

## REVIEW ARTICLE

## GLOBAL HEALTH

## Injuries

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**I**NJURIES HAVE TRADITIONALLY BEEN DEFINED AS PHYSICAL DAMAGE TO A person caused by an acute transfer of energy (mechanical, thermal, electrical, chemical, or radiation energy) or by the sudden absence of heat or oxygen. This definition has been broadened to include damage that results in psychological harm, maldevelopment, or deprivation.<sup>1</sup> Injuries are most commonly categorized with reference to the presumed underlying intent: injuries considered to be unintentional include those caused by road-traffic incidents, falls, drowning, burns, and poisonings, and injuries considered to be intentional include those caused by self-harm, interpersonal violence, and war and conflict.<sup>2,3</sup>

The subject of injuries has received relatively scant attention from the medical community, as evidenced by the absence of this topic in the curricula of most medical schools, and even schools of public health, and by the limited coverage of the topic in most medical journals. The Global Burden of Disease (GBD) study has at least placed injuries on the global health agenda by categorizing the major causes of death and disability worldwide into three main groups: group I includes communicable, maternal, perinatal, and nutritional conditions; group II includes noncommunicable diseases; and group III includes injuries.<sup>2,3</sup> Concurrent with the recognition of the burden of injuries has been the growing acknowledgment that an evidence-based approach to the prevention and management of injuries can and should be adopted, as has been done in the case of other major global causes of death and disability.<sup>4,5</sup>

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## BURDEN OF INJURIES

In 2010, there were 5.1 million deaths from injuries — almost 1 out of every 10 deaths in the world — and the total number of deaths from injuries was greater than the number of deaths from infection with the human immunodeficiency virus–acquired immune deficiency syndrome (HIV–AIDS), tuberculosis, and malaria combined (3.8 million).<sup>3</sup> Persons in low- and middle-income countries sustained a disproportionate number of injury-related deaths: 89% of the total number of deaths due to injury, as compared with 84% of deaths from all causes, occurred in these countries.<sup>2</sup> Whereas injuries accounted for 6% of deaths in high-income countries, they caused 12% of deaths in low-income countries in the Americas and 11% of deaths in low-income countries in Southeast Asia.<sup>2</sup> The burden of injury is even greater in some individual countries, such as South Africa, where injuries are the second leading cause of both death and disability-adjusted life-years (DALYs).<sup>6</sup>

A disproportionate number of injuries are sustained by males, who accounted for about 68% of all injury-related deaths in 2010 (Table 1).<sup>3</sup> Although injuries are sustained across the life cycle, they affect young people (persons between 10 and 24 years of age) in particular, accounting for more than 40% of deaths in this age group.<sup>3,7</sup> More than half of all deaths (52%) occurring in males 10 to 24 years of age are caused by injuries.<sup>3</sup>

**Table 1. Deaths from Cause-Specific Injuries in 2010.\***

Cause of Death	No. of Deaths/ 100,000 Persons	% of All Deaths	% of Injury- Related Deaths	% Involving Males
All causes	52,770	100.0	—	54.8
All injuries	5,073	9.6	100.0	68.2
Unintentional injuries	3,520	6.7	69.4	67.4
Transportation-related injuries	1,397	2.6	27.5	75.1
Falls	541	1.0	10.7	59.0
Drowning	349	0.7	6.9	70.5
Injuries from fires, heat, and hot substances	338	0.6	6.7	47.5
Poisonings	180	0.3	3.5	65.6
Other	715	1.4	14.1	66.9
Intentional injuries	1,340	2.5	26.4	70.7
Self-harm	884	1.7	17.4	65.5
Interpersonal violence	456	0.9	9.0	80.7
Forces of nature, war, and legal intervention†	214	0.4	4.2	65.4
Exposure to forces of nature	196	0.4	3.9	65.3
Collective violence and legal interventions	18	<0.1	0.4	63.9

\* Data are from Lozano et al.<sup>3</sup>

† Deaths from legal intervention include, among others, those that result from death penalties imposed by governments.

