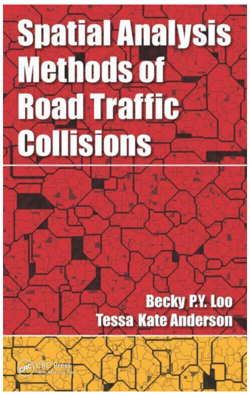

Spatial Analysis Methods of Road Traffic Collisions

Becky P.Y. Loo, Tessa Kate Anderson

Road Safety as a Public Health Issue

Publication details
https://www.routledgehandbooks.com/doi/10.1201/b18937-4
Becky P.Y. Loo, Tessa Kate Anderson
Published online on: 21 Sep 2015

3 Road Safety as a Public Health Issue

3.1 WHY WOULD ROAD COLLISIONS BE CONSIDERED A PUBLIC HEALTH ISSUE?

Road safety management does not make international headlines. The subject is absent from the agendas of global summits on poverty reduction, public health, engineering, and often transportation. Yet few issues merit more urgent attention. Road traffic deaths and injuries represent a global epidemic, and the costs of that epidemic are borne overwhelmingly by the world's poorest countries and people. When it comes to death and injury, no war or humanitarian disaster rivals the impact of road injuries. Few killer diseases pose an equivalent level of risk. Apart from the devastating human consequences, road traffic injuries are holding back progress in economic growth, poverty reduction, health, and education. With projections pointing to an increase in fatalities and injuries on the roads of the world's poorest nations, society needs to address the culture of neglect that pushes road safety to the margins of transport and development policy.

Public health is the science and practice of protecting and improving the health of *communities* through education; promotion of healthy lifestyles; and research on disease control, health promotion, and injury prevention (Sleet et al. 2007). Sleet et al. (2007) outlines that the three core functions of public health are consistent with the efforts to reduce motor vehicle injury:

1. Monitor and evaluate the health needs of communities.
2. Promote healthy practices and behaviors in populations.
3. Identify and eliminate environmental hazards to assure that populations remain healthy.

Motor vehicle injuries remain an important public health problem (Institute of Medicine [IOM] 1999). As the WHO indicates, road safety should be viewed as a shared responsibility and not the exclusive purview of a single agency (Peden et al. 2004). Traffic collisions affect not only transportation systems but also economic systems, health systems, jobs, families, and civil society. A culture of safety implies a systematic commitment by institutions, agencies, organizations, and individuals to recognize and address the unacceptable road toll and apply the best prevention strategies known to reduce it.

Transport infrastructure may seem far removed from human development concerns, but it is one of the building blocks for progress toward the Millennium

Development Goals (MDGs) of the United Nations (UN). MDGs are eight international development goals that all the 193 UN member states have agreed to achieve by 2015. Although road safety is not *one of the eight* MDGs, it arguably focuses within the context of many of the goals. Road safety therefore is another building block, or it should be. Death and injury on the world's roads is arguably the single most neglected human development challenge. The vocabulary of the road traffic injury epidemic helps to explain the neglect. While child deaths from, say, malaria are viewed as avoidable tragedies that can be stopped through government action, road traffic deaths and injuries are widely perceived as "accidents"—unpredictable events happening on a random basis to people who have the misfortune to be in the wrong place at the wrong time.

The vocabulary is out of step with reality. Road traffic fatalities and injuries are accidents only in the narrow technical sense that they are not intended outcomes. They are eminently predictable, and we know in advance the profile of the victims. Of the 3500 people who will die on the world's roads today, around 3000 will live in a developing country, and at least half will be a pedestrian or vulnerable road user who is not driving a car (Figure 3.1 and Table 3.1). Far from being the consequence of forces beyond human control, road traffic death and disability are in large also consequences of government action and inaction.

In 2002, the WHO (World Health Organization) estimated that 1.2 million people were killed and approximately 50 million injured in road collisions worldwide, costing the global communities an estimated $518 billion. In 2004, this figure had risen to 1.3 million people killed by road collisions worldwide. The International Federation of Red Cross and Red Crescent Societies have described the situation as "a worsening global disaster destroying lives and livelihoods, hampering development and leaving millions in greater vulnerability" (International Federation of Red Cross and Red Crescent Societies 1998). Without appropriate action, road traffic injuries are predicted to escalate from the ninth leading contributor to the global burden of disease in 1990 to the third by 2020. In 2004, the WHO acknowledged the growing number of deaths and injuries associated with road collisions and designated the World Health Day to *road safety*. The outcome was a comprehensive report alongside which the World Bank released a corresponding report and the UN General Assembly urged all countries to address the devastating nature of road collisions as a matter of urgency. The outcome of these actions was a working group of 42 agencies committed to reducing this preventable health burden. The agencies pledged to work within a common framework focusing on joint activities and projects including data collection and research, technical support, advocacy, policy, and financial support.

