Chapter 39

Unintentional Injuries

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This chapter examines the issue of unintentional injuries and focuses on a selected number of cause-specific unintentional injuries. Injuries have traditionally been defined as damage to a person caused by an acute transfer of energy (mechanical, thermal, electrical, chemical, or radiation) or by the sudden absence of heat or oxygen. Unintentional injuries consist of that subset of injuries for which there is no evidence of predetermined intent. The cause-specific unintentional injuries examined here include those that the World Health Organization (WHO) routinely analyzes and publishes data on and that individually account for the greatest unintentional injury burden in terms of mortality and disability-adjusted life years (DALYs). These include road traffic injuries (RTIs), poisonings, falls, burns, and drowning (figure 39.1).

BURDEN AND CAUSES OF UNINTENTIONAL INJURIES

This section provides a brief outline of the burden of unintentional injuries and then reviews the available evidence about known and potential causes of such injuries.

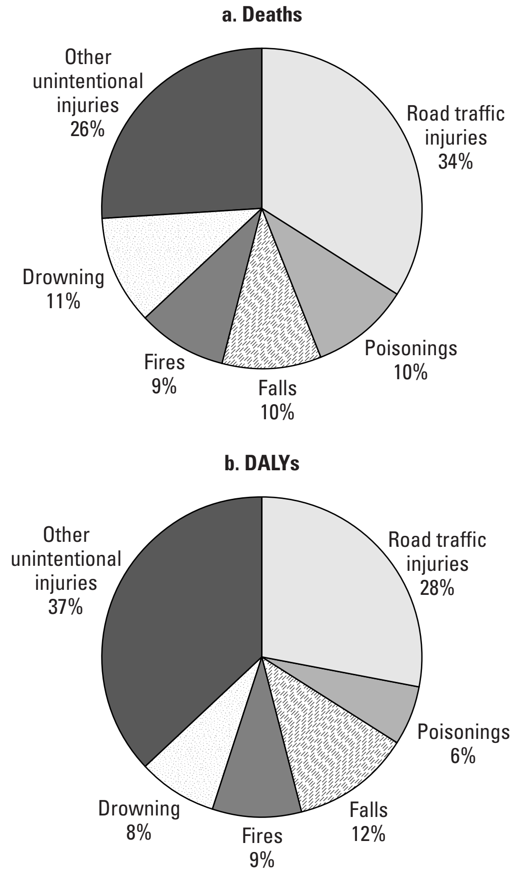
Burden of Unintentional Injuries

Worldwide, unintentional injuries accounted for more than 3.5 million deaths in 2001, or about 6 percent of all deaths and 66 percent of all injury deaths. Unintentional injuries were also responsible for more than 113 million DALYs in 2001, or about 8 percent of all DALYs and some 70 percent of all injury DALYs. More than 90 percent of unintentional injury deaths occurred in low- and middle-income countries (LMICs), accounting for around 7 percent of all deaths in those countries. Similarly, more than 90 percent of DALYs that were attributed to unintentional injuries occurred in LMICs, accounting for about 8 percent of all DALYs in those countries. Injury death rates per 100,000 population were higher in LMICs (62 per 100,000) than globally (57 per 100,000).

Males accounted for almost two-thirds of the deaths attributed to unintentional injuries in LMICs in 2001, with rates of both injury death and DALY losses higher among males than females (table 39.1). Compared with other age groups, young people age 15 to 29 accounted for the largest proportion of deaths from unintentional injuries in LMICs (figure 39.2).

RTIs accounted for the greatest burden of deaths from unintentional injuries in LMICs in 2001, or about 34 percent of the total burden, and the greatest burden of DALYs from unintentional injuries in LMICs in 2001, accounting for 28 percent of the burden (figure 39.1). Whereas young people age 15 to 29 years accounted for the highest proportion of all unintentional injuries, those age 45 to 59 accounted for the highest proportion of injuries from poisonings, while those age 70 to 79 accounted for the highest proportion of injuries from falls (figure 39.2).

Economic Burden of Unintentional Injuries. Estimates of the burden of unintentional injuries as measured in terms of economic costs are almost nonexistent. The best estimates available are for RTIs. Using road crash costs from 21 developed and developing countries, the Transport Research Laboratory Ltd. finds that the average annual cost of road crashes was equivalent to about 1.0 percent of gross national product in developing countries, 1.5 percent in transition countries, and 2.0 percent in highly motorized countries. The annual burden



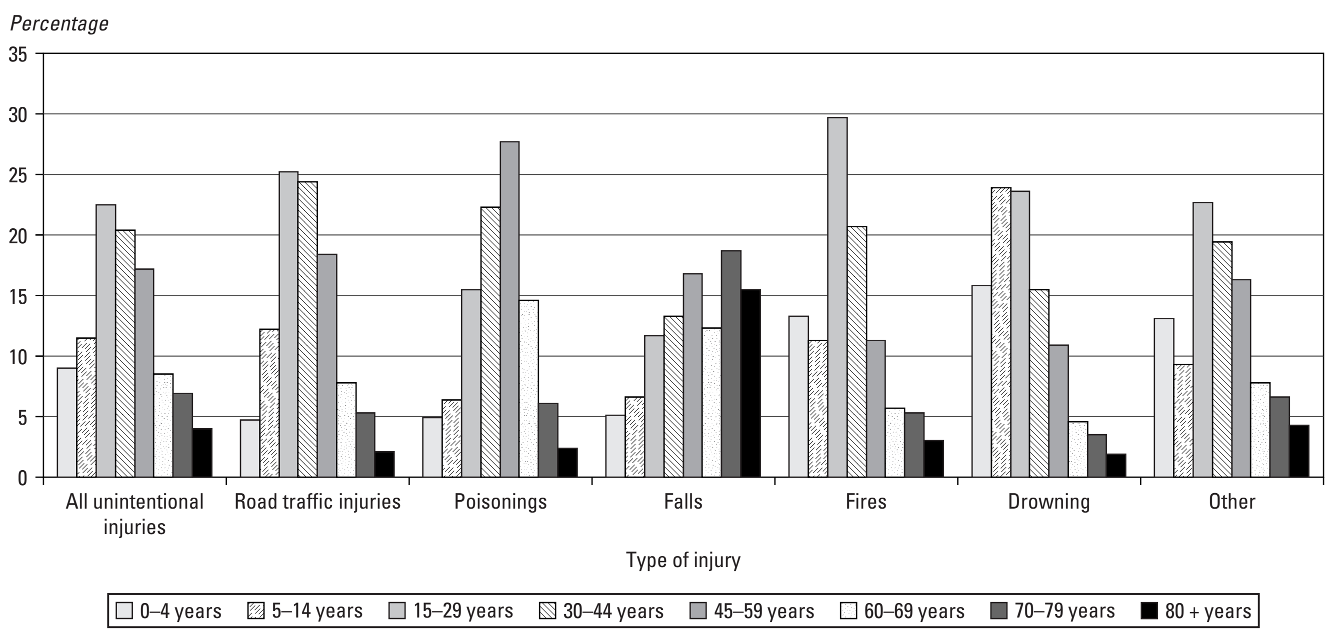
Source: Authors.

