countries, insufficient and unreliable data continue to limit our understanding of the magnitude of the problem. In many countries the actual numbers of children affected may be significantly underestimated, along with the extent of the burden imposed by their injuries.

Children's relative vulnerability to injury

Although young adults experience far higher rates of intentional injuries, children are disproportionately burdened by unintentional injuries. WHO figures for 1998, listing the 15 most common causes of death and disability, indicate that deaths per capita from unintentional injuries are slightly higher for children under 14 than for the 15–44 years age group, and that the burden of non-fatal injuries is more than twice as high, in part because children have more years ahead of them to be affected by disability (Krug et al. 2000). Injury-related DALYs in 1990 for children aged 0–14 years accounted for 49% of all injury-related DALYs, although children in this age group make up only about 30% of the population. By contrast, the 15–44 years age group, which makes up about 47% of the population, accounts for not quite 42% of injury-related DALYs. Children between 0–4 years experienced the highest relative burden of injury (Murray and Lopez 1996) (see Table 1).

A number of factors contribute to children's susceptibility to injury. Especially in young children, curiosity and the drive to explore and experiment are not matched by the capacity to understand or respond to danger (Matheny 1988; Jordán and Valdes-Lazo 1991). Constant supervision is necessary in hazardous environments, and this can be difficult when caregivers are overburdened and torn between conflicting responsibilities. Many young children are left unsupervised or are tended by siblings only a few years older, who may not yet

Table 1. Percentage of total injury-related DALYs experienced by children and young adults

Age group (years)	% of total injury-related DALYs	% of total population
0–4	22	10
5–14	27	20
0–14	49	30
15–44	42	47

have the foresight or concentration to keep them out of trouble. A study of child rearing practices in a Namibian community found that 33% of accidents occurred when young children were unattended (Zimba and Otaala 1991); research from Jordan confirms that many injuries occur while children are being cared for by siblings (Janson et al. 1994).

Even when children appear to understand the danger of a situation, this does not necessarily equip them to respond appropriately. The ability to interpret how fast a vehicle is moving, for instance, or to locate the sound of an approaching car, is limited before the age of six or seven, regardless of training (Pfeffer and Barnecutt 1996). Children may be still older before they can absorb and analyze a lot of information at once in a complex environment (Ljungblom and Köhler 1991). Even when they are developmentally mature enough to understand and respond appropriately to danger, the drive to play can override the need for caution. Among older children and adolescents, this can be complicated by a tendency to be drawn to risk-taking. As children grow older and their capacity to deal with risk increases, so too does their range of action, the complexity of their environment and the number of risk factors that they face; injury rates, therefore, do not decrease with age, but the kinds of injuries tend to be different for children of different ages (Jordán and Valdes-Lazo 1991).

A number of observers have suggested that susceptibility to injury is a function not only of developmental factors, but of individual behaviour and personality traits such as impulsiveness, hyperactivity or aggression that make a child more 'accident-prone' (Iltus 1994). A review of 17 studies examining this hypothesis suggests, however, that such factors make a minor contribution to injuries in comparison with environmental and social risk factors (Wazana 1997).

Boys account for the greater number of injuries in almost all studies where figures are disaggregated by sex (for instance, Matheny 1988; Reichenheim and Harpham 1989; Manciaux and Romer 1991; Odelowo 1992; Soori and Naghavi 1998). Studies in Cuba, Jordan, Ghana and the United Arab Emirates, for example, showed approximately two-thirds of child injury victims to be boys (Jordán and Valdes-Lazo 1991; Janson et al. 1994; Bener et al. 1997; Abantanga and Mock 1998). Global figures are compatible with these findings: boys aged 5 to 14 years in low- and middle-income countries are more than twice as likely to drown, more than twice as likely to be injured in falls, and about 80% more likely to be killed or injured in road traffic accidents than is true for girls (Krug et al. 2000). This gap has been attributed to behavioural differences (Bener et al. 1997), but it is likely that it is as much a function of the greater freedom afforded to boys, with the greater exposure to risk that this implies (Hart 1979; Ruangkanhasetr 1989). When adjustment is made for the actual *time* spent on bicycles, for instance, boys and girls have been found to have similar injury rates (Berger and Mohan 1996). Global figures also indicate that girls have a far greater likelihood of being killed or injured as a result of burns (Krug et al. 2000); this is most likely a reflection of the extra time that girls are expected to spend indoors, often with responsibility for cooking.

There is repeated evidence that children in poverty are disproportionately affected by injuries (Berger and Mohan 1996; Roberts and Power 1996; Bener et al. 1997; Reading et al. 1999; Butchart et al. 2000; Laflamme and Diderichsen 2000). Not only are their physical environments more likely to be hazardous, but their families are more vulnerable to the high levels of psychosocial stress which frequently accompany childhood injuries. Financial difficulties, challenging living conditions and health problems have all been found to contribute to adult preoccupation and lower levels of supervision (Berger and Mohan 1996). A study in the USA, however, provides reason to be cautious about such generalizations, and suggests that the outcome of such pressures can be mediated by culture. A comparison of injury patterns among the children of low-income Mexican, Mexican-American and non-Hispanic white families found that although the Mexican families were poorer, less educated, and lived in more hazardous and crowded conditions than the other groups, their children benefited from strong family ties, lower levels of adult dysfunction and child aggression, and an expectation that older children would watch over their younger siblings (Mull et al. 2001).