In October 2005, as a result of the initiatives, the UN General Assembly passed a new resolution on road safety asking for increased interagency working and commending the WHO on its efforts for advocacy. The assembly asked WHO to jointly organize the first UN Global Road Safety week in April 2007 and to recognize the third Sunday in November as the World Day of Remembrance for Road Traffic Victims. These global initiatives have led the academic community in recent years to take road collisions not as an engineering or transport problem but as a preventable global disease that should be managed in the global context.

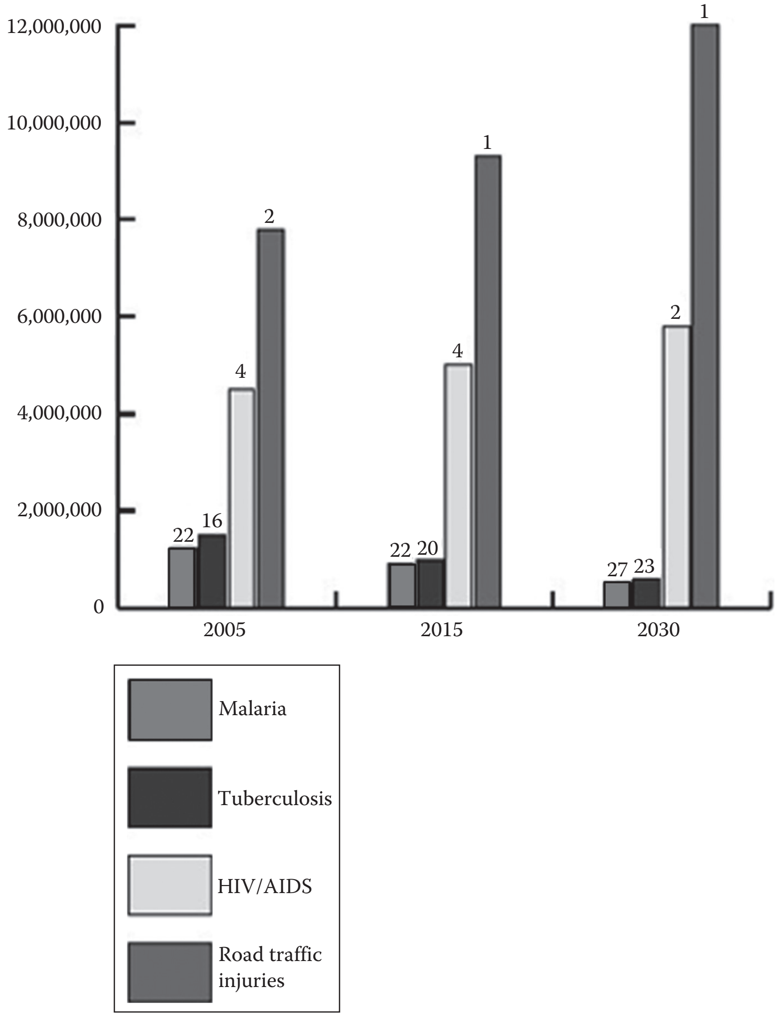

FIGURE 3.1 Projected disability-adjusted life years (DALYs) in developing countries (children aged 5–14). (Data from Mathers, C.D. and Loncar, D., Updated projections of global mortality and burden of disease, 2002–2030: Data sources, methods and results, Projected DALYs for 2005, 2015, and 2030 by country income group under the baseline scenario, World Health Organization, Geneva, Switzerland, October 2005, http://www.who.int/healthinfo/global_burden_disease/projections2002/en/.)

3.2 CURRENT GLOBAL ESTIMATES

In 2002, road collision injuries were the 11th leading cause of death in the world. The lowest rates were recorded in high-income European and Western countries; however, the highest rates were found in some African and eastern European countries.

