

Chapter 3

Road Traffic Injuries

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INTRODUCTION

Road traffic injuries (RTIs) are the leading cause of unintentional injuries, accounting for the greatest proportion of deaths from unintentional injuries. They are the leading cause of injury-related disability-adjusted life years (DALYs), and they pose a significant economic and societal burden. Despite this burden, RTIs remain a largely neglected public health problem, especially in low- and middle-income countries (LMICs), where urbanization and motorization are rapidly increasing. Unfortunately, reliable data on the burden of RTIs and cost-effective interventions in LMICs are sorely lacking. In 2010, global efforts to reduce the burden of road safety injuries received a major boost when the United Nations (UN) General Assembly launched the Decade of Action for Road Safety 2011–2020, with a goal of saving 5 million lives worldwide by 2020 (United Nations Road Safety Collaboration 2010). Since then, awareness of road safety and its close relationships to economic and social development has grown significantly, and activities that promote road safety at international and national levels have gained new momentum.

This chapter uses the latest global and regional estimates to characterize the burden of RTIs, including their mortality; morbidity; and economic and social impacts on individuals, families, and society. It summarizes economic evidence on proven and promising interventions that address the burden. The goal of this chapter is to

further inform the global discourse on reducing RTIs worldwide, with a special focus on LMICs, where 90 percent of fatal RTIs occurred yet only 54 percent of global vehicles were registered (WHO 2015a).

HEALTH BURDEN OF ROAD TRAFFIC INJURIES

Each day, more than 3,400 people die on the world's roads (1.25 million people each year), making RTIs the ninth leading cause of death globally (WHO 2014). The global rate of mortality resulting from RTIs has increased 46 percent since 1990 (Lozano and others 2012). Latest estimates from the Global Health Estimates (WHO 2014) show that road traffic crashes were responsible for 24 percent of all injury-related deaths globally (figure 3.1)—and a total of 78.7 million DALYs lost in 2012, up from 69.1 million in 2000 (WHO 2014). Current trends suggest that RTIs will become the seventh leading cause of death by 2030 unless action is taken (WHO 2015a).

Across World Health Organization (WHO) regions, the highest road traffic mortality rate was in Africa (26.6 per 100,000 population); the lowest was Europe (9.3 per 100,000) (WHO 2015a). Over the past two decades, in the absence of effective road safety programs, mortality resulting from RTIs has increased steadily in East Asia, South Asia, and Eastern and Western Sub-Saharan Africa

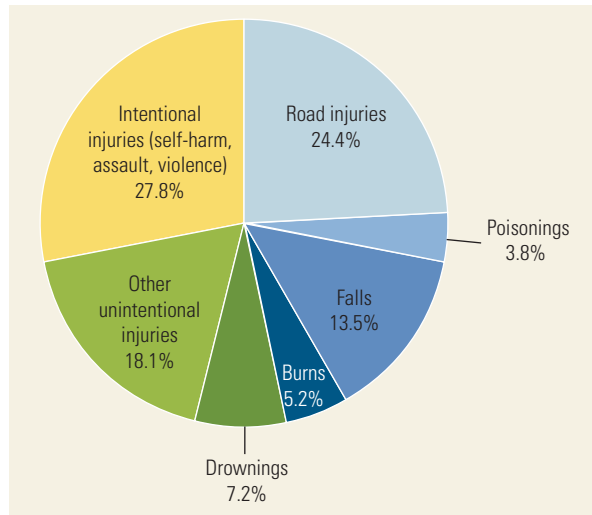
(Odero, Khayesi, and Heda 2003; WHO 2014). This trend contrasts with that in high-income countries (HICs), where road traffic fatalities are on a downward trajectory following the implementation of safety programs over the past decade (table 3.1) (Garcia-Altes, Suelves, and

Barberia 2013; WHO 2013a, 2014). Importantly, within the same region, considerable disparity exists in death rates across countries of different income status. In Europe, for example, low-income countries (LICs) had RTI mortality rates more than twice those for HICs (18.8 per 100,000 versus 8.3 per 100,000, respectively) (WHO 2015a).¹

LMICs overall bear a disproportionately high burden of RTIs (Hyder, Labinjo, and Muzaffar 2006; Hyder, Muzaffar, and Bachani 2008; Hyder and others 2013; Hyder and Peden 2003; WHO 2013a). They have a little more than 50 percent of the world's vehicles but more than 90 percent of the road traffic deaths (WHO 2015a). More than twice as many individuals per 100,000 population die from RTIs in LMICs compared to HICs (WHO 2014, 2015a) (table 3.1). Even within HICs, individuals from lower socioeconomic backgrounds are more likely to be involved in road traffic crashes than their more affluent counterparts (WHO 2015b).

All types of road users are at risk of RTIs, but marked differences exist in the fatality rates. In particular, *vulnerable road users* (such as pedestrians and users of two-wheelers) are at greater risk compared to motor-vehicle occupants, and they usually bear the greatest

Figure 3.1 Global Mortality from All Injuries, 2012



Source: WHO 2014.

Table 3.1 Death Rates and Rates of DALY Losses Resulting from Road Traffic Injuries, by Gender and Income, 2012 and 2000

	2012								
	Global			LMICs			HICs		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
<i>Deaths (per 100,000 population)</i>									
All unintentional injuries	52.5	67.0	37.8	55.6	70.6	40.1	39.0	50.3	28.0
RTIs	17.7	25.6	9.7	19.6	28.2	10.8	9.2	13.9	4.8
<i>DALY losses (per 100,000 population)</i>									
All unintentional injuries	3,211.4	4,216.2	2,190.2	3,434.0	4,477.8	2,361.6	2,216.5	3,011.7	1,446.4
RTIs	1,112.6	1,603.8	613.5	1,217.3	1,744.2	676.0	644.8	957.3	342.1
2000									
<i>Deaths (per 100,000 population)</i>									
All unintentional injuries	57.7	74.6	40.4	60.1	76.4	43.3	47.5	66.9	29.0
RTIs	16.7	24.3	8.9	17.0	24.7	9.1	15.4	22.9	8.3
<i>DALY losses (per 100,000 population)</i>									
All unintentional injuries	3,772.6	4,942.0	2,585.8	4,008.3	5,152.6	2,830.0	2,807.4	4,047.0	1,621.7
RTIs	1,129.0	1,636.1	614.3	1,163.0	1,672.4	638.4	989.9	1,481.8	519.4

Source: WHO 2014.

Note: DALY = disability-adjusted life year; HICs = high-income countries; LMICs = low- and middle-income countries; RTIs = road traffic injuries.

burden of injury (Peden and others 2004). For example, almost 50 percent of the global road traffic deaths occur among vulnerable road users—motorcyclists (23 percent), pedestrians (22 percent), and cyclists (4 percent) (WHO 2015a). In many LMICs, where the proportion of vulnerable road users is as high as 57 percent, few, if any, interventions are in place to protect these road users; pedestrian deaths account for almost 40 percent of all road injury fatalities in LICs and about 20 percent in middle-income countries (Bachani, Koradia, and others 2012; Bachani, Zhang, and others 2014; Hyder and Bishai 2012; Hyder, Ghaffar, and Masood 2000; WHO 2013a).