Figure 39.1 Distribution of Unintentional Injuries, Low- and Middle-Income Countries, 2001

Table 39.1 Cause-Specific Death Rates and DALYs Lost because of Unintentional Injuries, by Gender, Worldwide and in LMICs, 2001

	Global			LMICs		
Category	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**
Deaths (per 100,000 population)						
All unintentional injuries	57	75	41	61	80	44
RTIs	19	28	11	20	30	11
Poisonings	6	7	4	6	8	5
Falls	6	8	5	6	8	5
Fires	5	4	6	6	4	7
Drowning	6	9	4	7	10	5
Other unintentional injuries	15	19	11	16	20	11
DALY losses (per 1,000 population)						
All unintentional injuries	20	25	14	22	28	16
RTIs	6	8	3	6	9	4
Poisonings	1	2	1	1	2	1
Falls	2	3	2	3	3	2
Fires	2	1	2	2	2	2
Drowning	2	2	1	2	2	1
Other unintentional injuries	7	9	5	8	10	6

Source: Authors.
Note: All figures are rounded to the nearest 1,000.



Source: Authors.

Figure 39.2 Distribution of Unintentional Injuries by Type of Injury and Age Group, LMICs, 2001 of road crash costs is about US$518 billion globally and about US$65 billion in LMICs, exceeding the total annual amount these countries receive in development assistance (Jacobs, Aeron-Thomas, and Astrop 2000).

Causes of Unintentional Injuries in LMICs

As in the case of most diseases, unintentional injuries are caused by multiple factors. The traditional epidemiological paradigm of host, vector, and environmental factors that in combination contribute to the incidence of disease has been adapted and applied in determining the causes of unintentional injury. However, this paradigm has been extended to consider each factor in relation to the time of the injury—that is, factors operating before, during, and after the injury that might be associated with both its incidence and its severity (Haddon 1968). Although the matrix, called the *Haddon matrix,* was initially developed to address the problem of RTIs only, it provides a comprehensive framework in which researchers can consider the multitude of factors that may play a role in the causal injury pathway, as outlined in table 39.2.

In the past two decades, the evidence base for the identification of risk factors for unintentional injuries in high-income countries (HICs) has increased dramatically as the number of injury researchers and research institutions has increased. However, because of the paucity of injury researchers and research institutions in LMICs, the evidence base for the identification of risk factors for unintentional injuries in these countries is growing more slowly.

Although knowledge about risk factors for injuries in HICs may also be relevant for LMICs, the material presented in the following section focuses on information that has been obtained from studies in LMICs. However, the section also considers the extent to which information obtained from studies conducted in HICs may be relevant.

Risk Factors for Road Traffic Injuries. The increasing volume of traffic is one of the main factors contributing to the increase in RTIs in LMICs. Motorization rates rise with income (Kopits and Cropper 2005), and a number of LMICs experiencing growth have seen a corresponding increase in the number of motor vehicles (Ghaffar and others 1999). In some LMICs, this growth has been led by an increase in motorized two-wheeled vehicles, one of the least safe forms of travel, which has resulted in concurrent increases in related injuries (Zhang and others 2004).

The rapid growth in motor vehicles in many LMICs has not been accompanied by improvements in facilities for these road users or by facilities that respond to the continued predominance of nonmotorized traffic (Khayesi 2003). Many of the technical aspects of planning, highway design, traffic engineering, and traffic management that are the hallmarks of transportation systems in many HICs are absent in LMICs, which need to plan for a level of heterogeneity in traffic that HICs do not encounter (Tiwari 2000).

Studies undertaken primarily in HICs show a strong relationship between the increase in vehicle speeds and increased risk of crash and injury, both for motor vehicle occupants and for vulnerable road users, particularly pedestrians (European Road Safety Action Program 2003). This relationship is likely to be true for LMICs, and indeed, data obtained from routinely collected police reports in a number of LMICs show that speed is listed as the leading cause of road traffic crashes, accounting for up to 50 percent of all crashes (Afukaar 2003; Odero, Khayesi, and Heda 2003; Wang and others 2003).

Several case-control studies in HICs have confirmed the role of alcohol in the increasing risk of road crashes (Peden and

Table 39.2 The Haddon Matrix as Applied to Road Traffic Injuries

		Factors		
Phase	**Nature of intervention**	**Human**	**Vehicles and equipment**	**Environment**
Precrash	Crash prevention	Information Attitudes Impairment Police enforcement	Roadworthiness Lighting Braking Handling Speed management	Road design Road layout Speed limits Pedestrian facilities
Crash	Injury prevention during crash	Use of restraints Impairment	Occupant restraints Other safety devices Crash-protective design	Forgiving roadside (for example, crash barriers)
Postcrash	Life sustaining	First-aid skill Access to medical personnel	Ease of access Fire risk	Rescue facilities Congestion

Source: Authors.

others 2004). Studies conducted in LMICs showed that drivers had consumed alcohol in 33 to 69 percent of crashes in which drivers were fatally injured and in 8 to 29 percent of crashes in which drivers were not fatally injured (Odero and Zwi 1995). Alcohol consumption by pedestrians also increases their risk of injuries in HICs; moreover, in at least some LMICs, more than 50 percent of fatally injured pedestrians had consumed alcohol (Peden and others 1996).

Other factors that increase the risks of road crashes in HICs include fatigue, use of hand-held mobile telephones, and inadequate visibility of vulnerable road users (Peden and others 2004), all of which are equally likely to increase risks in LMICs. Indeed, a recent case-control study from China shows that the risks of a crash doubled with chronic sleepiness on the part of the driver (G. F. Liu and others 2003), and surveys of commercial and public road transport in a number of African countries have shown that drivers often work long hours and go to work exhausted (Mock, Amegashi, and Darteh 1999; Nafukho and Khayesi 2002). Studies in Malaysia clearly show that motorcyclists who use daytime running lights have a crash risk about 10 to 29 percent lower than those who do not because of their greater visibility (Radin Umar, Mackay, and Hills 1996).

Road- and vehicle-related factors may also increase the risk of crash involvement. Specific factors related to road planning include traffic passing through residential areas, conflicts between pedestrians and vehicles, schools located on busy roads, lack of median barriers to prevent dangerous passing on two-lane roads, and lack of barriers to prevent pedestrian access onto high-speed roads, although few studies have specifically examined the risks associated with those factors (Ross and others 1991).

Although the severity of crash injuries is related to in-vehicle crash protection, evidence indicates that many engineering advances found in vehicles in HICs are not present in vehicles in LMICs (Odero, Garner, and Zwi 1997). Perhaps one of the most important factors contributing to injury severity relates to crash protection for vulnerable road users. However, few HICs, let alone LMICs, require the fronts of cars or buses to be designed in a way that would protect vulnerable road users (Mohan 2002).

A significant risk factor for increased severity of injuries of users of motorized two-wheeled vehicles is riders' failure to use motorcycle helmets (B. Liu and others 2004). Studies in a number of Asian countries have shown that failure to use helmets, use of nonstandard helmets, and use of improperly secured helmets are not uncommon, even in countries with mandatory helmet laws (Conrad and others 1996; Kulanthayan and others 2000). Failure to wear helmets is also a risk factor for increased injury severity among bicyclists (Attewell, Glase, and McFadden 2001). Although the failure to use seat belts is a significant risk factor associated with injury severity among vehicle occupants, many LMICs have no requirements for seat belts to be fitted or used (Peden and others 2004).