TABLE 3.1
Leading Causes of Death in Children and Youth, Both Sexes, World, 2004

Rank	5–14 Years	15–29 Years	Total
1	Lower respiratory infections	**Road traffic injuries**	Ischemic heart disease
2	**Road traffic injuries**	HIV/AIDS	Cerebrovascular (stroke) disease
3	Malaria	Tuberculosis	Lower respiratory diseases
4	Drownings	Violence	Perinatal causes
5	Meningitis	Self-inflicted injuries	Chronic obstructive pulmonary disease
6	Diarrheal disease	Lower respiratory infections	Diarrheal disease
7	HIV/AIDS	Drownings	HIV/AIDS
8	Tuberculosis	Fires	Tuberculosis
9	Protein–energy malnutrition	War and conflict	Trachea, bronchus, lung cancers
10	Fires	Maternal hemorrhage	**Road traffic injuries**

Source: Data from World Health Organization, *The Global Burden of Disease: 2004 Update*, WHO, Geneva, Switzerland, 2008.

Table 3.2 illustrates countries and their estimated road traffic death rate (per 100,000 people). This gives an interpretation of the current global trends, with African countries having some of the highest death rates. Moreover, it is important to remember that these countries are likely to have the highest rates of underreporting as well.

The major issues associated with calculating these estimates are incomplete data, especially from the less developed countries. It was estimated that for the 2002 estimates, 35 countries out of the total of 110 used unreliable data. The point therein is that the current estimates of global fatalities might be grossly underestimated due to incomplete data. What is also important to remember is that often less developed countries such as China can have a high fatality rate due to road collisions; however, often this is offset by the size of the population, or there might be a low number of motor vehicles per head, all of which can contribute to skewed global fatality data.

There are three primary measures for comparing multinational road collision and fatality data: (1) deaths per 100,000 population or per capita rate, (2) deaths in relation to overall distance traveled (such as the vehicle-miles traveled in the United States), and (3) deaths in relation to the number of registered motor vehicles in the country. All three measures should be considered when comparing disparate countries, but using just one of these methods is generally acceptable when comparing countries of similar status (e.g., *highly motorized countries*, developed nations, and third world countries).

3.3 IRTAD DATABASE COVERAGE AND UNDERREPORTING

In many countries that belong to the Organisation for Economic Co-operation and Development (OECD), the number of road fatalities has been slowly reducing since the peak in the 1970s. The current number of road fatalities in some of the

TABLE 3.2
Estimated Road Traffic Death Rate (per 100,000 Population), 2010

Country	Estimated Road Traffic Death Rate (per 100,000 Population)
Cook Islands	9.9
Egypt	13.2
Afghanistan	19.8
Iraq	31.5
Angola	23.1
Niger	23.7
United Arab Emirates	12.7
Gambia	18.8
Iran (Islamic Republic of)	34.1
Mauritania	28.0
Ethiopia	17.6
Mozambique	18.5
Sudan	25.1
Tunisia	18.8
Guinea-Bissau	31.2
Kenya	20.9
Chad	29.7
United Republic of Tanzania	22.7
Jordan	22.9
Botswana	20.8
Madagascar	18.4
South Africa	31.9
Sao Tome and Principe	20.6
Liberia	19.0
Syrian Arab Republic	22.9
Senegal	19.5
Nigeria	33.7
Central African Republic	14.6
Democratic Republic of the Congo	20.9
Mali	23.1
Rwanda	19.9
Benin	23.9
Burkina Faso	27.7
Kazakhstan	21.9
Comoros	21.8
Ghana	22.2
Yemen	23.7
Saudi Arabia	24.8
Congo	17.1
Namibia	25.0
Lebanon	22.3

(*Continued*)

TABLE 3.2 (*Continued*)
Estimated Road Traffic Death Rate (per 100,000 Population), 2010

Country	Estimated Road Traffic Death Rate (per 100,000 Population)
Morocco	18.0
Sierra Leone	22.6
Cameroon	20.1
Togo	17.2
Zimbabwe	14.6
Lesotho	28.4
Swaziland	23.4
Malawi	19.5
Zambia	23.8
Pakistan	17.4
Russian Federation	18.6
Cape Verde	22.4
Uganda	28.9
Qatar	14.0
Malaysia	25.0
Burundi	21.3
Myanmar	15.0
Kyrgyzstan	19.2
Lithuania	11.1
Venezuela (Bolivarian Republic of)	37.2
Peru	15.9
Ukraine	13.5
Oman	30.4
Mexico	14.7
Montenegro	15.0
Philippines	9.1
Guyana	27.8
Paraguay	21.4
Thailand	38.1
Mongolia	17.8
Vanuatu	16.3
Seychelles	15.0
Brazil	22.5
Lao People's Democratic Republic	20.4
Maldives	1.9
Suriname	19.6
Latvia	10.8
Saint Lucia	14.9
Dominican Republic	41.7
Kuwait	16.5