Definite data on the number of people who survive RTIs but live with disabilities are almost nonexistent. However, estimates suggest that for every one RTI-related death, an additional 20–50 more individuals suffer some disability (Peden and others 2004). The WHO estimates that RTIs accounted for a total of almost 14 million life years lost annually due to disability in 2012 globally; RTIs represented 30 percent of the injury-related disability burden (WHO 2014).

Empirical evidence in LMICs (although limited and with varied quality) supports these estimates. For example, a study in Arkhangelsk, the Russian Federation, that investigated trends in traffic crashes between 2005 and 2010 found 217 fatalities and 5,964 non-fatal injuries. The study used police data, which was considered the most reliable existing data source for this purpose (Kudryavtsev and others 2013). Another study in China (using a national disability survey) estimated the prevalence of RTI-related disability to be 1.12 per 1,000 population in 2006 (Lin and others 2013). Given the high burden of disability associated with RTIs, better measurement of this disability is necessary not only to highlight but also to develop appropriate strategies for addressing this burden. Recent applications of approaches to obtaining empirical population-level data on the prevalence and impact of disability in LMICs is a step in the right direction (Bachani, Galiwango, and others 2014, 2015; Madans and Loeb 2013; Madans, Loeb, and Altman 2011).

The significant burden of RTIs in terms of both premature mortality and disability is attributable to the fact that young adults (ages 15–44 years) are among the most affected age group. More than 460,000 young people under age 30 years die in road traffic crashes each year—about 1,262 a day (WHO 2007, 2013b, 2014). Among them, more than 75 percent of the deaths occur among young men (WHO 2015b). The rates of both injury-related death and DALY losses were about three times higher among men than women in both LMICs

and HICs in 2012, and the gender disparity has persisted over the past decade (table 3.1) (WHO 2014).

ECONOMIC AND SOCIETAL BURDEN OF ROAD TRAFFIC INJURIES

Economic Burden

In addition to the health burden, RTIs account for profound economic costs to individuals, families, and societies. In resource-constrained settings, assessing RTI-related costs would help policy makers and health planners to prioritize and choose the most appropriate interventions to control and prevent RTIs (Bishai and Bachani 2012). However, accurately quantifying these costs is not easy. The tangible costs—direct costs, such as medical costs, and indirect costs, including lost productivity and economic opportunity—can be estimated in economic terms; the intangible costs associated with suffering and pain, however, often are more difficult to assess.

Three approaches have been developed to estimate costs of injury: the human capital, willingness-to-pay, and general equilibrium frameworks (Bishai and Bachani 2012).

- **The human capital approach** estimates the aggregated injury costs at societal, national, and regional levels as the sum of the costs at the individual level, including direct medical costs, indirect lost productivity costs, and intangible psychological costs of pain and suffering. The strategies for measuring pain and suffering in this model are not fully developed, and most studies using this approach exclude this component. Because of its structured nature and the ability to compartmentalize costs into different categories, the human capital framework remains the most common approach to value RTI-related injury and death, especially in LMICs (Bishai and Bachani 2012).
- **The willingness-to-pay approach** estimates the value of pain and suffering by asking what people would be willing to pay to live in a world with a lower risk of injuries. By placing monetary values on injuries that are grounded in the consumers' own preferences, this approach provides an option for including estimates of the value of pain and suffering to determine the cost of injuries.
- **The general equilibrium approach** provides strategies for actually measuring the costs from a broader macroeconomic perspective using simulation-modeling techniques. The estimates using this approach are a dynamic assessment of the present value of forgone consumption opportunities resulting from injuries. However, this approach has not been applied to estimating costs of injuries.

Comparisons across these approaches are not appropriate because of the different methodologies and different level of data (micro versus macro) used in the three measures.

Because of the demand for epidemiologic data on the number and nature of RTIs, as well as the challenges of measuring intangible costs, few studies have attempted to estimate RTI-related costs, but this has been changing over the past decade. One large 21-country study estimated that the global cost of RTIs was US\$518 billion; the costs of RTIs at the national level in most cases exceeded 1 percent of the gross national product (GNP) (Jacobs, Aeron-Thomas, and Astrop 2000). Another study that used the human capital approach in 11 HICs gave an average cost equivalent to 1.3 percent of the GNP in the 1990s—ranging from 0.5 percent for the United Kingdom to 2.8 percent for Italy (Elvik 2000). More recent studies in Australia (Connelly and Supangan 2006), the Republic of Korea (Lim, Chung, and Cho 2011), New Zealand (O’Dea and Wren 2010), and the United States (Blincoe and others 2015) have also highlighted the significant burden that RTIs impose on a nation’s economy. A WHO analysis reveals similar economic burden of RTIs across countries—ranging from 0.2 percent of the gross domestic product (GDP) in Chile and Jamaica to 7.8 percent in South Africa (WHO 2015a).

Cost studies on RTIs in LMICs often are scant because of the poor capacity of health information systems in these settings (WHO 2013a). Studies show that RTIs cost approximately US\$89.6 billion a year (in 2012 US\$) in LMICs, or 1–2 percent of their GNPs (Jacobs, Aeron-Thomas, and Astrop 2000). The high RTI-related costs as a share of GNP have also been shown in a few country-specific studies, including Bangladesh (Mashreky and others 2010), Belize (Perez-Nunez and others 2010), China (Zhou and others 2003), Uganda (Benmaamar, Dunkerley, and Ellis 2002), and Vietnam (Nguyen and others 2013; Nguyen and others 2015).

Using the human capital approach, researchers in Vietnam estimated that each RTI cost about 6 months of average salary during hospitalization (US\$420 [in 2012 US\$]), and the average costs during recovery (12 months after hospital discharge) were equivalent to an entire year of income (US\$919 [in 2012 US\$]) (Nguyen and others 2013, Nguyen and others 2015). Similarly, the total economic costs of injury including direct and indirect costs in Belize represented 0.9 percent of the GDP in 2007 (Perez-Nunez and others 2010). In addition, researchers using the willingness-to-pay approach estimated that each motorist fatality cost \$0.55 million (in 2012 US\$) in Malaysia (Mohd Faudzi, Mohamad, and Ghani 2011), and the value of a Sudanese pedestrian

ranged between US\$0.02 million to US\$0.10 million (Mofadal, Kanitpong, and Jiwattanakupaisarn 2015). Although these studies clearly demonstrate the adverse impact of RTIs on economic and social development, more studies and improved health information systems in LMICs are needed to document and understand the full extent and nature of this burden.

Societal Burden

Despite the progress made in understanding the epidemiology and economic burden of RTIs, understanding of the long-term societal impact of RTIs remains inadequate. Evidence of the significant societal impact of RTIs is limited and mostly available only for HICs. For example, the European Commission estimates that more than 30,000 people were killed and more than 120,000 were permanently disabled by RTIs in 2011; as a result, nearly 150,000 families struggled with the consequent devastation (European Commission 2014). A similar study in the United Kingdom estimated that about 1.1 percent of the total population (more than 130,000 individuals) in the whole of England and Wales had lost a close family member in a fatal RTI since 1971, subjecting many of them to mental health and other consequences (Sullivan and others 2009).