Studies in HICs suggest that roadside hazards, such as trees, poles, and road signs, may contribute to between 18 and 42 percent of road crashes and increase injury severity (Kloeden and others 1998), although the extent to which this is also true in LMICs has not been determined.

Risk Factors for Poisonings. The literature on poisonings in LMICs includes comprehensive information about intentional poisonings; significant information about occupation-related poisonings, especially pesticide poisonings; and a growing body of information about lead poisoning. Each of these types of poisoning is covered elsewhere in this book. This chapter focuses on risk factors for other types of poisoning in LMICs, and, in particular, focuses on risk factors for poisonings in young children.

The literature's focus on risk factors for childhood poisoning probably reflects the fact that child poisoning victims are seen more often than adults in most hospital settings (Ellis and others 1994; Nhachi and Kasilo 1992). This fact is in stark contrast to the data presented earlier, which clearly show that middle-aged individuals sustain the vast majority of deaths and DALYs from poisonings in LMICs. Those numbers no doubt reflect the importance of work-related poisonings.

Young males consistently appear to be at higher risk of poisonings than females (Ellis and others 1994; Fernando and Fernando 1997; Soori 2001). The most common agents involved in childhood poisonings are paraffin (or kerosene) and other household chemicals; pesticides; and various plants or animals, including snakes (Fernando and Fernando 1997).

Several case-control studies in LMICs indicate the importance of a number of sociodemographic risk factors, including young parents, residential mobility, and limited adult supervision of children (Azizi, Zulkifli, and Kasim 1993; Soori 2001). The studies also suggest that previous poisoning may be a risk factor (Soori 2001). Another important factor seems to be storage, including the number of storage containers used in the residence; the use of nonstandard containers for storage (for example, beverage bottles for storing kerosene); and the storage of poisons at ground level (Azizi, Zulkifli, and Kasim 1993; Chatsantiprapa, Chokkanapitak, and Pinpradit 2001; Soori 2001).

Risk Factors for Fall-Related Injuries. Risk factors for fall-related injuries in older people are generally considered in terms of risk factors for falling, risk factors associated with the severity of the impact following the fall, and risks factors associated with low levels of bone mineral density—insofar as almost all fall-related injuries in older people involve broken bones. The risk factors associated with the latter two categories are generally related to aspects of the aging process and, as a consequence, are considered in more detail in chapter 51.

Analytical studies conducted in a variety of LMICs have tended to show that risk factors for fall-related injuries, especially hip fractures, are consistent with the risk factors identified in HICs. Those risk factors include low bone density; poor nutritional status and low body mass index; low calcium intake; comorbid conditions, such as hypertension and diabetes; poor performance in activities of daily living; low levels of engagement in physical activity; poor cognitive function; poor perceived health status; poor vision; environmental factors affecting balance or gait; family history of hip fracture; and alcohol consumption (Boonyaratavej and others 2001; Clark and others 1998; Jitapunkul, Yuktananandana, and Parkpian 2001).

Some studies have identified other factors that may be more relevant in the context of LMICs. For example, studies in Thailand suggest that factors associated with poor socioeconomic status may increase risk—for example, not having electricity in the house and living in Thai-style houses or huts (Jitapunkul, Yuktananandana, and Parkpian 2001).

The literature specifically identifying risk factors for falls in younger people in LMICs is sparse, but the information there is indicates that such falls usually occur in and around the home, with a significant proportion being associated with falls from heights, including rooftops and trees (Adesunkanmi, Oseni, and Badru 1999; Bangdiwala and Anzola-Perez 1990; Kozik and others 1999; Raja, Vohra, and Ahmed 2001). However, falls other than from heights predominate and are frequently related to engagement in vigorous levels of physical activity.

Risk Factors for Burn-Related Injuries. Despite the focus of WHO's data on burn-related injuries sustained as a result of fires, a number of country-specific surveys conducted in medical facilities suggest that scalds from hot water may be equally important or more important causes of burn-related injuries (Chan and others 2002; Delgado and others 2002; Forjuoh, Guyer, and Smith 1995; Rossi and others 1998). However, in some countries, including China and particularly India, fire-related injuries clearly outweigh scald-related injuries (Ahuja and Bhattacharya 2002; Jie and Ren 1992).

Overall, women are at greater risk of fire-related burn injuries than are men; however, data from population-based and medical center surveys suggest that in some settings (excluding India), males may be at greater risk of burns than are females (Chan and others 2002; Zhu, Yang, and Meng 1988). In many studies, burn-related injuries account for a much higher proportion of injuries in young children compared with other age groups (Jie and Ren 1992; E. H. Liu and others 1998).

Rural location appears to be a consistent risk factor for burn-related injuries (Courtright, Haile, and Kohls 1993; Zhu, Yang and Meng 1988), as is the home (Delgado and others 2002; Forjuoh, Guyer, and Smith 1995; E. H. Liu and others 1998).

Investigators have undertaken case-control studies aimed at identifying risk and protective factors for burn-related injuries in Africa, Asia, and South America, and all focus on identifying risk factors for children. Environmental risk factors that have been identified include lack of a water supply, storage of a flammable substance in the home, cooking equipment in the kitchen within reach of children, and housing that is located in slums and congested areas. Persons with personal and socioeconomic risk factors included children who were not the first born, who had a pregnant mother, whose mother recently was dismissed from a job, who had recently moved, who had a preexisting impairment, whose sibling died from a burn or had a history of burn, whose parents lacked alertness to burns, whose clothing was made of synthetic fabrics, whose parents were illiterate, and whose parents were of low economic status. Protective factors included the presence of a living room, better maternal education, and a history of previous injury among males who lived in good environmental conditions (Daisy and others 2001; Delgado and others 2002; Forjuoh and others 1995; Werneck and Reichenheim 1997).

Risk Factors for Drowning. Most drowning incidents in LMICs are not associated with recreation or leisure, as is commonly the case in HICs, but instead are associated with everyday activities near bodies of water, including rivers, wells, and buckets (Celis 1997; Hyder and others 2003; Kobusingye, Guwatudde, and Lett 2001).

As noted earlier, men account for a higher proportion of drowning incidents than women, and children age one to four and young people appear to be at greatest risk, with drowning accounting for a high proportion of injury-related deaths in those age groups (Celis 1997; Kibel and others 1990; Kozik and others 1999; Tan, Li, and Bu 1998). Some surveys also suggest that older people may be at particularly high risk (Tan, Li, and Bu 1998).

Descriptive surveys indicate that those living in rural areas are at greater risk than those living in urban areas (Kobusingye, Guwatudde, and Lett 2001), probably indicating greater exposure to unprotected water surfaces. A number of studies find that most adult drowning incidents appear to be associated with positive blood alcohol tests (Carlini-Cotrim and da Matta Chasin 2000; Celis 1997).