#### UNINTENTIONAL INJURIES

In 2010, unintentional injuries were the cause of the majority of injury-related deaths (69%),<sup>3</sup> as well as the majority of DALYs (72%).<sup>8</sup> Transportation-related injuries (including injuries from both road-traffic incidents and non-road-traffic causes, such as incidents on the water or in the air) were the leading cause of injury-related deaths in 2010 and were responsible for 1.4 million deaths.<sup>3</sup> Injuries from road-traffic incidents were the eighth leading cause of death overall<sup>3</sup> and the leading cause of death among persons 10 to 24 years of age and were responsible for 17% of all deaths among males in this age group.<sup>3</sup>

Although injuries from road-traffic incidents impose a substantial burden across all regions of the world, the burden is greatest in low- and middle-income countries (Table 2). In 2004, injuries from road-traffic incidents were the sixth leading cause of death and the fourth leading cause of DALYs in middle-income countries.<sup>9</sup> The highest death rates, however, occurred in low- and middle-income countries in Africa and in the Eastern Mediterranean and Western Pacific regions. Notably, Africa currently has the lowest motorization rate (i.e., the number of registered vehicles

per person) of all the world's regions, but its fatality rates are already similar to those in regions that have considerably higher motorization rates.<sup>10</sup>

Falls are the next most common cause of deaths related to unintentional injuries globally, followed by drowning, burns, and poisonings (Table 1). The rates of death from falls and from poisonings are generally higher in high-income countries than in low- and middle-income countries combined<sup>2</sup>; however, the rate of death from falls is highest in the low- and middle-income countries of Southeast Asia, whereas the rate of death from poisoning is highest in the low- and middle-income countries of Europe (Table 2). More than 90% of deaths from drowning and from fires occur in low- and middle-income countries.<sup>2</sup> Males account for more than 50% of all injury-related, cause-specific deaths, other than deaths from burns (Table 1).

#### INTENTIONAL INJURIES

Deaths from self-harm and from interpersonal violence are, respectively, the second and fourth leading causes of injury-related deaths (Table 1) and of DALYs.<sup>8</sup> Self-harm is the cause of disproportionately more deaths among persons in high-income

**Table 2. Estimates of the Rate of Death per 100,000 Persons Associated with Cause-Specific Injuries, According to Income Level and Region, in 2008.\***

Cause of Death	High-Income Countries	Low-Income and Middle-Income Countries					
		Africa	The Americas	Eastern Mediterranean Region	Europe	Southeast Asia	Western Pacific Region
<i>rate per 100,000 persons</i>							
Unintentional injuries							
Road-traffic injuries	10.3	20.9	17.6	21.6	17.2	17.6	21.2
Falls	7.8	2.4	3.7	4.1	5.7	12.0	8.2
Drowning	1.8	5.2	2.8	3.9	5.5	5.5	5.7
Fires	0.9	4.9	0.7	5.2	4.2	4.8	0.9
Poisoning	4.1	4.9	0.7	2.8	18.1	1.8	2.9
Other	10.9	16.9	11.8	13.6	30.6	22.8	14.4
Intentional injuries							
Self-harm	13.4	6.3	5.8	5.5	16.9	15.6	11.4
Interpersonal violence	2.7	20.1	24.1	3.9	9.9	5.8	2.9
War and conflict	0.1	3.6	1.2	17.7	1.2	2.3	0.2

\* Data are from the World Health Organization.<sup>2</sup>

countries than among those in low- and middle-income countries,<sup>2</sup> although the rates of death from self-harm are highest in the low- and middle-income countries of Europe and Southeast Asia (Table 2). Almost 95% of deaths and DALYs due to interpersonal violence and almost all deaths and DALYs due to war and conflict occur among persons in low- and middle-income countries.<sup>2</sup> The rates of death from interpersonal violence are substantially higher in low- and middle-income countries in both Africa and the Americas than in other regions of the world, and the rates of death from war and conflict are highest in the low- and middle-income countries of the Eastern Mediterranean region (Table 2). In South Africa, almost 50% of all injury-related deaths result from interpersonal violence.<sup>6</sup>

#### OTHER HEALTH OUTCOMES

The data reported above clearly identify injuries as major causes of death and DALYs. However, the importance of injuries as a contributor to other health outcomes is not captured in these statistics. It has been shown, for example, that victims of childhood maltreatment suffer long-term psychological sequelae, such as low self-esteem, anx-

iety, and depression,<sup>11-13</sup> and survivors of sexual abuse during childhood are more likely to engage in high-risk sexual behaviors, have multiple sex partners, become pregnant as teenagers, and be the victims of sexual assault as adults.<sup>14-16</sup>