In LMICs, because of the scarcity of good medical care, rehabilitation services, and financial protection mechanisms, individuals often rely heavily on their social networks for support. In these settings, injuries often have far-reaching implications that need to be understood to better address the burden. Studies examining the social impact of RTIs in LMICs are almost nonexistent (Peden and others 2004). However, those that do exist show that road traffic crashes and resultant deaths or disabilities can take a heavy toll on families and friends of injured persons, many of whom experience adverse financial, physical, social, and psychological stresses. For example, families and friends of injured persons reallocate work or change work patterns to provide care. Often, debts are incurred because of the expensive rehabilitation services and reduced income (Mock, Arreola-Risa, and Quansah 2003). Children in these households can be pressured to leave school or can suffer from decreased supervision (Mock, Arreola-Risa, and Quansah 2003).

RISK FACTORS FOR ROAD TRAFFIC INJURIES

The Haddon matrix revolutionized the understanding of the multifactorial nature of the causes and risk factors of RTIs, and it has made a substantial contribution to the reduction of RTIs (Haddon 1968, 1973). The matrix

Table 3.2 Risk Factors of Road Traffic Injuries: The Haddon Matrix

Phase	Host (human)	Agent (vehicles and equipment)	Environment	
			Physical	Socioeconomic
Precrash	Speeding	Insufficient lighting	Flaws in road design (for example, lack of lane separation)	Lack of comprehensive traffic safety law
	Driving while impaired (for example, alcohol-impaired driving)	Compromised braking	Flaws in road layout (for example, lack of separation of vehicles and vulnerable road users)	Inadequate licensing system for drivers
	Inexperienced and young drivers	Inadequate maintenance	Improper speed limits	Economic pressure (for example, social deprivation)
	Distracted driving		Lack of pedestrian facilities	
	Poor road user eyesight Substance use		Lack of alternative modes of traveling Insufficient visibility	
Crash	Failure to use restraints (for example, seatbelt, child seat)	Lack of occupant restraints	Non-forgiving roadside (for example, lack of crash barriers)	
	Failure to wear a helmet	Compromised braking Insufficient crash-protective design	Poorly designed and maintained roads	
Postcrash	No first-aid skills	Fire risk	Inadequate rescue facilities	Inadequately trained EMS ^a and rehabilitation personnel
	Lack of access to medical personnel	Leakage of hazardous materials	Congestion	Inadequate prehospital care

a. Emergency Medical Services.

provided a framework to integrate the traditional epidemiological triangle of host, vector, and environment with a temporal perspective in terms of precrash, crash, and postcrash phases (table 3.2) (Haddon 1973). This approach facilitates the analysis of potential interventions covering the spectrum from primary prevention to rehabilitation. The matrix has been broadly applied in both HICs and LMICs to assist with a systematic understanding of the epidemiology and risk factors, and to facilitate the ability to prioritize the most appropriate preventive and curative measures (Brice and others 2011; Chorba 1991; Short, Mushquash, and Bedard 2013).

Precrash Risk Factors

Risk factors at the precrash phase include those that predispose individuals to be involved in a crash. At the individual level, these include speeding, driving while impaired, driving while distracted, being inexperienced or young, and using substances; at the vehicle level, these include compromised braking and inadequate lighting and maintenance; and at the environmental level, these include both physical and socioeconomic factors (Herbert and others 2011).

Crash Risk Factors

Risk factors at the crash phase mainly affect the outcomes in terms of injury severity and fatality. Risk factors at the individual level include failure to use seatbelts, helmets, and child restraints. Vehicles without occupant restraints and crash-protective design or with compromised braking lead to a higher risk of injury death and more severe disability. At the environmental level, poorly designed and maintained roads, low visibility, and lack of crash-protective roadside objects also put road users in danger. Although failure to use seatbelts, helmets, or child restraints significantly increases risk of RTIs and deaths among vehicle occupants, many LMICs have no mandatory requirements; even if they do, compliance and law enforcement often are limited (Peden and others 2004).

Postcrash Risk Factors

While preventing road traffic crashes is always desirable, a comprehensive road safety strategy is incomplete without a focus on improving postcrash care for injured persons to reduce fatalities and improve outcomes. Many LMICs lack appropriate and adequate postcrash

care, contributing to the high burden of deaths and disability resulting from RTIs (Khorasani-Zavareh and others 2009; Miranda and others 2013; Paravar and others 2013; Solagberu and others 2014).

In 2007, global efforts to improve postcrash care, including trauma and emergency care services, gained major momentum when a World Health Assembly adopted a resolution that called on governments and the WHO to increase their efforts to improve care for victims of injuries and other medical emergencies (WHO 2011). It also called on the WHO to raise awareness about affordable ways in which trauma and emergency care services can be strengthened, especially through universally applicable means, such as improvements in organization and planning (WHO 2011). Other studies from LMICs have highlighted a similar need and opportunities to improve care for injured patients (Hyder and Razzak 2013). Documented case studies have shown that improvements can be made even in the poorest and most difficult settings (Mock and others 2010). For example, the simple administration of tranexamic acid to actively bleeding patients in the acute care phase could prevent thousands of premature deaths (Ker and others 2012). Therefore, implementing interventions based on the assessment of risk factors, together with good post-crash care practices, has the potential to save and improve the lives of RTI victims and move closer to the goal of the Decade of Action for road safety (United Nations Road Safety Collaboration 2010).

INTERVENTIONS

Most road traffic deaths and serious injuries are preventable, because crash risk is largely predictable; therefore, many proven or promising countermeasures can be implemented. RTIs respond well to targeted interventions that prevent the occurrence of the injury, minimize the severity of the injury sustained, and mitigate the sequelae.

Although no blueprint for road safety exists, a broad consensus exists on several principles for interventions:

- Reducing risk exposure by stabilizing motorization levels, providing alternative modes of travel, and improving land-use planning practices
 - Reducing risk factors directly related to crash causation, such as speeding, drinking and driving, using unsafe vehicles on unsafe roads (with inadequate safety features for the traffic mix), and failing to enforce road safety laws effectively
 - Reducing severity of injuries by mandating and enforcing the use of seat belts, child restraints, and helmets, as well as by improving road infrastructure and vehicle design to protect all road users
- Improving postcrash outcomes, from appropriate and life-saving measures at the scene of the crash through rehabilitation services.

In addition to these fundamental principles, political will and commitment are essential to reducing the burden of RTIs.

The Decade of Action for Road Safety 2011–2020 adopts a systems approach to addressing the burden of RTIs, and proposes five pillars: road safety management, safer roads and mobility, safer vehicles, safer road users, and postcrash care (United Nations Road Safety Collaboration 2010).

Safer Road Users

Effective legislation that establishes safety codes and punishes unsafe behavior is the first and foremost intervention needed to reduce RTIs. Currently, 91 out of 180 countries have national laws that address the key risk factors, including speeding; driving under the influence; and failing to use motorcycle helmets, seat belts, and child restraints. Since 2011, 17 countries have amended their laws on one or more key risk factors for RTIs to bring them in line with best practice (WHO 2015a). However, little progress has been made globally in extending the coverage of national laws to include all key risk factors (WHO 2015a).