Case-control studies of drowning in young children have identified both sociodemographic risk factors and risk factors associated with proximity to bodies of water. Ahmed, Rahman, and van Ginneken's (1999) study in Bangladesh shows that the risk of drowning increased with the age of the mother and increased much more sharply the larger the number of children in the family. Celis's (1997) case-control study in Mexico finds that the risk of drowning associated with having a well at home was almost seven times that for children in homes without a well.

INTERVENTIONS

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. That is, interventions are considered in terms of preventing the occurrence of the injury, minimizing the severity of injury at the time of the injury, and minimizing the severity of injury following the injury event.

Although randomized controlled trials are the gold standard for assessing the effectiveness of injury interventions, such trials are still relatively rare in relation to injuries, and in many cases such trials may be impractical to implement. Studies comparing the incidence of injury before and after the implementation of an intervention, sometimes with reference to a control population in which the intervention has not been introduced, more commonly provide the only evidence of effectiveness. In some areas, findings from observational studies, such as case-control studies, provide the best available evidence. However, randomized controlled trials are clearly not needed for some interventions because their benefits are obvious. Other interventions, particularly those that may have modest but important benefits, may require rigorous evaluation methods.

Evidence of the effectiveness of interventions in LMICs, as opposed to HICs, is also relatively uncommon. Although the proven efficacy of some interventions in HICs does not require replication in LMICs—for example, the use of motorcycle helmets—strategies that may be effective in increasing the rates of helmet wearing in HICs may not necessarily be appropriate in LMICs. Thus, WHO and others increasingly endorse tailoring interventions found to be effective in HICs to LMICs, followed by rigorous evaluation (Peden and others 2004). Table 39.3 provides a summary of promising and recommended interventions, as well as interventions that have specifically been shown to be effective in LMICs.

Road Traffic Injuries

Many working to reduce RTIs use the "safer roads, safer vehicles, safer people, and safer systems" motto. A recent augmentation of this motto derives from the recognition of the important

Table 39.3 Promising and Effective Interventions for Injuries in LMICs

Injury	Promising interventions	Interventions shown to be effective in LMICs (references)
RTIs	Reducing motor vehicle traffic: efficient fuel taxes, changes in land-use policy, safety impact assessment of transportation and land-use plans, provision of shorter and safer routes, trip reduction measures	Increasing the legal age of motorcyclists from 16 to 18 years (Norghani and others 1998)
	Making greater use of safer modes of transport	
	Minimizing exposure to high-risk scenarios: restricting access to different parts of the road network, giving priority to higher occupancy vehicles or to vulnerable road users, restricting the speed and engine performance of motorized two-wheelers, increasing the legal age for operating a motorcycle, using graduated driver's licensing systems	
	Safer roads	
	Safety awareness in planning road networks, safety features in road design, and remedial action in high-risk crash sites: making provisions for slow-moving traffic and vulnerable road users; providing passing lanes, median barriers, and street lighting	
	Traffic calming measures, such as speed bumps	Speed bumps in reducing pedestrian injuries (Afukaar, Antwi, and Ofosu-Amaah 2003)
	Speed cameras	
	Safer vehicles	
	Improving the visibility of vehicles, including requiring automatic daytime running lights	Daytime running lights on motorcycles (Radin Umar, Mackay, and Hills 1996; Yuan 2000)
	Incorporating crash protective design into vehicles, including installing seat belts	
	Mandating vehicle licensing and inspection	
	Safer people	
	Legislating strategies and increasing enforcement of, for example, speed limits, alcohol-related limits, hours of driving for commercial drivers, seat belt use, bicycle and motorcycle helmet use	Increases in fines and suspension of driver's licenses (Poli de Figueiredo and others 2001) Legislation and enforcement of motorcycle helmets (Ichikawa, Chadbunchachai, and Marui 2003; Supramaniam, Belle, and Sung 1984).

Table 39.3 Continued

Injury	Promising interventions	Interventions shown to be effective in LMICs (references)
Poisonings	Better storage, including positioning and nature of storage vessels Use of child-resistant containers Warning labels First-aid education Poison control centers	Free distribution of child-resistant containers (Krug and others 1994)
Fall-related injuries	*Older people* Muscle strengthening and balance retraining, individually prescribed Tai chi group exercise Home hazard assessment and modification for high-risk individuals Multidisciplinary, multifactorial screening for health and environmental risk factors *Younger people* Multifaceted community programs of the Children Can't Fly type	
Burn-related injuries	*Fire-related injuries* Introducing programs to install smoke alarms Separating cooking areas from living areas Locating cooking surfaces at heights Reducing the storage of flammable substances in households Supervising children more effectively Introducing, monitoring, and enforcing standards and codes for fire-resistant garments *Scald-related injuries* Separating cooking areas from play areas Improving the design of cooking vessels *Fire- and scald-related injuries* Increasing awareness of burns prevention Providing first-aid education	
Drowning	Limiting exposure to bodies of water close to dwellings, such as by fencing Providing learn-to-swim programs Providing education about risks for drowning Increasing supervision and providing lifeguards at recreational facilities Equipping boats with flotation devices and ensuring their use Legislating and enforcing rules about the numbers of individuals carried on boats Having trained and responsive coast guard services	

Source: Authors.

role of appropriate transport and land-use policies in managing exposure to the risk of an RTI (Peden and others 2004).

Managing exposure to risk involves strategies aimed at reducing motor vehicle traffic, encouraging the use of safer modes of travel, and minimizing exposure to high-risk scenarios, as outlined in greater detail in table 39.3. Evidence from Malaysia shows that increasing the legal age of motorcyclists from 16 to 18 has been beneficial (Norghani and others 1998), but evidence of the effectiveness of many of the other strategies is not yet available for LMICs.

Safer Roads. Intervention strategies focusing on safer roads should incorporate safety awareness in planning road networks, safety features in road design, and remedial action for high-risk crash sites. HICs have adopted many of these strategies, and though they have not been examined in rigorously controlled studies, such strategies form the basis of best-practice guidelines and manuals now being used in LMICs (Ross and others 1991).

Traffic calming measures are among the strategies recommended for incorporating safety features into road design.

Although evidence from randomized controlled trials is not yet available (Bunn and others 2003), a before-and-after study conducted in Ghana suggested that speed bumps were effective in reducing traffic injuries, especially pedestrian injuries (Afukaar, Antwi, and Ofosu-Amaah 2003). A recent summary of research findings also suggests that automated speed enforcement virtually eliminates speeding (ICF Consulting Ltd. and Imperial College Centre for Transport Studies 2003).

Safer Vehicles. Strategies focusing on safer vehicles include improving the visibility of vehicles, incorporating crash protective design into vehicles, and promoting further development of "intelligent" vehicles. However, in LMICs, strategies that simply ensure regular maintenance of older vehicles or removal of vehicles in poor condition from the roads, as well as vehicle licensing and inspection, have the potential to be cost-effective (Peden and others 2004).

Meta-analyses of the effects of automatic daytime running lights on cars consistently show that they reduce road crashes (Elvik and Vaa 2004). Studies in both Malaysia and Singapore show similar positive effects for daytime running lights on motorcycles (Radin Umar, Mackay, and Hills 1996; Yuan 2000).