Some studies suggest that children from larger families are at higher risk of injury (Janson et al. 1994; Bang et al. 1997; Ahmed et al. 1999). This is probably due to the higher level of activity in a busy household, since risk factors increase with increasing complexity in the environment. Similarly, some researchers have reported a higher occurrence of injuries during the late afternoon and early evening, a particularly busy time in homes and neighbourhoods as children are out of school, workers are returning home and households become more chaotic around meal preparation (Ruangkanhasetr et al. 1991; Doumi et al. 1994; Janson et al. 1994; Bass et al. 1995). By contrast, a Bangladesh study found that more children were drowned during the morning hours, when mothers and other relatives were more likely to be involved in chores that separated them from children (Ahmed et al. 1999).

While there are few figures available, anecdotal evidence suggests that accidents are especially common among working children in the developing world. Children frequently perform work too demanding for their size and strength, or are required to use tools and equipment designed for adults. In some cases, they are exposed to unprotected machinery and hazardous conditions that they are ill equipped, developmentally, to deal with appropriately. This, combined with the loss of concentration resulting from fatigue, can mean high injury rates (Taket 1986; Blanc 1994; Boyden et al. 1998). An ILO survey in the Philippines found that more than 60% of working children were exposed to hazards in their work, and that, of these, over 40% had suffered serious injury (ILO 1996).

Not only are children highly susceptible to injury; their injuries can also have more serious effects because of their size and physiological immaturity. Berger and Mohan list the following vulnerabilities for children:

- Open epiphyses of bone means that children are subject to growth plate fractures that can cause permanent disfigurement;

- Immaturity of the nervous system and organ systems can lead to increased susceptibility to neurotoxins and increased absorption of toxins;
- Children's thin epidermis increases the severity of burns;
- Large head-to-body ratio increases the risk of head injuries;
- Smaller airway size increases the danger of aspiration (Berger and Mohan 1996).

Other factors that affect outcomes include:

- Children's proportionately larger body surface area to volume, which increases relative surface fluid loss after burns (Kalayi and Muhammed 1996);
- Children's relative immunological immaturity which makes them more prone to infection and may complicate even small burns or other injuries (Bang et al. 1997).

The incidence and causes of children's injuries in developing countries

Hospital-based studies

Most of the research on children's injuries is hospital-based (Table 2), which, given the limited access to hospital care and emergency transport in poorer countries, means that it is unlikely to be truly representative. Hospital records and hospital-based studies make it possible, however, to draw some generalizations about the relative weight of various causes of injury, especially for those injuries serious (or fortunate) enough to receive formal care in large medical centres. A survey of such studies conducted over the last 15 years in developing countries reveals a good deal of consistency, in spite of some regional variation, and, except for drowning, data are generally compatible with global figures from the WHO.

Falls are usually reported to be the most common cause of injury seen in hospitals, accounting for between 25 and 52% of all treated child injuries (Bangdiwala et al. 1990; Kibel et al. 1990a; Tandon et al. 1993; Shokunbi and Olurin 1994; Adesunkanmi et al. 1999). Falls are especially common for younger children and most frequently happen at home (Bangdiwala et al. 1990; Ruangkanchanasetr et al. 1991; Bener et al. 1997; Adesunkanmi et al. 1999). The reasons for falls vary according to local conditions. A Nigerian study, for instance, found that only 25% of children's treated falls happened from above ground level (Adesunkanmi et al. 1999); in India, by contrast, falls from unprotected house roofs, where children often play, are more common, and in one case were responsible for the majority of all treated injuries (Sharma et al. 1993; Tandon 1993).

Road accidents cause the most serious injuries, including abdominal and head injuries, and happen relatively more often for older children (Bangdiwala et al. 1990; Adejuyigbe et al. 1992; Sharma et al. 1993; Tandon et al. 1993; Doumi et al. 1994; Shokunbi and Olurin 1994; Gerbaka et al. 1996; Hsiang et al. 1996; Semple et al. 1998). In some places, particularly urban areas, road accidents are the most common cause of injuries receiving emergency attention for all age groups. In Kumasi, Ghana, for instance, a hospital-based study found that road accidents to pedestrians caused the greatest number of injuries overall (40%), followed by falls (27.2%) and burns (17.6%) (Abantanga and Mock 1998). In Thailand, traffic accidents were found to be the most common cause of injury for children over one year (Ruangkanchanasetr et al. 1991), and in South Africa they were the leading cause of death for children over one year (Kibel and Wagstaff 1995). These figures reflect the rapid growth in road traffic in many developing countries. In Pakistan, for instance, the number of motor vehicles per

Table 2. Thirty-six child injury studies from low-income countries, 1990–2000: a breakdown by methods