Encouraging a culture of safe road behavior guided by legislation requires not only a high level of enforcement but also a high public perception of enforcement (WHO 2013a). A large body of research (although few studies were conducted in LMICs) shows that:

- Establishing and enforcing speed limits according to designated functions of the roads can reduce RTIs by up to 34 percent (WHO 2013a).
- Setting legislative limits on blood alcohol concentrations at 0.05 grams per deciliter (g/dl) and conducting random breath tests can significantly reduce alcohol-related RTIs (Elvik and others 2009; Shults and others 2001). Despite global progress in strengthening legislation that penalizes alcohol-impaired driving, LMICs are less likely than HICs to adopt the practices (WHO 2013a).
- Introducing and enforcing the use of motorcycle helmets can reduce the risk of death by 40 percent and the risk of serious head injuries by more than 70 percent, yet LMICs are less likely to adopt the practices (Liu and others 2008).
- Introducing and enforcing the use of seatbelts can reduce the risk of fatal injuries by up to 50 percent for front seat occupants and up to 75 percent for rear seat

occupants (Zhu and others 2007). Although most countries have mandatory seatbelt laws, the legislation often does not extend to rear seat occupants (WHO 2013a).

- Mandating the use of child restraints can reduce the likelihood of a fatal crash for children by up to 80 percent (Zaza and others 2001). However, such laws do not always exist in LMICs. For example, only 1 out of 10 South-East Asian countries has a law requiring child restraints (WHO 2015a).

Effective enforcement of traffic laws in low-resource settings could provide economic benefits. Research shows that observance of traffic codes (Bishai and Hyder 2006) and the use of motorcycle helmets (Bishai and Hyder 2006) and seatbelts (Chisholm and others 2012) can be very cost-effective in preventing RTIs in LMICs. While a paucity of good evidence in LMICs of the effectiveness of education exists (as indicated by a systematic review of 15 randomized controlled trials on the effectiveness of safety education programs), some have testified to the synergistic effects of approaches that combine education with legislation and enforcement (Duperrex, Bunn, and Roberts 2002; Sedlák, Grivna, and Cihalova 2006).

Safer Vehicles

More than 1.8 billion vehicles are registered globally, and more than half of them are in LMICs (WHO 2015a). The increasing demand for mobility has led to rapid motorization (especially in LMICs), creating challenges for safer transport. Strategies focusing on safer vehicles have expanded, from protecting those inside of vehicles to protecting those outside of vehicles. As automakers have refined advanced technology designed to prevent or mitigate crashes, they have introduced it into passenger vehicle models. While limited data on the effectiveness of safety technologies exists, some (such as crash avoidance systems) showed the potential to mitigate RTIs (Jermakian 2011; WHO 2013a). A study in France shows that while public safety measures (such as speed cameras) contributed to a greater than 75 percent reduction in road crash fatalities, enhanced vehicle safety technologies directly saved 27,365 car occupants and 1,083 pedestrian from fatal crashes between 2000 and 2010 (Page, Hermitte, and Cuny 2011). Furthermore, a literature review on road safety interventions shows that electronic stability control systems were associated with a 2–41 percent reduction in RTIs (Novoa, Pérez, and Borrell 2009). The study also noted that the most successful interventions are those that reduce or eliminate the hazard of RTIs and do not rely on changes in road users' behavior (Novoa, Pérez, and Borrell 2009).

Safer vehicles in LMICs are scarce, however, because of costs and inadequate government safety regulations on the automotive industry (IIHS 2013). For example, the Latin New Car Assessment Program (NCAP) evaluated car models in the Latin America market and found that those earning the lowest rating in safety equipment (one out of five stars) were among the top selling cars (IIHS 2013). Furthermore, while frontal airbags for the driver and front passenger have been standard equipment on vehicles in the United States since 1999, they typically were optional equipment on car models in LMICs (IIHS 2013).

In addition to four-wheeled vehicles, the surge of motorized two-wheelers (motorcycles and electric bikes, or e-bikes) in LMICs is even more concerning, especially in South-East Asia and Africa. For example, in Malaysia and Thailand, these vehicles were adopted at a ratio of three persons per vehicle and four persons per vehicle, respectively, in 2011 (Sekine 2014). Both countries had significantly higher fatality rates in motorcycle crashes: 62 percent in Malaysia and 73 percent in Thailand (WHO 2015a).

Looking to address the safety of vehicles in LMICs, the Global NCAP offers a stakeholder movement (as part of the UN's Decade of Action for Road Safety) to encourage adoption and enforcement of harmonized motor vehicle standards in LMICs to promote safer vehicles (NCAP 2011).

Safer Infrastructure

Poorly designed road networks that lack sufficient safety measures significantly increase RTIs. Results of the International Road Assessment Program in LMICs show that about half of the roads assessed in these countries are rated in the highest risk category, largely because 84 percent of the roads assessed where pedestrians are present have no footpaths (WHO 2013a). This contributes in part to the high proportion (60 percent) of all road traffic deaths in these countries among vulnerable road users (WHO 2013a).

A growing number of countries have amended their national transport policies to encourage alternative modes of transport, such as walking and cycling, or to increase investment in public transport systems to deal with increased motorization and RTIs (WHO 2013a). However, these approaches often have lacked the appropriate strategies for heterogeneous traffic environments or the required resources to ensure the safety of vulnerable road users; these deficits have the potential to counteract the intended effect of the interventions (WHO 2013a). For example, separating vulnerable road users (pedestrians, motorcyclists, and cyclists) from larger and faster vehicles

while promoting programs such as city cycling has been shown to reduce injuries and fatalities (Herrstedt 1998; Radin, Mackay, and Hills 2000; Vieira Gomes and Cardoso 2012; Wittink 2001). However, only 91 countries have policies that physically separate vulnerable road users from other road users (WHO 2015a). Other safety features with proven effectiveness include adequate lighting (Radin, Mackay, and Hills 1996, 2000); adequate lane markings or signage (Ward and others 1989); appropriate pedestrian crossings (Dalby 1981); and roadside barriers (Bambach, Mitchell, and Grzebieta 2013), among others (Duduta and others 2011; Fuentes and Hernandez 2013; Mock, Arreola-Risa, and Quansah 2003).

Traffic calming measures (such as the use of speed bumps or rumble strips) are effective in reducing RTIs (Changchen and others 2010; Lines and Machata 2000; Novoa, Pérez, and Borrell 2009). Those and other measures that limit vehicle speed in areas with high concentrations of vulnerable road users were found to reduce the risk of vehicle crashes with pedestrians by 67 percent (WHO 2013a). However, only 47 countries representing 950 million people have set effective urban speed limits; of those, only 27 countries rate their enforcement of the speed laws as good (WHO 2015a).

Proven and Promising Interventions

The *World Report on Road Traffic Injury Prevention* remains the seminal document discussing proven and promising interventions for road traffic injury prevention (Peden and others 2004). Randomized controlled trials (RCTs) are the gold standard for assessing effectiveness of interventions; however, given the resources that such trials require and the ethical issues of randomizing life-saving interventions, RCTs are rarely used to evaluate road safety interventions.

Consequently, proven interventions rely heavily on case-control or before-and-after studies, but even these are largely concentrated in HICs. Road safety approaches in LMICs in recent years have focused on adapting strategies that worked in HICs and achieved good results. As table 3.3 shows, some interventions focus on reducing or eliminating exposure to risk factors among vulnerable road users, such as promoting alternative modes of transport (Duduta and others 2011), constructing exclusive lanes for motorcyclists (Radin, Mackay, and Hills 2000), increasing visibility of pedestrians and cyclists (Radin, Mackay, and Hills 1996, 2000), and supervising children walking to school (Muchaka and Behrens 2012; Muda and Ali 2006).