Although the fitting of seat belts—probably the most well-known and effective safer vehicle strategy—is covered by technical standards worldwide and is mandatory in most countries, anecdotal evidence suggests that vehicles in many LMICs lack functioning seat belts (Forjuoh 2003).

Safer People. Intervention strategies aimed at improving road user behavior are increasingly focusing on the introduction and enforcement of relevant legislation rather than on educational efforts. For example, Poli de Figueiredo and others' (2001) research in Brazil indicates that increasing fines and suspending drivers' licenses immediately reduced RTIs and deaths.

A large body of research, although little of it conducted in LMICs, shows that setting and enforcing speed limits reduces RTIs by up to 34 percent. It also shows that RTIs are reduced in varying magnitudes by setting and enforcing legal blood alcohol limits and minimum drinking-age laws, using alcohol checkpoints, and running mass media campaigns aimed at reducing drinking and driving (Peden and others 2004).

The introduction and enforcement of mandatory seat belt and child restraint laws reduces occupant deaths and injuries by up to 25 percent; however, such laws have not been introduced in all LMICs (Peden and others 2004).

Both bicycle and motorcycle helmets reduce head injuries among riders by up to 85 percent. Though education may be effective in increasing helmet use, the effect is greater when combined with legislation and enforcement, as demonstrated in Malaysia and Thailand (Ichikawa, Chadbunchachai, and Marui 2003; Supramaniam, Belle, and Sung 1984).

Poisonings

The prevention of unintentional poisonings includes consideration of both occupational and nonoccupational poisonings; however, chapter 60 provides a fuller discussion of effective interventions in relation to work-related poisonings, so these are not discussed here.

Suggested interventions to reduce exposure to nonoccupational poisonings include better storage of poisons in terms of both the location and the nature of the storage vessels used. Specific interventions include storing poisons outside the home and above children's head height and reducing the use of secondhand household containers—for example soda bottles—along with introducing and enforcing legislation to prohibit the sale of poisons in such containers (Nhachi and Kasilo 1994).

The efficacy of child-resistant containers in preventing access to poisons has been demonstrated, and data from a controlled before-and-after study in South Africa suggest that free distribution of child-resistant containers is a highly effective means of preventing poisoning in children (Krug and others 1994).

Fall-Related Injuries

Interventions proven effective for preventing falls by older people in HICs include muscle strengthening and balance retraining that is individually prescribed at home by a trained health professional; tai chi group exercise; home hazard assessment and modification that is professionally prescribed for older people with a history of falling; and multidisciplinary, multifactorial health and environmental risk factor screening and intervention programs, both for community-dwelling older people in general and for older people with known risk factors (Chang and others 2004).

In relation to fall-related injuries among young children, other than general recommendations about increased supervision of children and the importance of height reductions and appropriate ground surfacing to prevent playground injuries, only one intervention provides evidence of effectiveness that may be relevant for LMICs. The Children Can't Fly Program has four major components, which include surveillance and follow-up, media campaigns, community education, and the provision of free, easily installed window guards to families with young children living in high-risk areas (Spiegel and Lindaman 1977). The program has been shown to be effective in reducing falls in low-income areas.

Burn-Related Injuries

Evidence of the effectiveness of interventions to prevent fire-related injuries is limited. A randomized controlled trial of a smoke detector giveaway program in inner London was unable to show evidence of the program's effectiveness on the incidence of fires and fire-related injuries (DiGuiseppi and others 2002). However, a more recent study suggests that installation programs may be more effective in increasing the use of these alarms than giveaway programs alone (Harvey and others 2004).

Interventions that have been proposed but whose effectiveness has not yet been proven include separating cooking areas from living areas (including efforts to reduce the use of indoor fires for cooking), ensuring that cooking surfaces are at heights, reducing the storage of flammable substances in households, and supervising young children more effectively (Forjuoh 2004). The introduction, monitoring, and enforcement of standards and codes for and the wearing of fire-retardant garments have also been proposed (Bawa Bhalla, Kale, and Mohan 2000).

Evidence of the effectiveness of interventions to prevent scald injuries is minimal but promising, although such interventions primarily focus on education, legislation, and enforcement of efforts to regulate the temperature of water flowing from household taps (Macarthur 2003).

Finally, interventions directed at increasing awareness of burn prevention have been proposed, largely because of the success of safe community interventions involving a multitude of strategies (Ytterstad and Sogaard 1995).

Drowning

Evidence for the effectiveness of interventions to prevent drowning is almost nonexistent. The only available data come from case-control studies undertaken in HICs that suggest that fencing domestic swimming pools reduces the risks of drowning (Thompson and Rivara 2000). Extrapolation of those findings to a low-income setting suggests that covering wells with grills, fencing nearby lakes or riverbanks, and building flood control embankments might be effective in reducing drowning.

COSTS, COST-EFFECTIVENESS, AND ECONOMIC BENEFITS OF INTERVENTION

Data on effective interventions for preventing unintentional injuries in LMICs and on the economic costs of these injuries are limited. As a result, published data on the costs, cost-effectiveness, and economic benefits of interventions to prevent unintentional injuries in LMICs are virtually nonexistent. The economic evaluation of interventions and the measurement of the economic costs of injuries therefore remain a high research priority.

Some data are available from HICs on the costs and, in particular, the net economic benefits of interventions for RTIs. Also, a body of evidence suggests that many of the interventions designed to provide safer roads and vehicles, and to improve driver behavior, have clear net economic benefits (Peden and others 2004). Some data are also starting to emerge from HICs with respect to the cost-effectiveness of fall-related injury prevention programs for older people. However, data on either the costs or the cost-effectiveness of interventions to prevent poisonings, burns, or drownings are limited.

Cost-effectiveness studies done in HICs can only be suggestive for LMICs, because the costs of property losses, disability, and medical care are so vastly different. Furthermore, basic efficacy is not always guaranteed when a control strategy that worked in a modern city is exported to a poor LMIC village. Consequently, the ability to extrapolate from high-income to low-income countries is severely limited. Yet as middle-income countries progress, they will begin to consider interventions that have already been proven.

Despite the methodological challenges, we modeled the cost-effectiveness of five potential interventions to prevent unintentional injuries using information presented earlier on known effective interventions in LMICs. In each case, the evidence for effectiveness in an LMIC setting was strong. However, because so few interventions have been evaluated in LMICs, we had to make certain assumptions to extrapolate findings about costs and effectiveness in one LMIC setting to other settings (for an outline of the assumptions associated with this modeling, see Bishai and Hyder 2004). Our economic analyses are highly generalized and indicative of what might be achieved with the interventions considered.

For the analyses, we present all cost estimates in local currency converted to U.S. dollars (2001 exchange rates). We adopt a societal perspective for each intervention, but if appropriate, we comment on cost-effectiveness from a government perspective. The time horizon for each intervention is one year of sustaining the intervention. Costs are annualized so that a typical year of operating the intervention is known. As with any intervention, annual operating costs may fall as those involved learn ways to carry out their tasks more efficiently. Each year of program operation prevents an estimated number of deaths and injuries. In each case, we present estimates of the raw numbers of deaths and the undiscounted numbers of life years they represent. However, from an economic perspective, the life years and DALYs of those who sustain nonfatal injuries count less than the deaths. For comparability with other economic estimates, and in accordance with the economic analysis guidelines provided to authors, we discount estimates of DALYs using both a 3 percent and a 6 percent discount rate. The 3 percent discount rate is standard for economic evaluations in HICs; however, a higher discount rate may be appropriate in LMICs.