Study	Methods	Number	Comments
Community-based	Prospective	1	Most useful for generating the detailed local information needed for targeted prevention. Less useful for informing national or district policy, since it's not possible to generalize from conditions in one community.
	Parent recall	1	
	Recall plus home inventory	1	
	Total	3	
Population-based	Population-based surveillance	1	Most useful for a more comprehensive profile of the scale and nature of injury. Less useful for prevention where local conditions vary.
	Retrospective survey	1	
	Analysis of death certificates	3	
	Total	5	
Hospital-based	Population-based, but using hospital records retrospectively	2	Unlikely to establish an accurate profile of injury patterns in poor countries with limited use of medical facilities. More likely to detect patterns in the factors underlying more serious but less common injuries, especially in prospective studies.
	Prospective	5	
	Prospective case control	1	
	Retrospective analysis of records	20	
	Total	28	

capita increased by 47% between 1985 and 1994 (Ghaffar et al. 1999a); in Brazil, the total number of vehicles increased 60 times between 1950 and 1995 (Simkiss 2000). Poorly maintained roads and vehicles, the absence of hard-shoulders and pavements, multiple uses of roads and large numbers of pedestrians and cyclists, combined with growing numbers of motor vehicles, contribute to traffic accident rates that were estimated by 1986 to be higher than any rates ever recorded in Europe and the USA (Manciaux and Romer 1986). By the early 1990s, there were more road accident deaths in India than in the United States, although India had less than 5% as many motor vehicles (Hardoy et al. 2001). In both Ghana and Pakistan, commercial vehicles are reported to be responsible for a disproportionately high percentage of injuries (in Pakistan, for 90% of vehicle-related deaths) (Mock et al. 1999; Hyder et al. 2000). This may be due in part to the frequent practice of overloading buses and other public transport vehicles.

Hospital-based research indicates that burns are most common for children under four years, and that they generally occur at home. Although the Global Burden of Disease Study lists 'fires' rather than 'burns' as an injury category, research from numerous countries indicates that scalding water and other hot fluids are the most common source of burns for children (Cheng et al. 1990; Mock et al. 1993; Janson et al. 1994; Kalayi and Muhammed 1996; Bang et al. 1997; Rossi et al. 1998; Soltani et al. 1998). In one hospital in Nigeria, by contrast, most treated burns were the result of explosions that occurred during the use of kerosene appliances as a result of petrol contamination of the kerosene before delivery (Grange et al. 1988), and in Kuwait, some infants were reported to be scalded in the course of steam inhalation for respiratory infections (Ebrahim et al. 1990). A study in northern Nigeria found that the majority of burns occurred during the cool months and were associated with increased use of open fires; also that children's upper limbs were more frequently burned, reflecting the tendency of young children to explore by reaching for things (Kalayi and Muhammed 1996). The mortality rate from burns can vary considerably; in the Nigerian study, 27% of the 84 children admitted to a teaching hospital died as a result of their burns (Kalayi and Muhammed 1996); in Kuwait, by contrast, only 1% of a sample of 388 children died (Bang et al. 1997). In both cases, between 60 and 70% of the children had been scalded by hot liquids. The difference in outcome is probably a function of greater access to high quality care in Kuwait. In Ghana it was noted that major disability resulted for 14% of treated children who survived their burns (Mock et al. 1993).

According to studies from Saudi Arabia, Guadaloupe, Cuba and India, poisoning, like burns, is most common in young children and occurs most frequently at home. In Cuba, for instance, children under four years make up 71.3% of all poison victims (Jordán and Valdes-Lazo 1991). The poisoning agents are most often kerosene, household products and medications, although pesticides can also be involved (Abul-Ragheb and Salhab 1989; Al-Sekait 1989; Andre and Lorent 1990; Sarker et al. 1990; Jordán and Valdes-Lazo 1991; Mehta et al. 1996). Poisonous insects are also a factor in some areas; in Tunisia, scorpion bites were responsible for 7% of child

accident admissions to a medical centre, and 35% of the accident-related deaths (Rekik et al. 1989).

The relative prevalence of burns and poisoning varies more than is the case for falls and road accidents. In some studies they are not mentioned; in others they are a significant percentage of reported injuries. Hospital studies from the United Arab Emirates and Ghana, for instance, report burns and scalds as the most common overall cause of trauma among children under five years (64% and 61%, respectively) (Bener et al. 1998; Mock et al. 1999); at the same hospital in the United Arab Emirates, poisonings were the most frequent reason for actual hospital admission (Bener et al. 1997).

Drowning and near drowning are seldom mentioned in these hospital-based studies – possibly because victims are more likely either to die or to recover rapidly without hospital care, or perhaps because more drownings are in rural areas at a distance from the major hospitals most likely to undertake studies. Of more than 57 000 children seen over 5 years in a South African trauma unit, for instance, only 119 were victims of near-drowning (Kibel et al. 1990a). This is in marked contrast to WHO figures, which indicate that drowning accounts for approximately half the deaths by injury, and near-drowning for about one-quarter of the injury-related morbidity for children in low- and middle-income countries (Krug et al. 2000). Population-based studies (see below) have placed greater emphasis on drowning as a cause of death and morbidity.

Other events reported in hospital studies include fractures and chest injuries from kicks by livestock in India (Beg et al. 1988), fractures from collapsing mud walls in Nigeria (Archibong and Onuba 1996), cuts from knives and tools (Tandon et al. 1993) and animal bites, also in India (Mehta et al. 1996). There is no mention in any of the studies reviewed of harm to children from accidental recreational drug overdose, or of abuse to children being presented as unintentional injury.