Table 3.3 Examples of Proven and Promising Road Safety Interventions Implemented in LMICs

Interventions proven in HICs	Implementation and evaluation in LMICs		
	Country	Study design	Results
Providing and encouraging use of alternative forms of mass transportation	Guadalajara, Mexico	Before-and-after study of the impact of Macrobus on crashes	46 percent reduction in crashes after Macrobus was implemented (Duduta and others 2011)
Increasing the visibility of pedestrians and cyclists	Seremban and Shah Alam, Malaysia	Time series study of the use of daytime running lights for motorcycles	29 percent reduction in visibility-related motorcycle crashes (Radin, Mackay, and Hills 1996, 2000)
Supervising children walking to school	Kuala Teregganu, Malaysia	Case-control study assessing the risk of injury to children walking or cycling to school who were supervised by parents	Risk of injury was reduced by 57 percent among supervised children (Muda and Ali 2006)
Separating different types of road users	Selagor, Malaysia	Video observational study of crashes and outcomes after introduction of an exclusive motorcycle lane	39 percent reduction in motorcycle crashes, and 600 percent decrease in fatalities (Radin, Mackay, and Hills 2000)
Reducing average speeds through traffic calming measures	China	Before-and-after study of simple engineering measures (such as speed humps, raised intersections, and crosswalks) on speed and casualties	Average speed dropped by 9 percent in three of four intervention sites; overall number of casualties dropped by 60 percent (Changchen and others 2010)
Setting and enforcing speed limits appropriate to the function of roads	Londrina, Brazil	Time series study on enforcement of speed control, seat belt use, new traffic code, and improved prehospital care	Reduction in mortality to 27.2 per 100,000 population after one year of implementing a new traffic code (De Andrade and others 2008)

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Table 3.3 Examples of Proven and Promising Road Safety Interventions Implemented in LMICs (continued)

Interventions proven in HICs	Implementation and evaluation in LMICs		
	Country	Study design	Results
Setting and enforcing blood alcohol concentration limits	Kampala, Uganda	Time series study on enforcement of alcohol-impaired driving and speed laws	17 percent reduction in traffic fatalities after intervention (Bishai and others 2008)
	Villa Clara, Cuba	Time series study on enforcement of alcohol-impaired driving during weekends	29.9 percent reduction in traffic crashes, 70.8 percent reduction in deaths, and 58.7 percent reduction in injuries, compared with previous year (2002) (Garcell and others 2008)
Setting and enforcing the use of seat belts for all motor vehicle occupants	Iran, Islamic Rep.	Before-and-after study of seat belt and helmet enforcement and social marketing	Death rates reduced from 38.2 per 100,000 population in 2004 to 31.8 in 2007 ($p < 0.001$); death rate per 10,000 vehicles reduced from 24.2 to 13.4. (Soori and others 2009)
	Guangzhou, China	Before-and-after study of enhanced enforcement and social marketing on seat-belt wearing	12 percent increase in prevalence of seat belt use ($p = 0.001$) (Stevenson and others 2008)
Setting and enforcing motorcycle helmet use	Cali, Colombia	Time series analysis of fatalities following implementation of mandatory helmet law, reflective vests, restrictions on when motorcycles can be used, and compulsory driving training	52 percent reduction in motorcyclist deaths (Espitia-Hardeman and others 2008)
	Thailand	Before-and-after survey using trauma registry data following implementation of helmet law	Helmet use increased 5-fold, injuries decreased by 41 percent, and deaths decreased by 20.8 percent (Ichikawa, Chadbunchachai, and Marui 2003)
	Vietnam	Time series observational study in three provinces following introduction of mandatory motorcycle helmet law	16 percent reduction in injuries, and 18 percent reduction in deaths (Passmore, Tu, and others 2010)
	Malaysia	Time series study of motorcycle-related crashes, injuries, and fatalities following implementation of a Motorcycle Safety Program using annual police statistics	25 percent reduction in motorcycle-related crashes, 27 percent reduction in motorcycle-related casualties, and 35 percent reduction in motorcycle fatalities (Law and others 2005)
Encouraging helmet use among child bicycle riders	Czech Republic	Case-control study of helmet enforcement, education, and reward campaign at schools	100 percent increase in helmet use, and 75 percent reduction in head injury admission rates (Sedlák, Grivna, and Cihalova 2006)

Note: LMICs = low- and middle-income countries.

Other interventions focus on addressing the five major behavioral risk factors of RTIs by setting blood alcohol concentration limits (Bishai and others 2008; Garcell and others 2008), setting or reducing speed limits (Changchen and others 2010; De Andrade and others 2008), and enforcing the use of seatbelts for drivers and passengers and helmets for motorcyclists and bicyclists (Espitia-Hardeman and others 2008; Ichikawa, Chadbunchachai, and Marui 2003; Law and others 2005; Passmore, Nguyen, and others 2010; Passmore, Tu, and others 2010; Sedlák, Grivna, and Cihalova 2006; Soori and others 2009; Stevenson and others 2008).

Four additional types of interventions that have proven applicability in HICs but that have yet to be eval-

uated in LMICs (or the results of studies yet to be published in the peer-reviewed literature) are as follows:

- Setting and enforcing lower blood alcohol limits for novice drivers
- Setting and enforcing the usage of appropriate child restraints
- Reducing speed limits around areas with high pedestrian densities, such as schools and hospitals
- Implementing graduated driver licensing systems for new drivers.

However, challenges exist when adapting interventions to the LMIC context. The “effectiveness” realized often is subject to a variety of factors, including the

law-making process and long-standing values, norms, and behaviors. Moreover, when trying to identify and quantify the interventions in LMICs, research and implementation capacity (as well as access to funding and costs) play important roles in the effectiveness element (Perel and others 2007).

Economic Analysis of Interventions

Data on the economic benefits of these interventions, especially in LMICs, are limited. Although some data are available in HICs (such as the net economic benefits of these interventions), the starkly different costs associated with property losses, disability, and medical care make simply translating the conclusions from HICs to LMICs difficult. A recent systematic review of studies on costs, cost-effectiveness, and economic benefits of interventions for RTIs and other types of unintentional injuries in LMICs found that, of the 30 economic evaluations published before February 2013, only two studies analyzed the costs of road safety interventions or devices (Wesson and others 2013). The costs reported below have been updated to 2012 US\$ for easier comparison.

Bishai and others (2003) estimated that the budgetary expenditure on road safety at all levels of government in Uganda and Pakistan is US\$0.12 and US\$0.11 per capita, respectively. Hendrie and others (2004) examined availability, urban price, and affordability of child and family safety devices across 18 economically diverse countries and found that child safety seats and bicycle helmets were more expensive in lower-income countries than higher-income countries. For example, a bicycle helmet cost 10 hours of factory work in lower-income countries, while the cost in higher-income countries was equivalent to less than one hour of work. The study also noted that booster seats were usually not available in lower-income countries, and the average price of one was US\$277 based on limited data from eight LMICs in the study sample.