Increased Penalties for Speeding and Other Effective Road Safety Regulations

Poli de Figueiredo and others (2001) provide evidence from Brazil on the effectiveness of an intervention to publicize and enforce traffic speed and other road safety regulations. This intervention required three components—legislation to impose stiffer penalties, media coverage of the new regime, and better enforcement—and achieved a 25 percent reduction in traffic fatalities between 1997 and 1998.

On the basis of a model of the costs of media coverage and of better police enforcement, we estimate that implementing such an intervention in a population of 1 million people might range from as low US$8,100 in South Asia to US$196,000 in LMICs in Europe and Central Asia (table 39.4). Those intervention costs are incremental costs that assume that the population already has 50 percent of the necessary police strength. We define adequacy as one officer for every 5,000 vehicles and use regional data on vehicles per 1 million people to estimate the number of police officers and amount of equipment needed to enforce traffic laws. The assumption is that after the intervention the population will have enough officers to issue citations to one-third of their beat's 5,000 vehicles each year. This effort would require them to write about 7 to 10 citations per workday. Using the estimates of traffic injury burdens in the regions listed in the table and the potential to lower traffic deaths by 25 percent, as reported in the Brazilian study, we estimate potential DALY reductions and cost per DALY averted (table 39.4; for details of the calculations see Bishai and Hyder 2004).

The cost estimates shown in table 39.4 do not include potential cost offsets from savings derived by preventing expenditures on medical care or vehicle repair. Including those potential savings would lower the societal cost and enhance the estimated cost-effectiveness. Those cost offsets will vary widely by region. To demonstrate the importance of cost offsets, we use data from Bangladesh, for which the Transport Research Laboratory Ltd. (2003) has estimated the medical and property costs of traffic crashes. On the basis of these estimates, we calculate 1 fatality, 8 serious injuries, and 28 slight injuries occur for every fatal crash in Bangladesh. Each serious injury is associated with US$2,016 in costs for property, administration, lost output, medical care, and pain and suffering, and each slight injury incurs US$929 in similar costs (Bishai and Hyder 2004). Thus, if we associate 1 prevented traffic fatality with preventing 8 serious injuries worth US$16,128 (8 × US$2,016) and 28 slight injuries worth US$26,012 (28 × US$929), then total additional cost savings would amount to US$42,140.

If intervention costs in Bangladesh were close to the US$8,105 shown in table 39.4 for South Asia, then the intervention would save society more than it cost if it prevented only one death and the expected proportion of nonfatal injuries. If an enforcement intervention in Bangladesh were as effective as the one documented in Brazil, it could lower fatalities by 25 percent. With 83 traffic fatalities per 1 million population, the intervention could prevent 21 deaths and lead to net savings of US$876,835—or (21 × US$42,140) − US$8,105—for every million population receiving this intervention.

Speed Bumps

A study in Ghana (Afukaar, Antwi and Ofosu-Amah 2003) showed that road traffic fatalities fell by more than 50 percent following the introduction of speed bumps. Because speed bumps are usually most effective when installed at the most hazardous junctions or near pedestrian crossings, planners need to know which junctions are the most hazardous. We assumed that half of a city's crashes occur at junctions and that cities have different numbers of treatable junctions. A few junctions would have multiple fatalities per year, but most would have one or zero fatalities per year. We assumed that the number of fatalities per junction would be distributed as a negative exponential to calculate how many junctions might lack effective speed control modifications and could thereby be targeted as those responsible for 10 percent or 25 percent of a city's preventable fatalities. Assuming a 10-year useful life for a speed bump and using regionalized estimates of speed bump construction costs, we modeled the annualized cost of constructing speed bumps at junctions responsible for 10 percent or 25 percent of fatalities. As before, we lacked an evidence

Table 39.4 Costs, DALYs, and Costs per DALY of an Intervention to Improve and Publicize Traffic Enforcement by Region *(2001 US$)*

Region	Cost to intervene in a population of 1,000,000 for 1 year[a]	Present value of annual DALYs averted: Discounted at 3 percent per year	Present value of annual DALYs averted: Discounted at 6 percent per year	Cost per DALY averted: Discounted at 3 percent per year	Cost per DALY averted: Discounted at 6 percent per year
East Asia and the Pacific	11,817	1,517	956	8	12
Europe and Central Asia	195,971	1,433	903	137	217
Latin American and the Caribbean	225,513	1,333	840	169	268
Middle East and North Africa	114,915	2,166	1,365	53	84
South Asia	8,105	1,528	963	5	8
Sub-Saharan Africa	24,518	2,003	1,370	12	18

Source: Authors' calculations.
a. Costs do not include cost offsets from prevented medical care and prevented vehicle repair.

Table 39.5 Annualized Costs and DALYs of an Intervention to Build Speed Bumps for the Top 10 Percent of the Most Lethal Junctions in a City of 1 Million, by Region

Region	Cost to intervene in population of 1,000,000 for 1 year[a]	Present value of annual DALYs averted (2001 US$)		Cost per DALY averted (2001 US$)	
		Discounted at 3 percent per year	Discounted at 6 percent per year	Discounted at 3 percent per year	Discounted at 6 percent per year
East Asia and the Pacific	725	167	105	4.34	6.89
Europe and Central Asia	708	158	99	4.48	7.11
Latin American and the Caribbean	299	147	92	2.04	3.23
Middle East and North Africa	1,070	238	150	4.49	7.12
South Asia	324	168	106	1.93	3.06
Sub-Saharan Africa	498	220	151	2.26	3.30

Source: Authors' calculations.
a. Annual costs in local currency converted to US$ around 2001. Costs do not include cost offsets from prevented medical care and prevented vehicle repair.

base from which to estimate cost offsets from prevented medical care or vehicle repair and could not include those potential savings.

Table 39.5 presents the costs of DALYs saved and costs per DALY saved by building speed bumps at the top 10 percent of the most lethal junctions in a city of 1 million people. We assumed the speed bumps could lower injuries by 50 percent, as observed in the Ghana study. Given the low costs per DALY averted and the typical high expenditures for medical care for crash victims, we are confident that the medical savings to society would more than offset the intervention's costs, but we lack the data to prepare complete estimates.