Most hospital-based studies are retrospective, and unless record keeping has been unusually detailed, they offer only superficial information about the risk factors associated with children's injuries. Prospective studies designed with the objective of identifying and analyzing causes can be far more informative. A particularly exemplary study from a Kuwait hospital, already mentioned above, involved prospective research on risk factors associated with scald burns among children (Bang et al. 1997). Researchers looked at 35 variables, including children's cultural background, family size and work patterns, socioeconomic standing, scalding agents and circumstances surrounding the incident. Based on their findings, they were able to make practical recommendations for prevention.

Community-based studies

Community-based studies point more precisely than most hospital studies to the context in which various kinds of injuries occur, and can take into account the large numbers of injuries that are not seen in hospitals. In the Ikadan neighbourhood in the centre of the city of Ibadan, Nigeria, for

instance, where 436 children were involved in 1286 injuries over a 3 month period, less than 1% were treated in formal health facilities (Edet 1996). Over 96% of these injuries involved puncture wounds, lacerations, sprains and dislocations. Although none of these were major injuries, attention to specific causes (broken bottles, easily available knives, rocky outcrops) might still have prevented pain and distress, potentially serious infections and the possibility of more critical injuries. Descriptive and focused information like this makes it possible to determine how limited funds can most effectively be allocated, especially at the primary care level. Community-based studies are unfortunately rare, however (see Table 2). Those that focus specifically on children's injuries are still harder to find. A search of the literature found only the following few studies.

Research in a Brazilian squatter settlement in 1989 undertook interviews with the mothers of 600 children under five years from 10 randomly selected areas within the settlement. Over a 2 week recall period, 30% of the children were reported to have had at least one injury; 12% of these required care at a clinic or hospital. Falls, cuts and burns were the most common injuries, comprising 66, 17 and 10%, respectively. The high prevalence of falls was related to the rough topography of the settlement. Other risk factors considered by researchers were social rather than physical – the age of the children, the stress levels of their mothers and the amount of time mothers spent working out of the home. Injuries in this settlement accounted for 19% of children's overall health problems. The authors point to the importance in this community of incorporating safety measures such as street lighting and walls around deep ditches into any settlement upgrading efforts. They call also for attention to safety awareness measures and improved child-care provision (Reichenheim and Harpham 1989).

A study in a Jordan community paid closer attention to the environmental factors contributing to injury. Researchers also surveyed mothers of young children (335 children at one time, and 424 four months later), asking about injuries that had occurred in the previous week, and in addition conducted home risk inventories in 50 sample households (Janson et al. 1994). This research, the authors emphasized, looked at a suburban area where conditions were less challenging than in nearby squatter areas and refugee camps. But even here they found that kerosene heaters were used in most households and that two-thirds of them were accessible to children. One-quarter of the houses surveyed exposed children to the risk of serious falls – there were roofs without fences, high windows without protection, stairways without rails. One-third of the children depended on unsafe streets or roofs for play. Only 38% of families stored chemicals or poisons out of the reach of children, and the level of parental education made no difference to this. In summary, researchers found that 60% of the sample families lived in conditions that exposed their small children to a range of significant dangers; only 8% of households were considered to be safe. The single most dangerous feature was considered to be exposed kerosene heaters. In these 50 households, 22 children had required professional help for significant injuries – 11 were badly burned, four injured in falls, two in traffic accidents, three

were poisoned, one suffocated and one was electrocuted. The larger surveys within the same project found that 5% of children under six were injured within a the first 1 week period, 7% 4 months later, a lower rate than was found in the Brazilian study. Burns and cuts were the most common injuries. It could be assumed that within the poorer settlements nearby, rates of injury would be at least as high and the capacity to get emergency care would most likely be more difficult.

A third community-based study, set in South Africa, did not focus exclusively on children, and included violence as well as unintentional injuries (Butchart et al. 2000). However, it is particularly instructive in that it explores variation in the incidence and causes of injury across socioeconomic and environmental settings, and discusses the implications of local involvement for assessment and prevention. This study was undertaken in six neighbourhoods in a low-income area in Johannesburg – two informal settlements, two neighbourhoods consisting of council houses and two composed primarily of council-built apartment buildings. A sample of 1075 residents, approximately 12% of the population, was interviewed on the incidence of injuries in the preceding year, and their perceived causes and solutions. The content of responses was coded and analyzed, and clear patterns of difference emerged between neighbourhoods. There were sharply elevated rates of reported injury in the informal settlements; and perceptions of causes and solutions also varied by neighbourhood. Within the formal housing areas, respondents focused on inadequate enforcement of road laws or parental neglect as causes of children's injuries. Residents of the informal areas, by contrast, cited hazardous environmental conditions as the predominant causes. They pointed to their proximity to a busy freeway, the absence of safe crossing points and the necessity for unattended children of working parents to cross the highway in order to reach local shops and essential services. They also spoke of the combination of poor housing, inadequate recreation space, the lack of electricity and the use of off-site toilet arrangements in the dark as major causes for burns, falls and other injuries. Almost all residents considered drivers of stolen cars to be a major safety hazard.