(*Continued*)

TABLE 3.2 (*Continued*)
Estimated Road Traffic Death Rate (per 100,000 Population), 2010

Country	Estimated Road Traffic Death Rate (per 100,000 Population)
Solomon Islands	14.7
Georgia	15.7
India	18.9
Bolivia (Plurinational State of)	19.2
China	20.5
Indonesia	17.7
Timor-Leste	19.5
Viet Nam	24.7
Belarus	14.4
Belize	16.4
Trinidad and Tobago	16.7
Costa Rica	12.7
Nepal	16.0
Republic of Moldova	13.9
Slovakia	9.4
Greece	12.2
Palau	14.7
Estonia	6.5
Guatemala	6.7
Poland	11.8
Slovenia	7.2
Bahamas	13.7
Bhutan	13.2
Micronesia (Federated States of)	1.8
Nicaragua	18.8
Papua New Guinea	13.0
Tajikistan	18.1
Albania	12.7
Armenia	18.1
United States of America	11.4
Brunei Darussalam	6.8
Argentina	12.6
Chile	12.3
Croatia	10.4
Honduras	18.8
Sri Lanka	13.7
Turkey	12.0
Bulgaria	10.4
Azerbaijan	13.1
Republic of Korea	14.1
Samoa	16.4

(*Continued*)

TABLE 3.2 (*Continued*)
Estimated Road Traffic Death Rate (per 100,000 Population), 2010

Country	Estimated Road Traffic Death Rate (per 100,000 Population)
Panama	14.1
Romania	11.1
Bangladesh	11.6
El Salvador	21.9
Hungary	9.1
Jamaica	11.6
Barbados	7.3
Bahrain	10.5
Cambodia	17.2
Czech Republic	7.6
Colombia	15.6
Ecuador	27.0
Mauritius	12.2
Bosnia and Herzegovina	15.6
Cyprus	7.6
Portugal	11.8
Belgium	8.1
New Zealand	9.1
Iceland	2.8
Serbia	8.3
Uzbekistan	11.3
Italy	7.2
Spain	5.4
Canada	6.8
Cuba	7.8
Ireland	4.7
Austria	6.6
Australia	6.1
France	6.4
Kiribati	6.0
Finland	5.1
Fiji	6.3
Tonga	5.8
The former Yugoslav Republic of Macedonia	7.9
Saint Vincent and the Grenadines	4.6
Germany	4.7
Israel	4.7
United Kingdom	3.7
Sweden	3.0
Japan	5.2
Norway	4.3

(*Continued*)

TABLE 3.2 (*Continued*)
Estimated Road Traffic Death Rate (per 100,000 Population), 2010

Country	Estimated Road Traffic Death Rate (per 100,000 Population)
Switzerland	4.3
Netherlands	3.9
Singapore	5.1
Uruguay	21.5
Malta	3.8
San Marino	0.0
Marshall Islands	7.4

Source: Reprinted from World Health Organization, *Road Traffic Deaths: Data by Country*, Global Health Observatory Data Repository, http://apps.who.int/gho/data/node.main.A997?lang=en, accessed October 29, 2014. With permission.

OECD countries is approximately 50% less than their peak value. Against this background, it may be easy to assume that road collisions are gradually becoming less of a problem in the world as a whole. However, this assumption would be wrong. The reality is that the overall number of road fatalities is still increasing every year. By 2020, the WHO predicts road collisions to be the sixth leading cause of death worldwide.

The most international database and information on global road collisions is the International Traffic Safety Data and Analysis Group International Road Traffic and Accident Database (IRTAD), which was established in 1988 by the OECD. It was created to serve as a mechanism for providing an aggregated database in which international road collision and victim data as well as exposure data could be collected on a continuous basis. IRTAD is both a working group and a database. The IRTAD database includes collision and traffic data and other safety indicators for 29 countries. The International Traffic Safety Data and Analysis Group (known as the IRTAD Group) is an ongoing working group of the Joint Transport Research of the OECD and the International Transport Forum. It is composed of road safety experts and statisticians from safety research institutes, national road and transport administrations, international organizations, universities, automobilist associations, motorcar industry, and so on. Its main objectives are to contribute to international cooperation on road collision data and its analysis.