Bicycle Helmet Legislation and Enforcement

Thompson, Rivara, and Thompson's (1989) case-control study indicates that the effectiveness of a bicycle helmet for a single rider is 85 percent. The effect on lives saved and DALYs averted depends on how many people in a population ride bicycles and the roadway environment for riders. Although the degree of energy transferred to the brain in a crash and the clinical efficacy of helmets may be the same worldwide, few data are available on exposure and the bicycle crash burden in LMICs. Thus, in modeling the effects of bicycle helmet legislation, we were limited to assessing the case of the one country with adequate data on bicycle injury epidemiology: China. In China, bicycle-related deaths kill 22 people per 1 million population per year (Li and Baker 1997). Given estimates of the annualized cost of helmet acquisition for all the bicyclists in a Chinese population of 1 million and of the enforcement costs of penalizing unhelmeted riders, we estimate that protecting bicyclists with helmets would cost US$265,000. Assuming that China could convert from zero to 100 percent adherence to helmet use, it could achieve an 85 percent reduction in head injuries from this intervention and would avert 2,478 DALYs at a 3 percent discount rate and 1,562 DALYs at a 6 percent discount rate. Thus, the cost-effectiveness of going from zero to 100 percent helmet use in China would be US$107 (US$265,000/2,478) per DALY at a 3 percent discount rate or US$170 (US$265,000/1,562) per DALY at a 6 percent discount rate.

Motorcycle Helmet Legislation and Enforcement

As with bicycles, we have epidemiological data for China, where motorcycle-related deaths kill 16 people per 1 million population per year (Zhang and others 2004). We assume that a population of 1 million in China has 125,000 regular motorcyclists, which will require the equivalent of half the time of a police officer to cite 1 percent of them for helmet violations. At Chinese salary levels, this effort would cost the equivalent of US$7,500 per year. The helmets for this population would cost US$250,000 at US$2 per year of helmet use. Thus, the total cost of the intervention would be US$257,500. Assuming a mean age of injury of 20 years and a disability weight of 0.4 for head injury, we estimate the DALYs averted by motorcycle helmet legislation as 589 at a 3 percent discount rate and 357 at a 6 percent discount rate. This intervention therefore costs US$437 (US$257,500/589) per DALY based on a 3 percent discount rate or US$721 (US$257,500/357) per DALY based on a 6 percent discount rate.

Childproof Paraffin Containers

The use of childproof paraffin containers is relevant primarily in Sub-Saharan Africa, where households use paraffin as a cooking fuel and frequently store it in bottles previously used to store beverages. Studies from South Africa have significantly enhanced our understanding of the cost-effectiveness of distributing child-resistant containers. According to Krug and others'

(1994) findings, a population of 1 million who used paraffin regularly in South Africa experienced 1,040 poisonings a year. After child-resistant containers were distributed, the incidence dropped to 540, indicating that 500 poisonings per year had been prevented. We therefore assume that (a) in a population of 1 million, child-resistant containers would need to be distributed to 200,000 households; (b) each child-resistant container costs R 0.85 (US$0.33), including the costs of distribution; and (c) total direct costs would be US$66,000 (200,000 × US$0.33).

The average cost of treating a poisoned child in a South African hospital was R 256.13 (US$100). Thus, indirect cost savings would be US$50,000 (500 × US$100), which would partially offset the US$66,000 in direct costs, leading to a net cost of US$16,000 to intervene. The mean age of children who suffered poisoning in South Africa was 12 to 24 months. Although no deaths were reported among children in the South African study, the most common figure in the literature is a 2 percent case fatality rate (Krug and others 1994), suggesting that the prevention of 500 poisonings averted 10 deaths among children around two years old. Life tables provided to the authors for Sub-Saharan Africa show life expectancy at age 2 is 49 years; thus, the US$16,000 intervention could save 490 life years. Therefore, a rough estimate of the cost-effectiveness of child-resistant containers as a way of preventing paraffin poisoning in South Africa would be US$1,600 (US$16,000/10) per death averted.

Most survivors of paraffin poisoning do not suffer permanent disability, and because we lack any objective means for assigning disability weights to those who are disabled, we neglect years lived with a disability in calculating DALYs. The investment of US$16,000 thus results in 10 children surviving for 49 more years. Undiscounted, this is 490 (10 × 49) life years. The impact is 263 DALYs averted at a 3 percent discount rate or 166 DALYs averted at a 6 percent discount rate. The cost-effectiveness is US$61 (US$16,000/263) per DALY at a 3 percent discount rate or US$96 (US$16,000/166) per DALY at a 6 percent discount rate.

Summary

Estimated costs per DALY from the interventions considered here range from negative (that is, savings) to a few hundred U.S. dollars per DALY. The order of magnitude of the costs per DALY averted using these injury countermeasures suggests that they could be categorized as highly cost-effective (Murray and others 2000). Our estimates of intervention costs neglect the potential savings from prevented medical spending but still appear quite promising. Although our estimates provide some indicative information about the economic properties of counterinjury interventions, these findings point primarily to the lack of information about the global economic burden of injury that could enable more comprehensive estimates.

IMPLEMENTATION OF PREVENTION AND CONTROL STRATEGIES

Investments in the health sector to address specific problems are a critical indicator of political commitment, sectoral efforts, and priorities at the national and international levels. In some cases, investments are so low that they provide a useful reference point for assessing the returns on additional investments in the future. Such a situation has been described as a null point in health systems, and current expenditures on injury prevention and control in LMICs approximate this concept (Murray and others 2000).

This concept can be illustrated by considering investments in preventing RTIs, which are responsible for the majority of the burden of unintentional injuries and about which much is known regarding effective interventions, even though such interventions have not been examined in the context of rigorously controlled studies in LMICs (see box 39.1).

Peden and others (2004) recognize that, despite the global burden of RTIs, the levels of investment are pitifully small, largely because of a lack of awareness of the scale of the problem and a lack of awareness that interventions can prevent and reduce the levels of harm. As a consequence, the report directs a number of recommendations at governments and communities in the hope that these recommendations will enable countries, particularly LMICs, to begin a sustainable process that will eventually lead to the adaptation and implementation of effective preventive strategies. The recommendations include the following:

- Identify a lead government agency to guide the national road safety effort.
- Assess the problems, policies, and institutional settings relating to RTIs and the capacity for preventing RTIs in each country.
- Prepare a national road safety strategy and plan of action.
- Allocate financial and human resources to address the problem.
- Implement specific actions to prevent crashes, minimize injuries and their consequences, and evaluate the effect of those actions.
- Support the development of national capacity and international cooperation.

Although few data are available to show the levels of investment in other areas of unintentional injury prevention, those levels are no doubt considerably lower than for RTIs. With increases in the proportions and numbers of older people in many LMICs, the burden of fall-related injuries is likely to increase significantly in the coming years. Recognition of the changing demographics in countries such as China, Mexico, and Thailand plus a growing body of evidence on effective

Box 39.1

Implementation: Case Study of RTIs

Bishai and others (2003) quantify the magnitude of government investment in road safety and the extent of RTIs in Pakistan and Uganda. They estimate that Pakistan spent \$0.07 per capita, or 0.015 percent of gross domestic product (GDP) per capita, on road safety in 1998 and that Uganda spent \$0.09 per capita, or 0.02 percent of GDP per capita. This type of evidence stands in stark contrast with the high burden of RTIs in these countries.

These findings occur in the context of public expenditure on health of 1.8 percent of GDP by Pakistan and 1.6 percent by Uganda (UNDP 1998). Per capita health spending by households in Uganda was \$7.70 in 1995/96, and public spending on health at the district level was \$4.84 per capita in 1997/98 (Hutchinson 1999). Public spending on road safety amounts to about 1 percent of public spending on health in each country. It is equivalent to 0.2 percent of military spending in Pakistan and 1.1 percent of Uganda's military budget.