Larger population-based studies

Larger population-based studies, undertaken with a representative sample, can offer an indication of the extent and distribution of injuries, or of some particular injury, over a far wider area. Such studies are also quite rare; Forjuoh and colleagues, for instance, claim that their 1995 study of the prevalence and age-specific incidence of burns in young children in the Ashanti region of Ghana is the first of its kind. This study offers a good example of how community-based assessment can be taken to scale in the investigation of a particular type of injury (Forjuoh et al. 1995a). Researchers surveyed over 15 000 children from 50 randomly selected rural and semi-urban sites, and found evidence of burns serious enough to have caused scarring in 6% of children, with the highest incidence in children aged between 18 and 23 months. Although the authors acknowledge limitations in their methods, their quantification of prevalence by locality

and of incidence by age group offers valuable information for preventive efforts. The data, for instance, indicated particularly high occurrence of burns in four districts, pointing to the need to identify local risk factors that call for the most concentrated prevention efforts.

A similar effort in Bangladesh, although longitudinal rather than retrospective, sought through a surveillance system to determine the prevalence of drowning deaths among children under four in a rural area of Bangladesh; an associated case control study was carried out to determine risk factors. Drowning was found to account for between 10 and 25% of all child deaths over the 12 years of the study; the risk of drowning was especially high in the second year of life, and risk increased with both the age of the mother and the number of children in the family (Ahmed et al. 1999). A similar prospective study of over 40 000 schoolchildren in Thailand found that 35% of all injury deaths were related to drowning. The leading causes of non-fatal injuries were animal bites and puncture wounds (Kozik et al. 1999). Neither drowning, animal bites nor puncture wounds figure to any extent in hospital studies, an indication of the limited population that these studies probably draw on.

Another population-based account is from Cuba, where statistics on death are reportedly very reliable. A total of 2371 death certificates, representing all deaths by injury of children under 15 over a 3-year period, were analyzed to determine the main causes of death for different age groups, thereby making it possible to design targeted and developmentally responsive interventions and health education programmes (Jordán and Valdes-Lazo 1991). An interesting feature of this analysis involved the percentage of injury-related deaths (10%) involving children under 1 year, who are frequently disregarded as injury victims in statistics and publications, since other causes of death are so dramatically much higher for them.

Preventive measures

There are proven ways to reduce both the incidence and the severity of children's injuries, as attested to by progress in the world's higher income countries. The dramatic decline over recent decades in injury death rates for children in OECD countries is a reflection of serious efforts in research, lobbying and legislation, education, environmental modifications and emergency services (UNICEF 2001).

Theoretically, the effective and systematic work contributing to this progress in higher income nations could be usefully applied in other parts of the world (Forjuoh 1996). But Zwi and others warn that, although countries can learn from one another, caution should be exercised in attempting to transpose interventions between vastly different contexts (Berger and Mohan 1996; Zwi 1996). Many of the underlying policies rely on systems and technologies not easily achievable in low-income countries (Mohan 1997), and many of the interventions developed are neither available, affordable, nor even relevant in these countries (Meyer 1998; Simkiss 2000). Mandatory seat belt laws and the use of child safety seats in cars, for instance, would be of relatively limited

use in countries where the great majority of road accident victims are pedestrians.

International collaboration in injury prevention research would appear to be another fruitful avenue, but Larson warns of the possible drawbacks, including lack of control within low-income countries, and pooled research results which are likely to be too generalized to be useful in any specific situation (Larson 1998). Nor has there been much investment on the part of high-income countries in such efforts. Donor aid for injury prevention falls well below the level of aid directed at other health problems. In 1990, worldwide external assistance was US\$50 per DALY for leprosy and onchocerciasis, US\$6.90 for blinding conditions, US\$0.15 for acute respiratory infections and only US\$0.01 for unintentional injuries (Zwi et al. 1996).

And in spite of their growing injury burden, few of the world's low-income countries have developed their own measures for addressing prevention. There are exceptions; in Zimbabwe, for instance, injury control was identified as a priority in 1986, and there have been systematic efforts to improve surveillance and to research and implement effective prevention strategies (Zwi 1996). In general, however, prevention is not addressed in any systematic way. The constraint of limited health budgets is a major factor in the absence of adequate preventive measures for child injuries, as is the relatively greater burden imposed by communicable disease. But health budgets seldom reflect even the proportional burden presented by injuries. In Pakistan, for example, where injuries consume a significant portion of public health expenditures (22% of emergency room visits, for instance, are injury related), there is no line item in the Ministry of Health or in district health departments for injury prevention (Ghaffar et al. 1999b).

The minimal attention given to injuries is a function, in part, of health systems that are still biased toward curative services rather than prevention (Hyder et al. 2000). The problem is also frequently related, as already noted, to the continued perception of accidents as random and unavoidable events, and hence not a reasonable target for public health measures. Health systems in the developing world seldom include injury prevention as a routine part of their responsibilities. In rural Iran, for instance, where unintentional injuries are responsible for 41% of all deaths of children aged between 1 and 14 years, the activities of community Health Houses, which are responsible for all primary health care in rural areas, do not include any efforts in the area of injury control. Health Houses record all deaths that occur in their areas, but do not include any details on deaths from unintentional injuries (Soori and Naghavi 1998). In Bombay, a prospective study of acute poisonings in children found that none of the caretakers of the children involved had received any instruction in the prevention of accidents or poisoning prior to the episode, in spite of multiple contacts with health care providers (Mehta et al. 1996). These examples are not an attempt to single out these countries for criticism; on the contrary, identification of the problem is a first step in remedying it.