The systematic review (Wesson and others 2013) also includes six cost-effectiveness analyses exploring costs associated with RTI interventions. When comparing across interventions that report costs in terms of years of life saved (YLSs) or DALYs averted, the authors applied the WHO standards of the Choosing Interventions that Are Cost-Effective (WHO-CHOICE) project. WHO-CHOICE considers an intervention “very cost-effective” if it generates a healthy life year for less than the GDP per capita; “cost-effective” if it produces a healthy life year for less than three times the GDP per capita; and

“non-cost-effective” if it produces a healthy life year for more than three times the GDP per capita (Tan-Torres Edejer and others 2003). The authors found four cost-effectiveness studies, which have been updated to US\$ 2012:

- Bishai and Hyder (2006) modeled the cost-effectiveness of four potential interventions to increase enforcement of traffic codes (including media coverage, speed bumps, bicycle helmet legislation, and motorcycle helmet legislation) in several LMICs, using previous research findings on effective interventions in LMICs. The results indicated that the average costs per DALY averted (discounted at 3 percent) are US\$12 for installing speed bumps at high-risk junctions where 25 percent of RTIs occurred, US\$84 for providing traffic enforcement, and US\$615 for setting and enforcing motorcycle helmet use, all of which were very cost-effective.
- Chisholm and others (2012) studied the global public health responses to RTIs by estimating the population costs and effects of five enforcement strategies—speed cameras, alcohol-impaired driving and breath testing campaigns, seatbelt use, helmets for motorcyclists, and helmets for bicyclists—on reducing the RTI burden in South-East Asia and Sub-Saharan Africa. In addition to confirming the previous studies, the results suggested that simultaneous enforcement of multiple road safety laws could lead to the most health gains at the least expense.
- Ditsuwan and others (2013) focused on RTIs related to alcohol-impaired driving in Thailand and associated interventions. From a health sector perspective, they found that, when compared with doing nothing and considering only intervention costs (average costs per DALY averted), selective breath testing (US\$555), random breath testing (US\$611), mass media campaign (US\$440), selective breath testing with mass media campaign (US\$542), and random breath testing with mass media campaign (US\$576) were all very cost-effective. They also estimated that implementing all the interventions together would potentially reduce the burden of alcohol-related RTIs by 24 percent in Thailand.
- Bishai and others (2008) modeled the costs and potential effectiveness of enhanced traffic safety patrols in the capital of Uganda from the perspective of the police department. The evaluation concluded that traffic enforcement could be very cost-effective (US\$32 per YLS) in low-income countries, even from a government perspective.

Although limited, these studies demonstrate that road safety interventions are among the most cost-effective interventions. In environments of limited resources and competing priorities, such studies have resonated with policy makers. More economic evaluations of road safety interventions need be conducted in LMICs to advance this important agenda.

IMPLEMENTATION OF PREVENTION AND CONTROL PROGRAMS

Safe Systems Approach

Road traffic crashes and their outcomes depend on complex interactions, which makes a systems approach to addressing road safety desirable. The safe systems approach recognizes that multiple sectors need to work in harmony to minimize the occurrence of these crashes and their impacts (SafetyNet 2009). This approach has taken center stage and is being adapted in many settings globally (Elvik and others 2009; Gururaj 2011; WHO 2009). Among the key principles of this approach are recognizing human error in transport systems; appreciating human physical vulnerability and fallibility; promoting accountability of systems and shared responsibilities; integrating interventions; developing intersectoral approaches; highlighting ethical values; and promoting societal values for economic development, human health, and individual choices (WHO 2013a). Some well-known and successful examples of such an approach include the Swedish Vision Zero (Swedish Road Safety 2013), the Sustainable Safety Model of the Netherlands (SWOV 2006), and the Safe Systems approach of Australia (Australian Transport Council 2011).

Road Safety Policies and Integrated Approaches

To work effectively, the safe systems concept needs to be part of an integrated policy framework and a national road safety plan that define goals and objectives based on burden of RTIs at population level. Some components of the integrated strategic approach for road safety include the following:

- Developing a sound road safety management system
- Building institutional capabilities and mechanisms for interaction
- Developing sustainable policies
- Strengthening human and financial resources and capabilities
- Providing advocacy approaches

- Developing epidemiologically sound and robust information systems on road crashes, injuries, and fatalities
- Promoting intersectoral approaches
- Developing a suitable choice of evidence-based scientific interventions in conjunction with integrated monitoring and evaluation (Schopper, Lormand, and Waxweiler 2006).

The safe systems approach builds on the unique strength of each sector—ministries, other governmental agencies, private organizations, and NGOs—to integrate road safety into different policies systematically, both vertically within each sector and horizontally across sectors. The European Commission, for example, advocates that road safety policies need to utilize other related policy avenues to identify areas of integration, thereby creating opportunities for useful synergies that are in line with the safe systems approach (Elvik and others 2009; International Transport Forum 2008). The United Nations Road Safety Collaboration (UNRSC) is a great example of bringing together different sectors and stakeholders at the global level to advocate for comprehensive multisectoral approaches to addressing the burden of RTIs (United Nations Road Safety Collaboration 2010). Another great example is the Bloomberg Philanthropies Global Road Safety Program (box 3.1), a large-scale initiative that brings together a multisectoral consortium at the global and national levels to implement promising interventions to reduce the burden of RTIs in LMICs (Hyder and others 2012; Peden 2010).

The health sector is well-positioned to play a leading role in developing and integrating road safety into its mainstream agenda. Reducing occurrence of RTIs not only improves population health but also likely has far-reaching health benefits by addressing the key risk factors for road safety (Schopper, Lormand, and Waxweiler 2006). For example, limiting alcohol-impaired driving will help control non-communicable diseases, as well as improve the social welfare of the population (Global Road Safety Partnership 2007; Gururaj and others 2011). Similarly, health professionals can use their close involvement in the delivery of trauma care and rehabilitation services to advocate road safety practices, such as use of motorcycle helmets, seat belts, and child restraints. In short, the health sector needs to expand its traditional caregiving role and be involved in areas that are relevant to promoting road safety, such as data collection, advocacy, policy development, and capacity building (WHO 2013a).

Box 3.1

Case Study: Improving Seatbelt Use in the Russian Federation

Background: The Russian Federation is an upper-middle-income country with one of the highest road traffic injuries (RTIs) mortality rates (18.9 per 100,000 population in 2013 in the European Region (WHO 2015a). Every year, nearly 30,000 people are killed from RTIs, and an additional 260,000 are injured or permanently disabled on Russian roads (Department of the Federal Road Safety Inspectorate of the Russian Ministry of Interior [<http://www.gibdd.ru/stat/>]; Institute for Health Metrics and Evaluation 2013).