The database includes more than 500 data items aggregated by country and year (from 1970) and shows up-to-date collision and exposure data, including (International Transport Forum 2011) the following:

- Injury collisions classified by road network
- Road deaths by road usage and age, by gender and age, or by road network
- Car fatalities by driver/passengers and by age
- Hospitalized road users by road usage, age bands, or road network

- Collision involvement by road user type and associated victim data
- Risk indicators: fatalities, hospitalized, or injury collisions related to population or kilometrage figures
- Monthly road collision data (three key indicators)
- Population figures by age bands
- Vehicle population by vehicle types
- Network length classified by road network
- Kilometrage classified by road network or vehicles
- Passenger kilometrage by transport mode
- Seat belt–wearing rates of car drivers by road network
- Area of state

The IRTAD database covers the following countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland, United Kingdom, and the United States. It is obvious from this list of countries that a vast majority of countries are missing, and the countries that are missing are often the ones with the most serious problem with road collisions.

It is well known that the reporting of road collisions in official statistics can be incomplete and biased. Incomplete or inaccurate road collision data are part of the larger problem concerning the availability of accurate information about road collisions in general. The first major source of error on global statistics is lack of reporting to the police. Many collisions go unreported to the police due to lack of injury, deniability, and crimes. Although at a countrywide and regional level, a lot of these unreported police data can be supplemented by insurance data (whereby the insurance companies will hold accurate information of any claims made for road collision damage to a vehicle that will not necessarily include injury). However, this information is hard and almost impossible to collect at the global scale. The sheer number of insurance companies and the data privacy of clients will mean that there will be a high number of road collisions globally, which are not reported because they resulted in no or limited injury. It is known from a large number of studies summarized by Elvik and Mysen (1999), and Loo and Tsui (2007) that the reporting of reportable injury collisions in official statistics is very incomplete. A large number of important human factors relating to the road collision are not recorded (Elvik and Mysen 1999). Finally, there are errors or missing information in some of the recorded data elements of a road collision.

3.4 ECONOMIC, SOCIAL, AND HEALTH BURDENS

Apart from the humanitarian aspect of reducing road collisions, especially in developing countries, there is an increasing need to reduce road collisions from an economic standpoint as well. Road collisions consume large amounts of financial resources. However, one must bear in mind that there are many problems in developing countries that demand a share of the funding. Difficult decisions often have to be made on the amount of resources a country can devote to road safety and preventing road collisions. In order to assist this decision-making process, it is essential that a method is devised to determine the cost of road collisions and the value of preventing them (in economic terms).

Peden et al. (2004) estimated global fatalities due to road collision cost up to 3% of the global gross domestic product (GDP) every year. The global economic cost of motor vehicle collisions was estimated at $518 billion per year in 2003, with $100 billion of that occurring in developing countries. The Center for Disease Control and Prevention in the United States estimated an economic cost of $230 billion in 2000. The first requirement for costing is at the level of national resource planning to ensure that road safety is ranked equitably in terms of investment in its improvement. Fairly broad estimates are usually sufficient for this purpose but must be compatible with competing sectors. A second need for road collision cost figures is to ensure that the best use is made of any investment and that the best (and most appropriate) safety improvements are introduced in terms of the benefits that they will generate in relation to the cost of their implementation. Failure to associate specific costs with road collisions will result in the use of widely varying criteria in the choice of measures and the assessment of projects that affect road safety. As a consequence, it is extremely unlikely that the pattern of expenditure on road safety will, in any sense, be *optimal* in terms of equity. If safety benefits are ignored in transport planning, there will inevitably be associated underinvestment in road safety.

Road traffic injuries place an enormous strain on already overstretched health systems. The systems are in effect hemorrhaging resources as finance, equipment, and skilled staff are diverted to treat the victims of road traffic injuries. For instance, road traffic injury patient represent 45%–60% of all admissions to surgical wards in Kenya (Odero et al. 2003). Studies in India show that road injuries account for 10%–30% of hospital admissions (Gururaj 2008). And one hospital in Uganda reports spending around U.S. $399 per patient treating road traffic injuries (Watkins and Sridhar 2009). This is in a country with national spending of U.S. $20 per person only. The experience of poor communities in coping with medical catastrophes is very different from that experienced by economically well-off communities. The special problems faced by poor families can include inappropriate or absence of treatment leading to complications and longer treatment time; reallocation of labor of family members and reduced productivity of whole family; permanent loss of job for the victim even if he/she survives; loss of land, personal savings, and household goods; poor health and educational attainment of surviving members; and dissolution or reconstitution of household. None of these issues are officially documented, and the economic calculation for estimating the true cost of road collisions in poor societies is impossible. The knock-on effects of someone in a poor family being affected by a road collision, whether it is death or injury, are huge. The division of labor within the family will change, often affecting people's earnings; children may miss school, and older family members will not be able to look after children or infants. The impact of this is reduced schooling, decreased income, less able to manage the home, and overall added pressure.