A laissez-faire response to injury is also observed at the household level. In a study of child rearing approaches in

Namibia cited earlier, 24% of the children of respondents, many of them unattended at the time, had recently been injured, mostly in cases involving scalding water and fire. But when parents were asked what measures might help to prevent such events, 60% had no ideas (Zimba and Otaala 1991). Berger and Mohan argue that the extent to which people endeavour to prevent injuries is related to the degree of control they experience over their own lives; another reason, possibly, why families in poverty have been found to be disproportionately affected by injuries (Berger and Mohan 1996). A comparison in the United Kingdom of 1981 and 1991 injury rates offers some support for this hypothesis. In 1981, injury related deaths were 3.5 times greater for children in the lowest socioeconomic group compared with those in the highest group; by 1991, when death rates across the board had dropped, there were 5 times more deaths in the lowest group than in the highest group, indicating that prevention measures had been least successful among the group most affected (Roberts and Power 1996). The work of Butchart and colleagues in South Africa offers reason for challenging the assumption of widespread fatalism, however. A small percentage of people in this community-based study asserted that accidents were unavoidable; but the predominant view, among the poorest as well as the more affluent residents, was that injuries were the outcome of clearly identifiable causes, whether social, environmental or political. People identified not only causes, but also practical strategies for prevention (Butchart et al. 2000).

Krug and colleagues list four steps in any public health prevention effort: (1) determining the scale, scope and characteristics of the problem; (2) identifying factors that contribute to risk; (3) identifying interventions and evaluating their relative value; and (4) implementing the most promising interventions (Krug et al. 2000). The available literature on child injuries in the developing world can be considered in terms of the contributions it makes to these steps.

Determining the scale and characteristics of the problem

The studies discussed here all contribute in some way to this objective. Hospital-based studies are least helpful, however, especially in the poorest countries, since they are unlikely to establish an accurate profile of injury patterns, especially in areas where large numbers of people make limited use of modern health facilities, whether because of expense, accessibility or preference for other modes of treatment (Forjuoh et al. 1995a). The author of a report from Pakistan, for instance, concluded that without a community-based approach almost 70% of burn cases would not have been detected (cited in Forjuoh et al. 1995a). Many events resulting in immediate death would also not show up in hospital-based studies. The figures for children's drowning, discussed above, indicate how hospital records might misrepresent the scale of a problem. Population and community-based studies, if their samples are representative, are better able to establish the scale and nature of injuries within given locales. While community-based assessments are critical in developing relevant responses to local conditions, however, they are less useful for informing national or district-wide policies. Larger surveys can provide the information necessary to inform policy-makers and health

systems of the scale of a particular problem, the existence of larger injury patterns, and the need for appropriate legislation and resource allocation (Ghaffar et al. 1999b). An issue that is bypassed in all of these studies, whether hospital, population or community-based, is the long-term impact of injury for children and their families – an aspect that should certainly be considered in working toward a comprehensive understanding of the scale and nature of the problem of injury.

Identifying the factors that contribute to risk

The design of successful prevention measures requires an understanding not only of how and why injuries occur within a particular locale, but also of who is affected (Meyer 1998; Butchart et al. 2000). The studies reviewed here make it clear that risk factors can vary from one setting to another. Some causes of injury occur widely – such as scalding for young children. But for prevention it makes a difference to know whether scalding is a consequence of overcrowded kitchens, cooking pots set within the reach of small children or the practice of using steam to treat the symptoms of respiratory infection. Again, descriptive community-based studies are most likely to generate the information that is useful in identifying specific risk factors and working towards targeted prevention at the primary care level. Except in work by Butchart, however, no consideration is given to the potential role of community members in helping to assess risk factors. Larger population-based studies can point to wider patterns that might be tackled at the policy level. Although hospital-based studies are not generally effective in assembling information most useful in working towards prevention, they have one advantage: because a higher concentration of serious injuries is seen in hospitals, prospective hospital-based studies focused on identifying risk factors might be more likely to detect patterns in the factors underlying more serious but less common injuries.

Identifying interventions and evaluating their relative value

A number of relevant prevention strategies have been suggested in both the reviewed studies and in the comments and reports of international experts. These include improvements in surveillance and information collection, education and awareness campaigns at various levels, modifications of the environment and improved capacity for treatment. Specific suggestions are presented in Table 3. Some general themes emerge which have particular relevance for the prevention of child injuries: the necessity for bringing a developmental perspective to both education on the subject and to environmental modifications; the need for adequate child care alternatives in settings where caregivers are overburdened; and the need for safe play space for children.