#### FUTURE BURDEN OF INJURIES

The global burden of injuries is expected to increase over the next 20 years; it is projected that by 2030, injuries from road-traffic accidents will be the 5th leading cause of death worldwide, and deaths from self-harm will be the 12th leading cause of death.<sup>9</sup> Overall, the number of deaths from injuries increased by 24% between 1990 and 2010. The increases in deaths from transportation-related injuries, self-harm, falls, burns, and interpersonal violence during this period suggest that further increases in these categories might be observed over the next 20 years. In contrast, deaths from drowning and poisonings ranked lower in 2010 than in 1990.<sup>3</sup>

The burden of injuries is likely to diminish over the next 20 years in high-income countries, whereas injuries are projected to continue to be a major burden in middle-income countries and to become increasingly important in low-income

countries.<sup>9</sup> These projections probably reflect the increasing exposure to risks in the low- and middle-income countries (e.g., increasing motorization) combined with the increasing implementation of effective prevention strategies in the high-income countries.<sup>3,17,18</sup> If these projected increases in injuries are to be thwarted, efforts aimed at prevention, especially in low- and middle-income countries, must become a priority.

#### PREVENTION OF INJURIES

The prevention of injuries, which should be the first priority, is achievable, as evidenced by the halving of rates of death from road-traffic injuries over the past three decades in countries such as Australia, Canada, and the United States.<sup>18</sup> These achievements have required a multisectoral response, focused not only on road users, but also on vehicles, roads, and to a lesser degree the broader transportation system (i.e., the ways in which transportation systems are organized and planned). Rigorous methodologic approaches to assessing the effectiveness of these prevention efforts have been limited, and interventions have been adopted largely on the basis of before-and-after comparisons of their effects on a range of noninjury-related outcomes, such as changes in behavior or increases in knowledge.<sup>5,18</sup>

#### UNINTENTIONAL INJURIES

In 2004, the World Health Organization (WHO) and the World Bank published the World Report on Road Traffic Injury Prevention.<sup>18</sup> The report provided a comprehensive summary of the best available evidence on the prevention of injuries from road-traffic incidents and also highlighted the paucity of research data from low- and middle-income countries. Since then, the WHO, in partnership with governments around the world, especially those in low- and middle-income countries, has taken the lead in facilitating campaigns to implement legislation aimed at further reducing injuries from road-traffic incidents globally.<sup>19,20</sup> These campaigns have focused on efforts to reduce the rates of speeding and drinking while driving and to increase the use of motorcycle helmets, seat belts, and child safety restraints — interventions that have been shown in data from high-income countries to be effective in reducing injuries<sup>18,21,22</sup> and for which appropriate legislation in many low- and middle-income countries

has been lacking.<sup>19</sup> Concurrently, the WHO has supported research in countries such as Vietnam that has shown that the introduction of legislation requiring the use of helmets by motorcyclists, accompanied by education and enforcement, has had a substantial effect both on increasing the use of motorcycle helmets (from about 40% to >90%) and on decreasing the numbers of deaths (by 18%) and head injuries (by 16%).<sup>23,24</sup>

A multisectoral and legislative approach toward prevention has been extended to most other cause-specific unintentional injuries<sup>25</sup> (Table 3) — in part because the majority of preventive strategies lie outside the traditional health sector (e.g., the installation of isolation fencing around swimming pools to prevent drowning<sup>26</sup> or the setting and enforcing of standards for playground equipment to prevent falls and injuries from falls<sup>27</sup>) and in part because there is still little evidence to support the effectiveness of educational strategies. For example, programs to promote (but not require by law) the installation of smoke alarms to prevent household fires have had only modest beneficial effects with respect to ownership of alarms and the presence in the house of functioning alarms and no proven beneficial effects with respect to the prevention of fires or fire-related injuries.<sup>28</sup>

The health sector, and especially the primary care sector, can play a potentially important role in the prevention of injuries to children and the prevention of falls among the elderly. Although it is possible that these sectors can also play a role in the prevention of injuries in other age groups, evidence to support this is lacking.<sup>29</sup> Promising interventions include those that focus on counseling and educating parents regarding the prevention of childhood injuries<sup>30</sup> and those that are aimed at reducing the risks of falling among older populations through the use of individually prescribed home-based exercise programs or programs to review and modify medication regimens.<sup>31</sup>

Much of the evidence regarding effective strategies for the prevention of unintentional injuries is derived from research conducted in high-income countries and thus may have limited direct applicability for the prevention of injuries in low- and middle-income countries.<sup>5,32</sup> However, it is highly likely that strategies that are effective in high-income countries can be suitably adapted to low- and middle-income settings — as was