3.5 GLOBAL GEOGRAPHY OF ROAD RISK

As a whole, it is acknowledged that Australia, New Zealand, and Europe have among the most favorable road safety records with the traffic risk being lower than in any other parts of the world (Loo et al. 2005). North, Central, South America, and Eastern Europe have higher traffic risk. In Central and South America, the health risk is low, and this relates to the fact that the level of motorization is relatively low. However, the standard deviations of both health risk and traffic risk are high compared to the average risk.

Road collisions are a burden not just to the developed countries but also to the developing countries. Africa as a continent has some of the highest death rates associated with road collisions in the world. One of the key issues is lack of accurate data; however, the data that are available already highlights cause for concern. Some of the key causes of road collisions in Africa (see Jacobs et al. 2000) include poorly built roads, aged vehicles, tax regulations, and a culture that has less regard to human risk. While currently Southeast Asia has the highest proportion of global road fatalities (one-third of the 1.4 million occurring every year), the road traffic injury mortality rate is the highest in Africa (28.3 per 100,000 population, when corrected for underreporting). Developing countries account for approximately 85% of all road traffic deaths in the world; the increased number of vehicles per inhabitant will result in an 80% rise in injury mortality rates between 2000 and 2020. In Africa, it was estimated that 59,000 people lost their lives in road collisions in 1990, and this figure will increase to 144,000 by 2020. This 144% increase is significantly worrying. In contrast, countries in the developed world have experienced a decreasing trend since the 1960s. Due to the traditional misconception that road traffic injuries were inevitable, random, and unpredictable events, the international community's response to this worldwide public health crisis came relatively late. The number of vehicles per inhabitant is still low in Africa: less than one licensed vehicle per 100 inhabitants in low-income Africa versus 60 in high-income countries. Car ownership growth leads to increased road traffic in developing countries. This explains, for example, the reported 400% increase in road deaths in Nigeria between the 1960s and the 1980s. Available historical data from developed countries show that it is only when a development threshold is achieved that the road mortality starts to decrease (Vasconcellos 1999; Kopits and Cropper 2005; Bishai et al. 2006). This is often called the environmental Kuznets curve. Such a threshold is far from being reached in sub-Saharan Africa. Indeed, in South Africa, the most developed African country, there were already 17 licensed vehicles per 100 inhabitants in 2005, and no decline in road traffic deaths has been observed so far.

3.6 ROAD SAFETY AND DEVELOPMENT

As recently advocated by Khayesi and Peden (2005), road safety in Africa is "part of the broader development process." The situation is particularly worrying in this continent because of the combination of conflicting road users, poor vehicle condition, underdeveloped infrastructure, lack of risk awareness, and ineffective enforcement jeopardized by corruption or bribery. The road transport system is the dominant form of land transportation and carries more than 95% of passenger traffic. This sector is often prioritized in donor development plans in countries such as Cameroon, Ghana, Gabon, and Senegal, to cite only a few African countries receiving European Union development aid. Road transportation is essential to access markets and services, and to unlock agricultural potential, which will lead to improved incomes in rural areas.

Table 3.3 summarizes different countries' methods of collecting fatal and nonfatal data from road traffic collisions. Collection methods and procedures vary greatly from country to country and need to be accounted for when analyzing global data.

3.7 GLOBAL STATISTICS, DATA, AND ASSESSMENT

Previous reviews of global fatalities undertaken by Transport Research Laboratory (TRL) in the United Kingdom, the World Bank, and others have produced a wide range of estimates. While problems of data reliability and underreporting have been regularly acknowledged, traditional reliance has been on the use of officially published statistics based on police reports. In estimating causes of death and disability, the WHO used a different method, based on registered deaths and health sector data that produced higher estimates than those using official police statistics. For example, the WHO estimated a million deaths worldwide in 1990, while the TRL values were of the order of half of this.