Specific injury prevention strategies are not all equally appropriate; within any given setting they must be evaluated for their utility. Although the literature reviewed here includes numerous suggestions for interventions, it makes little contribution to their evaluation (although environmental modifications are noted to be more effective generally than attempts to modify behaviour). Forjuoh and Li (1996), in their review of transport and home injury interventions,

Table 3. Interventions for prevention of child injuries: suggestions from developing countries

Intervention	Suggestions
Research and information collection	<p>Funds for research, intervention trials and capacity development for research (Larson 1998; Ghaffar et al. 1999b; Hyder et al. 2000).</p> <p>Increased multilateral and bilateral investment (Zwi 1996).</p> <p>A greater role for the health sector in data collection and analysis (Ghaffar et al. 1999b).</p> <p>Systematic surveillance for injuries at various levels of health services (Forjuoh and Gyebi-Ofusu 1993).</p> <p>Improvement in the quality of record keeping; recording the circumstances of injury (Berger and Mohan 1996; Tursz 1986).</p> <p>Establishment of injury audits and registries (Bener et al. 1997).</p> <p>Better documentation of non-fatal outcomes (Hatton et al. 1986; Krug et al. 2000).</p> <p>Linking of data from different sources and different kinds of studies to compensate for inadequacies in individual sources, and to create a more comprehensive picture (Tursz 1986; Bezzaoucha 1988; Rahman et al. 2000).</p> <p>Greater reliance on population-based research (Kibel et al. 1990b; Forjuoh et al. 1995a; Mock et al. 1995).</p> <p>Greater reliance on community-based studies, descriptive and observational studies, and the detailed knowledge of local residents (Edet 1996; Larson 1998; Butchart et al. 2000).</p>
Education and awareness campaigns	<p>Use of the mass media and pamphlet campaigns (Jordán and Valdes-Lazo 1991; Mehta et al. 1996).</p> <p>Education in prevention for parents, children, health professionals and policy makers (Al-Sekait 1989; Forjuoh and Gyebi-Ofusu 1993; Tandon et al. 1993; Bass et al. 1995; Archibong and Onuba 1996; Mehta et al. 1996; Bang et al. 1997; Bener et al. 1997).</p> <p>Culturally appropriate education (Berger and Mohan 1996).</p> <p>Education for community members in first aid (Edet 1996).</p> <p>Injury prevention awareness for policemen, municipal officials, construction workers (Janson et al. 1994).</p> <p>Support for marginalized communities in lobbying local government (Butchart et al. 2000)</p> <p>Education and awareness-raising only in combination with facilitation of safety-enhancing environmental change (Reichenheim and Harpham 1989; Butchart et al. 2000).</p> <p>Home injury risk inventories by health visitors (Janson et al. 1994).</p> <p>Preventive strategies and education that recognize the implications of children's developmental capacities (Peltzer 1989; Jordán and Valdes-Lazo 1991).</p> <p>Adaptation of safety curricula to local conditions and local knowledge (avoiding the tendency to use generic information which repeats much of what people already know (Jordán and Valdes-Lazo 1991; Butchart et al. 2000).</p> <p>Application of relevant elements from programmes directed at infectious, nutritional and perinatal disorders (Deen et al. 1999).</p>
Environmental modifications and improvements	<p>Ensuring use of child-proof caps for pesticide, medicine and kerosene containers proper storage for drugs, chemicals and inflammable substances (Al-Sekait 1989; Forjuoh et al. 1995b; Zwi et al. 1996).</p> <p>Cooking above floor level (Kalayi and Muhammed 1996).</p> <p>Electrification to reduce dependence on candles and kerosene (Butchart et al. 2000).</p> <p>Safe stove design (Butchart et al. 2000).</p> <p>Barriers between children and kitchen safety hazards, designated safe areas for children (Bang et al. 1997).</p> <p>More reliable power supply systems (Datubo-Brown and Keieh 1989).</p> <p>Improved house construction (Al-Sekait 1989; Tandon et al. 1993; Archibong and Onuba 1996; Mehta et al. 1996; Rossi et al. 1998; Butchart et al. 2000).</p> <p>Fences, roof rails, stair rails, window bars, well covers (Berger and Mohan 1996; Janson et al. 1994).</p> <p>Settlement upgrading measures, including street lights, covered or walled ditches and drains, removal of rocky outcrops, (Reichenheim and Harpham 1989; Edet 1996; Butchart et al. 2000).</p> <p>Sanitation provision to prevent need for walks in darkness to toilets (Butchart et al. 2000).</p> <p>Improved recreational space for children (Butchart et al. 2000).</p> <p>Provision of pedestrian pathways and other measures to separate pedestrians from motorized traffic (Reichenheim and Harpham 1989; Archibong and Onuba 1996; Butchart et al. 2000).</p> <p>Traffic calming measures such as speed bumps (Butchart et al. 2000).</p> <p>Waste collection and clean-up campaigns to remove dangerous debris (Edet 1996; Butchart et al. 2000).</p> <p>Footwear for children (Edet 1996).</p> <p>Attention to the condition and use of commercial vehicles (Mock et al. 1999; Hyder et al. 2000).</p> <p>Establishment of child care programmes (Reichenheim and Harpham 1989; Forjuoh et al. 1995b).</p>
Improved post-injury care	<p>Coordinated emergency services (Hyder et al. 2000).</p> <p>More local clinics (Butchart et al. 2000), with simple first aid measures (Forjuoh and Gyebi-Ofusu 1993).</p> <p>Increased use of non-medical health providers in remote areas (Mock et al. 1993)</p> <p>Improved ambulance services (Zwi et al. 1996).</p> <p>Improved traumatology and emergency care (Bezzaoucha 1988; Kibel et al. 1990a).</p> <p>Improved rehabilitation services (Zwi et al. 1996).</p>
Legislation	<p>Review of legislation from a child perspective (Janson et al. 1994).</p> <p>Coordination of legislation with awareness campaigns (Ghaffar et al. 1999a).</p> <p>Improved enforcement of existing laws (Butchart et al. 2000).</p>

have developed a useful framework for such evaluation. They consider not only the *efficacy* of an intervention, but also *affordability, feasibility* and *sustainability*; and they rate an intervention as poor, satisfactory or excellent on each of these criteria. In evaluating measures to protect bicyclists, for instance, the establishment of bicycle paths is rated as excellent in terms of efficacy, but only satisfactory on other criteria. Bicycle safety programmes, by contrast, are considered excellent in terms of affordability and feasibility, but poor in terms of their proven effectiveness. Ideally, researchers will begin to make use of this framework in establishing the value of various strategies within different settings. Currently, no work along these lines has been identified.