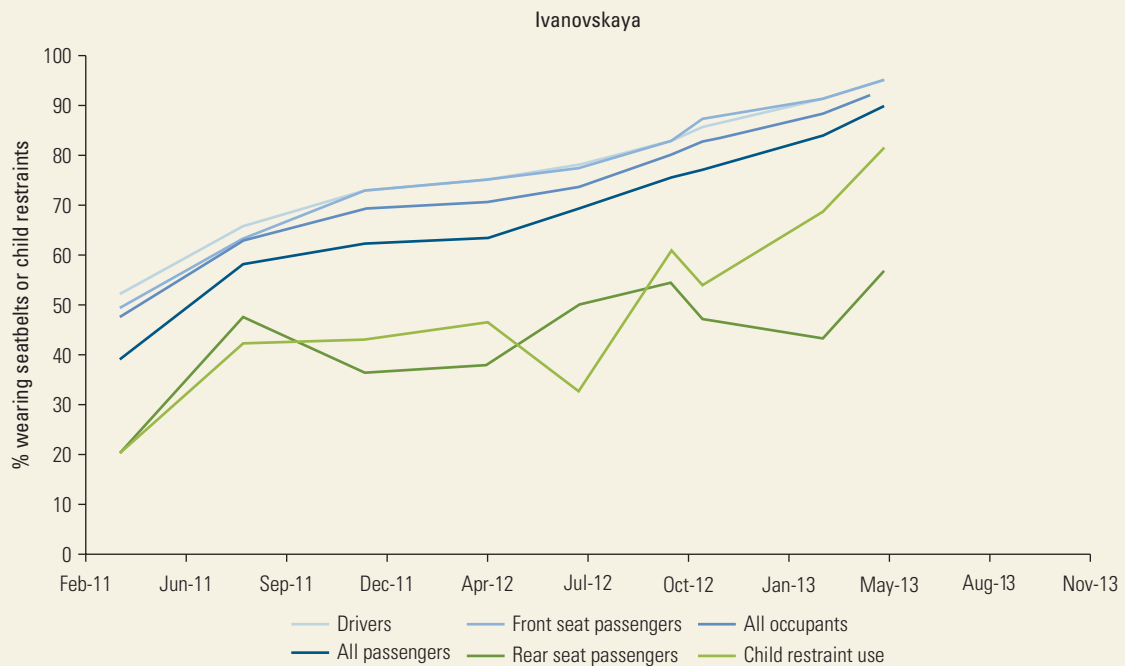
Intervention: The Bloomberg Philanthropies Global Road Safety Program (the Global Road Safety Program) in Russia aims to support the government's implementation of its national objectives in preventing deaths and serious injury on the country's roads. The program focuses on increasing the use of seatbelts and child restraints, as well as speed management, through three key activities: legislation, enhanced police enforcement, and social marketing campaigns.

Key Stakeholders and Setting: The program is administered by the Department of Road Safety within the Russian Ministry of Interior and jointly implemented by other governmental departments at the national and regional levels in two intervention sites: Ivanovskaya and Lipetskaya Oblast.

Results: Prevalence of seatbelt and child restraint use was monitored using observation studies. Results from these studies show a steady increase in seatbelt use rates in the two sites over time. As figure B3.1.1 shows, the overall prevalence of seatbelt use increased from 47.5 percent to 88.8 percent among all occupants in Ivanovskaya Oblast. Similar trends were observed in Lipetskaya Oblast, where overall seatbelt use increased from 52.4 percent to 73.5 percent over the same period. Although lower than seatbelt use, child restraint use also has increased over this period in both intervention regions.

The preliminary results of observational studies show promising signs that seatbelt use is moving in the right direction in both Oblasts since the implementation of the measures.

Figure B3.1.1 Seatbelt Use in Ivanovskaya, Russia, following Implementation of a Seatbelt Program



Source: Slyunkina and others 2013.

OPERATIONALIZING ACTION FOR ROAD SAFETY

The information presented throughout this chapter can be crystallized into actionable items that can be undertaken by countries or organizations to enhance road safety. As described in previous sections of the chapter, countries around the world have diverse landscapes for road safety, with different financial and infrastructural contexts, policy and legislative environments, as well as human resource capacities. As such, a *one-size fits all* list of “must-dos” for road safety may not be practical, but the principles of injury prevention and evidence base of road safety must guide all actions. Accordingly, we highlight five key areas of focus: resource mobilization; policy and legislative environment; intervention implementation; data systems; and capacity development.

Resource Mobilization

Despite the increasing burden of deaths and disabilities from RTIs, generating financial and political support for road safety has not been without its challenges. The health sector, for example, often pays relatively little attention to RTIs as a significant health issue, which has contributed to the limited support from government health sectors and health funders generally. This calls for a multifaceted approach that could involve the following areas:

- Forming intersectoral partnerships
- Targeting high-risk individuals and groups
- Promoting effective interventions
- Developing a clinical research agenda.

Forming Intersectoral Partnerships

While the health sector primarily deals with treating and caring for RTIs, effective solutions to road safety require a multisectoral approach. In order to contribute to the evidence base in this area and ultimately to reductions in the incidence and burden of RTIs, health professionals ought to work with nonhealth sector colleagues. Given their expertise and experience in dealing with RTIs, health professionals, for example, could make significant contributions to the design of preventive interventions, or provide input to product manufacturers working to improve the effectiveness of safety devices. This would enable them to leverage financial and political support for their activities from non-health sector funders. Countries or cities could promote these linkages by supporting intersectoral working groups, providing seed funding for multidisciplinary research, or both.

Targeting High-Risk Individuals and Groups

Continuing to document and highlight the significance of the health and economic burdens of RTIs on individuals and their families is a major part of a profile-raising strategy. Highlighting the burden in high-risk populations (such as adolescents and young people) might well prove to be a more effective strategy than a population-wide approach, given the overwhelming burden of RTIs in these age groups. Additionally, highlighting the greater impact of these injuries on poor people might provide an impetus for some governments and some funders to take action.

Promoting Effective Interventions

Continuing to identify and promote cost-effective, evidence-based strategies for the prevention of RTIs could form an important component of a profile-raising strategy. In particular, promoting the implementation and evaluation of the initiatives that have produced sustained reductions in RTI-related crashes or those that are proven cost-effective and feasible among low socio-economic groups might be particularly effective.

Developing a Clinical Research Agenda

Partnering with clinicians involved in the acute and postacute care for the victims might form another strand of the approach to fostering intersectoral engagements on this issue. Our knowledge about the longer-term physical, psychological, and economic impacts is still scant, as is our knowledge about the impact of RTIs on health care systems. Consequently, developing a research agenda in partnership with clinicians to access this information might provide a useful stimulus to mobilize resources and action.

Policy and Legislative Environment

The WHO has published *Strengthening Road Safety Legislation*, a manual that outlines the strategies and resources that might be used to facilitate implementation and enforcement of such legislation (WHO 2013c). The manual presents some enabling factors for countries to adopt and implement legislation, including the following:

- Recent trends in injuries and fatalities
- Social norms and values
- Financial, human, and other resources.

The manual outlines a framework to support governments and those working with governments to facilitate the implementation of legislation. The framework includes conducting an institutional assessment to identify local, regional, and national bodies responsible for

making and enforcing legislation; reviewing and assessing the gaps in national laws and regulations; and improving their comprehensiveness based on evidence. The manual also outlines an advocacy process to facilitate the legislative and regulatory changes.

In addition to a focus on behavioral risk factors, policies and legislation to prevent RTIs need to focus on issues such as safe road infrastructure, protection of vulnerable road users, land use, and safer vehicles. Furthermore, research examining factors that influence policy change around the prevention of RTIs is much needed. Such research, especially in LMICs, ought to include intervention studies to test what approaches have the greatest success in bringing about legislation, as well as studies that show which approaches might be the most cost-effective. Unfortunately, funding for such implementation or policy research is woefully inadequate, and a significant challenge remains in undertaking such research and developing a strong, policy-oriented evidence base.