In keeping with the traditional approach used by transport specialists in compiling road collision statistics, the starting point to study is the official fatality figure reported by countries. Using these values to obtain an accurate estimate of the current global fatality situation requires several factors to be taken into account as follows:

- Updating the fatality figure from the latest year (usually 1995 or 1996) to 1999.
- Estimating for those countries where fatality data were not obtained.
- Underreporting due to both recording deficiencies and nonreporting to the police.

The general problem of underreporting includes both recording deficiencies, *under recording* where injuries are reported to the police but are not included in the published statistics and nonreporting where the police are not notified of road injuries. To highlight the extent of underreporting, the problems of recording deficiencies and nonreporting have been discussed separately in this book.

3.8 GLOBAL DIVIDE OF INJURY AND DEATH, AND ULTIMATELY BURDEN

The developing world, with regard to countries such as China, India, Thailand, Vietnam, and Malaysia, has experienced rapid urban growth in recent years. Cities in

TABLE 3.3
Selected Data Sources about the Burden of Road Traffic Collisions in Iran, India, Mexico, and Ghana

Country	Deaths	Non-fatal Injuries
Iran	*National death registration system*: Covers 29 provinces (i.e., all except Tehran); ICD-10 (International Classification of Diseases, 10th revision) derivative causes of death. *National forensic medicine system*: Estimates available for all provinces.	*Hospital data sample*: Data collected from all hospitals in 12 provinces (outpatient for 4 days, and hospital admissions for 4 weeks), followed back to household post discharge. *Demographic and Health Survey* (*DHS*): Approx. 110,000 households, included questions about road traffic injury involvement and care.
India	*National Sample Registration System*: Nationally representative sample of deaths in India causes evaluated by verbal autopsy. *National Medical Certification of Cause of Death* (*MCCD*) *System*: Cause of death for reporting hospital in urban areas; covers approx. 500,000 deaths from all causes annually.	*World Health Survey* (*WHS*): Representative sample with questions about road traffic injuries and care; conducted in six states *Survey—New Delhi*: 5,412 households, all injury causes. *Survey—Bangalore*: 20,000 households, stratified by urban/rural and socioeconomic status. *Survey—near New Delhi*: Morbidity patterns in 9 villages, 25,000 households, monitored for 1 year. *Hospital—Hyderabad*: Five hospitals, approx. 800 victims, followed back to household post-discharge.
Mexico	*National death registration system*: ICD-10 coded cause of death, estimated to be near complete.	*SAEH—Ministry of Health national hospital discharge database*: Covers all Ministry of Health hospitals, approx. 115,000 unintentional injury hospital admissions. *Instituto Mexicano del Seguro Social* (*IMSS*) *national hospital discharge database*: Approx. 175,000 injury hospital admissions; external causes not recorded. *World Health Survey*: Representative sample with questions about road traffic injuries and care. *Encuesta nacional de Salud y Nutricion* (*ENSANUT*) *national health survey*: Sample size 54,068 individuals, included questions on RTI (road traffic injuries) involvement and care.
Ghana	*Mortuary data—Kumasi*: Data collected from 1996 to 1999. *Demographic Surveillance System (DSS) Sites at Navrongo*: Verbal autopsy based cause of deaths.	*World Health Survey*: Representative sample with questions about road traffic injuries and care. *Survey—Kumasi (urban) + Brong Ahafo region (rural)*: Sample of approx. 21,000 individuals. *Hospital records—Accra*: Reporting hospitals.

Source: Reprinted from Bhalla, K. et al., *Int. J. Injury Control Saf. Promot.*, 16(4), 243, 2009. With permission from Taylor & Francis Ltd.

these countries have strived to be developed quickly and efficiently. According to official statistics in China, over 73,500 people died in 2008 as a result of road collisions. China is now the world's second largest automobile market in the world, which corresponded to its road collision statistics. The development of China as a country, both income and urban growth, has meant a large increase in car ownership and usage, especially among the middle- and high-income classes. However, it is the low- and middle-income classes that are most affected, and where loss of life can be detrimental to the victim's immediate family. In China, road collisions are the leading cause of death for 15–45-year olds. They are the second cause of premature death, and this causes an acute drain on productivity due to short- and long-term disabilities. The most worrying aspect of road deaths in China is the high number of pedestrian victims (approximately 25%), closely followed by motorcyclists (23%). These statistics give us an insight into the type of road collision that is occurring, that is, vehicle–pedestrian collisions, in urban areas. Although a large proportion of collisions occur in urban areas, still over half of the road collisions occur in rural areas. Farmers and workers are the people most likely to be injured in these areas, and they are less likely to be able to afford to go to the hospital or doctors. There is lack of signs and proper infrastructure for traffic safety on many roads. Most of the road collisions occurred on roads that lack traffic management. A study by Loo et al. (2011) shows that while urban road collisions are larger in number and higher in density, rural road collisions are often more deadly. There is a lack of urban planning toward road safety especially pedestrians and cyclists.