**Table 3. Evidence-Based Strategies Involving Legislative and Nonlegislative Approaches for Primary Prevention of Cause-Specific Injuries.\***

Cause of Injury	Legislative Approaches	Nonlegislative Approaches
Road-traffic injuries	Implementing and enforcing speed limits; implementing and enforcing legislation regarding driving under the influence of alcohol, the use of motorcycle helmets, the use of seat belts and child safety restraints, and the addition of daytime running lights on motorcycles; implementing graduated driver licensing systems for novice drivers	Developing safer roadway infrastructure, including separating four-wheeled vehicles from pedestrians, bicyclists, and sometimes motorcyclists; introducing traffic calming (engineering and other measures put in place on roads with a goal of slowing down or reducing traffic) to reduce speeds in urban areas; implementing vehicle and safety-equipment standards
Falls	Implementing and enforcing window-guard laws for tall buildings	Redesigning furniture and other products; implementing and enforcing standards for playground equipment; implementing home-based exercise programs for older persons
Drowning	Implementing and enforcing legislation related to isolation fencing around swimming pools	Removing or covering water hazards; promoting the use of personal flotation devices
Burns	Implementing and enforcing laws on smoke alarms and on hot tap water temperatures	Implementing and enforcing standards for child-resistant lighters
Poisoning	Implementing and enforcing laws for child-resistant packaging of medicines and poisons	Removing toxic products from homes and other environments where they might be accessed easily
Self-harm		Ensuring early detection and effective treatment of mood disorders and behavioral therapy for persons with suicidal thoughts and behaviors; restricting access to the means of self-harm (including pesticides, guns, and unprotected heights)
Interpersonal violence		Developing safe, stable, and nurturing relationships between children and their caregivers; developing life skills in children and adolescents; reducing the availability and harmful use of alcohol; reducing access to guns and knives; promoting sex equality to prevent violence against women; changing cultural and social norms that support violence

\* Data are from Norton et al.<sup>5</sup> and the World Health Organization.<sup>25</sup>

shown in the case of the prevention of injuries from road-traffic incidents. For example, the required use of isolation fencing or covers to prevent access to open water in low- and middle-income countries will probably reduce deaths from drowning in much the same way that the enactment and enforcement of legislation relating to isolation fencing around swimming pools has in high-income settings.

#### INTENTIONAL INJURIES

The best available evidence regarding the prevention of self-harm suggests that the medical sector has an important role to play (Table 3). Specifically, there is increasingly strong evidence of the effectiveness of educating clinicians in the appropriate identification and treatment of persons with mood disorders.<sup>33</sup> In addition, there is good evidence to suggest that restricting access to the means of suicide, including the access to pesticides,

guns, and unprotected heights, is an effective preventive strategy, although it is one that is traditionally outside the realm of the health sector.<sup>33</sup>

Evidence regarding effective interventions to prevent interpersonal violence is not strong but is accumulating (Table 3). Two U.S.-based programs, the Nurse-Family Partnership home visiting program<sup>34</sup> and the Positive Parenting Program (Triple P),<sup>35</sup> have been shown to be successful in reducing the incidence of child maltreatment. In contrast, the best evidence regarding the prevention of violence against women is emerging from low- and middle-income regions. The Intervention with Microfinance for AIDS and Gender Equity (IMAGE) initiative in South Africa<sup>36</sup> combines the provision of small loans with sex-equity training, and the Stepping Stones programs in Africa and Asia<sup>37</sup> use life-skills training focused on sex-based violence, relationship skills, assertiveness training, and communication about HIV infection.

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 IMPROVING THE MANAGEMENT  
OF INJURIES
 

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Although prevention is likely to have the greatest effect on reducing the global burden of injuries, safe, effective, and affordable prehospital and hospital management, as well as appropriate rehabilitation services, are essential to reducing this burden. However, on a global level, the financial and human resources available to deliver these services vary widely. In most high-income countries, care of injured persons is characterized by sophisticated trauma systems. These organized and coordinated services within defined geographic areas deliver the full range of care to injured persons by integrating prehospital, transport, and trauma-center components within the local public health system.<sup>38,39</sup> Emergency medical technicians, emergency department physicians, and trauma surgeons are typically central to the management of severe injuries. Such systems contrast sharply with the care available in the majority of low-income settings where, except for urban centers, trauma care is dependent mostly on lay first responders, unplanned and often inconsistently available transportation for the injured, and health facilities with varying capabilities for managing severe injuries.<sup>40</sup>