Implementing the most promising interventions

Almost no documentation has been found of programmes to implement prevention strategies. Discussion by experts in the field, however, points to some practical principles. While action at national and district level is clearly essential – for instance in terms of legislation, policy and resource allocation – there appears to be broad agreement that injury prevention is most effective when it is targeted at specific conditions and contexts, and individual locales (Berger and Mohan 1996; Edet 1996; Zwi 1996; Meyer 1998). Many risk factors requiring very particular interventions can be overlooked when prevention responses are shaped by some generalized set of concerns. While public health intervention should be supported and coordinated at higher levels, implementation, like information collection, is most effectively planned at community level. At the First World Conference on Accident and Injury Prevention in Stockholm in 1989, a ‘Manifesto for Safe Communities’ established the following principles:

- The public must be actively involved in planning and implementation;
- There should be national policies to support safe communities;
- Priority should be given to prevention for the most vulnerable groups – children, the elderly and the poor;
- Responses should be multi-sectoral and should build on existing networks (Berger and Mohan 1996).

A global effort to promote injury prevention at the local community level is the Safe Communities Network, organized by the WHO Collaborating Centre on Community Safety Promotion at the Karolinska Institute in Sweden. This network currently consists of between 50 and 60 communities worldwide which, based on their achievements in this area, have been designated as ‘safe communities’; other communities are working towards this designation, and regional injury prevention centres offer coordination and technical support (<http://www.ki.se/phs/wcc-csp/safecom>). There has been apparently little application of this model in poorer countries however. Most of the member communities are located in Europe, North America, Australia or New Zealand (although a few communities in South Africa, Thailand and Bangladesh are reported to be working towards safe community designation). The two exceptions appear to be Wang Khoi in Thailand and El Dorado in South Africa, which were designated as a ‘safe communities’ in 1991 and 1997, respectively.

Wang Khoi’s response to the issue of child safety is described in Berger and Mohan’s volume on injury control (Berger and Mohan 1996). In 1986 the village asked for assistance in promoting injury prevention from the Nakhonsawan Research and Development Project (NRDP), a government and WHO supported health project. Meetings were arranged between village heads, local officials and project leaders, as well as with villagers, and health volunteers were selected to survey injuries, with training provided by the NRDP. Volunteers collected information on sample forms during home visits and, together with health workers and village participants, identified and prioritized problems, discussed solutions and developed a plan of action. Preventive information was disseminated through home visits, group discussions, village loudspeakers, radio programmes, leaflets and posters. Children were taught in school about hazards to avoid during work, play and travel, and student volunteers were trained to serve as crossing guards and to recognize home and community hazards. A Village Fund Committee was established to ensure the continuity of village programmes, and villagers are able to borrow for small-scale projects. Interventions at the time of this report included attention to traffic, insecticide use, falls and burns. There is no evaluation of the success of the programme however, and their web site was last updated in 1997.

The El Dorado programme appears to be vital and on-going. In addition to numerous violence prevention efforts, interventions include home safety training for informal settlement residents (with a focus on burns and poisoning); distribution of child-proof containers and caps; safety audits of stairs and balcony rails in apartment buildings; lobbying for environmental upgrades and safe recreation areas; traffic calming and pedestrian crossing efforts; and three Neighbourhood Safety Promotion programmes for environmental upgrading (e.g. electrification, sanitation, formalization of housing) (http://www.ki.se/phs/wcc-csp/safecom/eldorado_park.html). Although the programme has been well documented, evaluations of its success have focused on the violence prevention efforts rather than on unintentional injuries (Butchart et al. 1996). It is clear that an important contribution to tackling the problem of child injuries in low-income countries will be improved documentation and evaluation of prevention efforts, so that lessons learned can be more widely shared.

Conclusions

Although child injuries are considered a minor issue in low-income countries relative to the burden imposed by communicable disease and malnutrition, they are the cause of death and disability for millions of children each year; injury rates have been estimated to be at least five times higher than those in higher income countries. Children are disproportionately affected, and their injuries are likely to be relatively more serious than those of adults. Children in poverty are more often the victims of injuries. Risk factors include poor living conditions, lack of safe play space and inadequate child-care.

The scope and quality of data available on this issue is extremely poor. There is an urgent need for research that can guide the development of effective preventive measures.

Since conditions vary between countries and communities, and since limited resources call for economical and well-targeted responses, it is important to encourage descriptive, locally based assessment to support programmes that can respond appropriately and efficiently to local conditions. In addition to research on the scope and causes of injuries, and of their consequences for children, families and communities, it is essential that steps be taken to promote the documentation and evaluation of a range of preventive measures in order to promote further learning about effective ways to respond to the problems.

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Biography

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