Intervention Implementation

As evidenced from the findings in the most recent *Global Status Report on Road Safety*, those countries without adequate laws were almost exclusively LMICs (WHO 2015a), and the implementation challenge for road safety interventions is greatest in these countries. An implementation research agenda may help in overcoming this challenge.

In the case of legislation implementation, undertaking research to gain a systematic understanding of why relevant legislation has not been implemented might provide a useful starting point to determining what sort of additional research might be needed to facilitate change.

Some governments, even when evidence of efficacy is strong, require the evidence of effectiveness within their specific jurisdictions. However, to provide such evidence, legislative action must be implemented first, which usually is difficult. In such cases, the most useful approach would be to undertake small scale efforts or even simulation exercises that could show governments the potential reductions in disease burden and the potential cost-savings of introducing specific legislations or interventions.

The identification of evidence to support the efficacy and effectiveness of non-legislative interventions must also be a continuing endeavor.

Data Systems

Accurately and regularly collecting comprehensive data on RTIs is vital to monitoring a country's progress in addressing road safety. Such information can be

instrumental in guiding a country's health system in planning for and addressing the burden. In addition to mortality and morbidity estimates, reliable information and data on modifiable risk factors, costs associated with RTIs, and age- and gender-specific RTI data at both the national and local levels could inform researchers and policy makers about cost-effective interventions, as well as provide implications of the future health and economic burden—which could be a powerful advocacy tool for action.

Current efforts in HICs such as the EU project JAMIE (2011–2014, Joint Action for Injury Monitoring in Europe) have enabled participating member states to have a relatively limited but useful set of injury data collected from emergency departments. This project has significantly improved comparable injury surveillance systems across EU Member States (Bauer and others 2014; Rogmans 2012).

In LMICs, however, the absence or limited availability of strong and robust injury information systems presents a significant challenge to obtaining consistent and quality data on injuries. These measurement limitations render demonstrating the magnitude of the injury problem or even tracking a nation's progress in addressing it difficult. Establishing simple yet robust data systems in LMICs would facilitate the flow of continuous, reliable, and systematic information on key variables to all stakeholders (Chandran, Hyder, and Peek-Asa 2010; Hofman and others 2005; Kruk and others 2010; Lett, Kobusingye, and Sethi 2002; Mock and others 2004; Razzak, Sasser, and Kellermann 2005). Integrating systems for collecting key information on risk factors and outcomes into new and existing programs to address RTIs in LMICs therefore is essential to begin closing this gap (Bachani, Koradia, and others 2012; Bachani and others 2013; Hyder and others 2013; Slyunkina and others 2013).

Capacity Development

A recurring theme in the preceding sections is the scarcity of appropriately skilled human resources in LMICs to address the burden of RTIs effectively. This scarcity is evidenced by the relatively few studies on the burden (health, economic, and social) of RTIs and effectiveness of interventions for RTIs originating from LMICs in the peer-reviewed literature (Wesson and others 2013). Clearly, the level of investment in research and development on RTIs in LMICs must increase. This investment will be critical for generating local evidence and for promoting injury on the global public health agenda. Key areas for such capacity include epidemiological research to describe the existing burden, causes, and distribution of RTIs, as well as intervention research.

Table 3.4 Example of Intersectoral Contributions across the Five Domains to Increase the Use of Seatbelts and Child Restraints

	Health	Police	Finance/donors	NGOs	Academia
Resource mobilization for increasing seatbelt/child restraint use	Leadership; Stakeholder engagement	—	Funding	Advocacy	Generation of evidence/data
Seatbelt/child restraint policy and legislation	Review of laws	Implement law	Leverage networks/influence	Review of laws	Policy analysis
Intervention implementation	Technical assistance	Enforcement	Funding	Creating awareness; implementation	Monitoring
Data systems	Indicators defined	Evidence for enforcement	—	Technical or logistical support	Evaluation; technical support
Capacity development	Technical training	—	Funding	—	Training

Note: — = not available; NGO = nongovernmental organization.

Any technical assistance delivered to countries for road safety must include a capacity development component, with the ultimate goal of improving local capacity to conduct injury research, plan services needed, and reduce the burden of injuries. The Global Road Safety Partnership, an organization that works with LMICs to promote the Decade of Action for Road Safety, is a good example (United Nations Road Safety Collaboration 2010).

More accessible training and mentoring programs for road safety also are needed. Although many road safety training programs exist globally, not all are accessible to interested individuals from LMICs, mainly because of the training programs' locations or associated costs or both. A few (such as the Teach-VIP and Mentor-VIP developed by the WHO) make training materials and mentorship for LMIC researchers available at no cost (Hyder, Meddings, and Bachani 2009; Meddings 2010, 2015; Meddings and others 2005). Another online training program for prevention and control offered by the Johns Hopkins International Injury Research Unit takes advantage of the increasing internet connectivity in LMICs to provide free formal classroom-type instruction on key topics, ranging from understanding the burden of RTIs to selecting and implementing interventions and evaluating them (JHU-IIRU 2013). The reach and effectiveness of these new approaches have not yet been determined; however, they are a step in the right direction, and more such efforts are needed to improve road safety globally.

An example of an action agenda for increasing seatbelt use using the five elements described is provided in table 3.4.

CONCLUSIONS

RTIs continue to contribute to a significant amount of the health, social, and economic burden to society, and global interest in slowing or even halting this trend has

been renewed. By implementing interventions and legislation targeted to behavioral factors, vehicle and equipment factors, and infrastructure, as well as the availability of adequate postcrash care, addressing this burden is possible, especially in LMICs. However, more research is needed to better understand the specific needs in LMICs, as well as policy and legislation frameworks that may be appropriate for such settings. Systems must be established that will yield the data necessary to inform these activities; adequately trained human resources also are needed both to generate new research and design and to implement the appropriate policies and programs.

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NOTES

WHO Member States are grouped into six geographical regions: African, the Americas, South-East Asia, Europe, Eastern Mediterranean, and Western Pacific.

World Bank Income Classifications as of July 2014 are as follows, based on estimates of gross national income (GNI) per capita for 2013:

- Low-income countries (LICs) = US\$1,045 or less
- Middle-income countries (MICs) are subdivided:
 - a) lower-middle-income = US\$1,046 to US\$4,125
 - b) upper-middle-income (UMICs) = US\$4,126 to US\$12,745
- High-income countries (HICs) = US\$12,746 or more.

1. *The Global Status Report on Road Safety 2015* by the World Health Organization aims to describe the burden of road

traffic injuries and implement effective interventions in all Member States using a standardized methodology, and it aims to assess changes since the first and second *Global Status Reports* in 2009 and 2013. The data presented in the report were collected from 180 countries and areas, covering 6.97 billion people (97.3 percent of the world's population). Data collection in each country was coordinated by a National Data Collector and driven by a number of individual respondents from different sectors within a country, each of whom completed a self-administered questionnaire with information on key variables. This group was then required to come to a consensus on the data that best represented their country, which is presented in the report. Response rates by region covered were between 95 percent of the population in the European region to 99.6 percent in the Western Pacific region. Data collection was carried out in 2014; accordingly, while data on legislation and policies were related to 2014, data on fatalities were related to 2013 (WHO 2015a).

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