**PREHOSPITAL MANAGEMENT**

There continues to be debate regarding the level of training that should be required for health care providers in the prehospital care setting and the interventions that can be safely undertaken in the field without causing undue delay in the transfer to a hospital.<sup>41,42</sup> Much of the evidence relies on the results of before-and-after studies.<sup>43</sup> Randomized trials need to be conducted in light of the diversity of prehospital care services that are proliferating despite limited evidence to support their effectiveness.<sup>44</sup>

A range of low-cost strategies to improve access to prehospital care, especially in low- and middle-income countries, has been outlined in detail; these strategies include the use of trained lay first responders, access to essential equipment and supplies, improved communications, and provision of appropriate transportation systems.<sup>40</sup> Although there is evidence to show that trained lay first responders do improve trauma outcomes,<sup>45</sup> other strategies still need to be examined.

**HOSPITAL MANAGEMENT**

In the past decade, large-scale, randomized, controlled trials conducted in emergency departments and intensive care units, including research focused specifically on the care of injured patients, have set new benchmarks for the provision of evidence-based, in-hospital trauma care.<sup>46-49</sup> These trials provide evidence regarding effective treatments, such as the use of tranexamic acid to reduce the risk of death in patients with trauma-related bleeding (as shown in the Clinical Randomisation of an Antifibrinolytic in Significant Hemorrhage 2 [CRASH 2] study<sup>46</sup>). They also provide evidence of useless and potentially harmful practices, such as the administration of glucocorticoids<sup>47</sup> and the use of albumin for fluid resuscitation in the treatment of patients with major head injuries.<sup>48</sup>

In low-resource settings, where surgeons are not readily available, evidence indicates that outcomes can be improved if nonspecialist physicians or nonphysician clinicians can be trained in certain skills that would normally be carried out by emergency physicians or trauma surgeons in centers with better resources.<sup>50-54</sup> Although such task shifting is likely to be widespread, particularly in low-income countries, there is scant information on exactly how it is done, and rigorous evaluations are needed to inform practice. Many important issues remain unresolved, even in high-income countries, such as which system (e.g., specialist pediatric trauma center, adult trauma center, or adult trauma center with pediatric specialists) offers severely injured children the best odds for recovery<sup>55</sup> and how best to evaluate the effectiveness of trauma systems.<sup>56</sup>

**REHABILITATION**

In June 2011, the WHO and the World Bank issued the World Report on Disability, the first-ever global report on disabilities.<sup>57</sup> The report comprehensively outlined the scope of rehabilitation services available worldwide and the range of services that might be provided, especially in low- and middle-income countries, where few such services currently exist. However, the report also made it clear that although some rehabilitation services are supported by an evidence base, the majority are not, and the field is almost totally lacking in large, randomized, controlled trials. The Physiotherapy Evidence Database,<sup>58</sup> for example, which records

information on more than 20,000 trials, shows that many of these trials were poorly designed, involved small numbers of patients, and did not provide evidence of effectiveness with regard to major health outcomes. Not surprisingly, the World Report calls for more research to ensure the development of rehabilitation guidelines that are based on strong evidence.<sup>55</sup>

#### THE WAY FORWARD

Given the uncertainties about the quality of current data on injuries in some countries<sup>59</sup> and the absence of data in others,<sup>60</sup> there remains a need to more accurately define the burden of injuries. Yet, there can be no doubt that injuries are already a major global health issue and require the same attention as that afforded HIV-AIDS, malaria, and tuberculosis.

Increasing economic development in low- and middle-income countries, accompanied by increasing levels of motorization, almost ensures that the projected increases in the global burden

of injury will be realized. These increases can be mitigated only if the evidence-based strategies for prevention and management that have been developed are adopted worldwide and if innovative and cost-effective approaches continue to be identified. To achieve the latter, we must ensure that the medical and public health communities, particularly in low- and middle-income countries, become “injury-literate.” In addition to capacity-building initiatives such as those offered by the TEACH-VIP<sup>61</sup> and MENTOR-VIP<sup>62</sup> programs of the WHO — both of which aim to introduce those in public health to the topic of injury prevention, with the latter focusing particularly on those committed to working in the injury field — and the capacity-building activities offered by the Road Traffic Injuries Research Network,<sup>63</sup> medical schools, schools of public health, and programs associated with the training of allied health professionals will need to be at the forefront of providing such education.

Disclosure forms provided by the authors are available with the full text of this article at [nejm.org](http://nejm.org).

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