A review of road safety initiatives in Benin, Côte d'Ivoire, Kenya, Tanzania, and Zimbabwe found similar underinvestment in road safety and attributes this insufficient investment to conflicts between government ministries, inefficient civil services, and corruption rather than to a lack of knowledge about possible road crash countermeasures (Assum 1998).

RTIs have an inverted U-shaped relationship to economic development—injuries rise early during development, then plateau with investments in road safety, and then fall as appropriate interventions succeed (van Beeck, Borsboom, and Mackenbach 2000). This biphasic pattern is known as a Kuznets curve. Attempts to estimate a Kuznets curve for road fatalities suggest that the inflection point at which fatalities begin to decline occurs at GDP per capita in the range of \$5,000 to \$10,000 (Bishai and others, forthcoming; Kopits and Cropper 2005). This relationship, although based on historical records from HICs, has an important lesson for LMICs: they do not need to experience massive death and disability from RTIs provided that they undertake safety investments now. Waiting for overall economic development before implementing specific interventions will result in the needless loss of millions of lives.

Note: All dollars in box 39.1 are 1998 international dollars.

interventions to prevent falls suggest that investments in this area could lead to significant benefits. Similarly, increasing recognition of the significance of the burden of drowning in children is leading to growing awareness of the need to invest in that area. However, the absence of any effective evidence-based interventions may be a barrier to further investment, suggesting that research into the burden of drowning must be a priority.

Investment in prevention and control activities in other areas of unintentional injuries is minimal in most LMICs, in large part because the burden of those injuries is unrecognized and because evidence of effective interventions is lacking. Therefore, there is clearly a need to consider the development, implementation, and evaluation of prevention strategies in combination, so that effective interventions can be identified and promulgated and so that ineffective interventions can be identified and discarded.

RESEARCH AND DEVELOPMENT AGENDA

The Global Forum for Health Research (2002) estimates that of the US\$73.5 billion spent on health research globally in 1998, less than 10 percent was spent on addressing problems related to 90 percent of the world's population. Analyses revealed that RTIs were a highly neglected area for investment compared with the burden of disease RTIs represented as measured in U.S. dollars per DALY. As a result, increasing the level of investment for research and development (R&D) on RTIs and other injuries should be a focus of global advocacy efforts, and investment is critical for promoting an R&D agenda on injuries in LMICs.

Developing and prioritizing a global R&D agenda for unintentional injuries, though, is challenging, and such an exercise may be more useful at national or large subnational levels. However, a number of issues requiring R&D are likely to be common across a range of LMICs.

Epidemiological research to describe the existing burden, causes, and distribution of unintentional injuries in LMICs is still needed. Often the data are most limited for areas with the greatest potential burden of injuries. Assessing the loss of health and life from unintentional injuries—whom they affect, how, and under what specific circumstances—is thus a continuing research agenda for LMICs. Problems of underreporting and other biases in available data also need to be addressed.

The lack of intervention research in LMICs is a huge gap in global health research. For the most part, no scientific trials of injury interventions have been conducted in LMICs, and existing and new interventions need to be modified, adapted, and tested in those specific settings. Three broad domains should be the foci of intervention research:

- R&D to enhance the efficiency of currently available efficacious interventions. For example, increasing the use of helmets would prevent motorcycle injuries in East Asia.
- R&D to enhance the cost-effectiveness of interventions that are currently not being implemented or that could be used more widely. For example, seat belts and child restraints are known effective interventions, and reducing the cost of such interventions might enhance their wide-scale implementation in LMICs.
- R&D to develop new interventions for unintentional injuries and to respond to that proportion of the burden that is not currently being addressed. For example, childhood falls from rooftops in South Asia have been recognized as an issue, but a locally derived intervention is currently unavailable.

Although some might argue that intervention research should be the priority in most LMICs, unless the basic underpinning research on the burden and determinants of unintentional injuries has been undertaken, the political and financial support for such research will not be forthcoming.

The dearth of economic and policy analysis of unintentional injuries in LMICs is an embarrassment for the global health research community. A recent review of economic analysis of road traffic interventions found a complete absence of any detailed studies from the developing world (Waters, Hyder and Phillips 2004). This gap in health systems research would need to be addressed to develop and implement successful injury prevention programs.

Defining a research agenda is necessary but is not by itself sufficient to conduct research or to implement the results. Two key conditions are required for moving forward: a critical mass of people to conduct research and appropriate funds to support R&D. Developing human resources for all aspects of injury prevention and control in the developing world should be a high priority. Individuals need to be trained and institutions supported and empowered to conduct quality scientific research in their own countries and on issues relevant to their locations, which would then be used within their countries. This approach involves paying attention to the issue of strengthening the capacity for research, a major cross-cutting theme for the health sector in the developing world.

Funding is and always will be a limiting factor for research; however, the mismatch between the burden of injuries and R&D investments can be corrected. Unintentional injuries are a major health problem. They cause preventable loss of life and health, and they have major economic implications. As a result, R&D investments are a health and economic imperative for developing countries and donor organizations.

CONCLUSIONS: PROMISES AND PITFALLS

Unintentional injuries are an important contributor to global death and disability burdens, especially in LMICs. However, the significance of the burden is not matched by substantive knowledge about risk factors or effective interventions in LMICs. Nevertheless, the models outlined in this chapter indicate that several interventions for preventing unintentional injuries are highly cost-effective and in some cases could result in significant cost savings.

Recent evidence shows that public efforts in injury control, such as traffic safety, are poorly funded in developing countries (Bishai and others 2003). The low expenditure compares unfavorably with expenditure on other health conditions and with expenditures in more developed nations, where government efforts in relation to such issues as traffic safety are well funded. Even adjusting for the 20-fold to 30-fold difference in gross domestic product per capita between HICs and LMICs, the investment disparities suggest that LMICs attach a low priority to injury prevention.

Given the current low level of investment, initial investments in safety, if chosen with care, could turn out to be extremely beneficial to public health and welfare. If, in the first instance, investments were to be made only in the interventions modeled here, then injury reductions would likely be significant. The next step would be to modify other interventions that have proven effective in HICs and to combine the introduction of such interventions with evaluations of their effects. Policy makers will be concerned that many of the cost-effective interventions are not low-cost interventions. They save many lives but require an extensive upfront investment. Using cost-effectiveness analyses of these interventions to document high returns would encourage financing of these interventions and widespread replication efforts.

Policy makers would be unwise to wait for advanced stages of economic development to attend to the problem of road safety or other unintentional injuries. Indeed, given the limited but growing knowledge that low-cost, effective interventions exist, for governments not to intervene would be unethical. Even though institutional obstacles are formidable in developing countries, governments routinely overcome them to address other perceived threats to public well-being—such as crime, terrorism, and war—that disrupt fewer lives than unintentional injuries. The real enigma is that such a profound loss of life can take place each year in LMICs without an outcry that would trigger sustained and effective political commitment by governments and civil society.

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