Essentially, a lot of the use of the road environment can be argued to be cultural. In China, for example, there are a lot of migrants in large cities. These migrants have often come from rural areas in a different province. The road environment and how they interacted in that road environment would be very different from that of the larger cities in China. There are many cultural and behavioral reasons especially in developing countries for road collisions to be so common. Some of these include migrants having different ideas of risk and mortality in the road environment, they are not being used to busy road traffic in large cities, and their assumption that vehicles will stop/avoid them and that they have right-of-way. Chen et al. (2012) explore some reasons for the different cultures of migrants in affecting their risk of involving in nonmotorized traffic collisions. Yet, in general, the reasons for road collisions in low- to middle-income countries are far more complex than in high-income countries. Traffic in low-income countries has a much more diverse number of vulnerable road users.

3.9 ROAD COLLISION COSTING

Road collision costing is an important global element of road collisions themselves. Road collisions have been shown to cost annually between 1% and 3% of GDP in developing countries. The gross national product is often more readily available than the GDP figure although it is usually slightly higher than the GDP. Knowledge of road collision costs allows safety impacts to be economically justified. Road safety measures have been frequently ignored or downplayed in cost–benefit analysis on the grounds that the associated costs and benefits are too intangible. Where road safety is included in a cost–benefit analysis of road improvements, it is often factored only on a subjective basis and so does not get applied in a consistent manner required for project comparisons. In road collision costing, there are generally two elements. They are casualty-related costs (such as injury, pain, grief, and lost output) and road-collision related costs (such as property damage and administration). The cost of road collisions is the sum of these two elements.

Lost output is an important concept in road collision costing. It refers to the contribution that a road collision victim was expected to make with future earnings weighted to present value. One of the major issues is that often especially in developing countries, road collisions are more likely to affect men between 15 and 45 years, which is the prime working age and most productive to society. Lost output for serious and slight injuries is the daily earning rate multiplied by the number of days off work. This is usually derived from hospital and victim surveys.

Vehicle damage costs relate to the property that was damaged in the road collision. Insurance claims are the traditional source for vehicle damage costs, but the low rate of insurance coverage in many developing countries raises questions as to how representative collision claims are. Medical costs are a particularly difficult element of road collision costing. They rarely account for more than 5% of all road collision costings. Few governments/officials are able to estimate the cost of patients per night in hospital as well as outpatient costs. In developing countries, medical costs do not reflect the reality of the situation, as scarce resources limit the hospital beds and medical services available. The medical costs alone do not necessarily reflect the actual opportunity costs.

Apart from the humanitarian aspect of reducing road deaths and injuries in developing countries, a strong case can be made for reducing road collision deaths on economic grounds alone, as they consume massive financial resources that the countries can ill afford to lose. That said, it must of course be borne in mind that in developing and emerging nations, road safety is but one of the many problems demanding its share of funding and other resources. Even within the transport and highway sector, hard decisions have to be taken in the country on the resources to be devoted to road safety. As a consequence, it is extremely unlikely that the expenditure on road safety will, in any sense, be *optimal* in terms of equity. In particular, if safety benefits are ignored in transport planning, there will be underinvestment in road safety.

3.10 INTERNATIONAL ROAD INFRASTRUCTURE: A NEGLECTED MEASURE?

The "Safe System" views the road transport system holistically by seeking to manage the interaction between road users, roads and roadsides, travel speeds, and vehicles. It aims to reduce the likelihood that collisions occur and minimize the severity of those that do happen. Central to the Safe System approach is the recognition that human beings make mistakes and are fragile. As Figure 3.2 demonstrates, impacts at what might be considered reasonable speeds can significantly increase the risk of death and serious injury. The Vision Zero philosophy adopted by the Swedish Government (Johansson 2006) illustrates many of the principles required of the Safe System. Vision Zero provides a viable policy framework for sustainable safety whose basic principles can be applied in any country, at any stage of development.

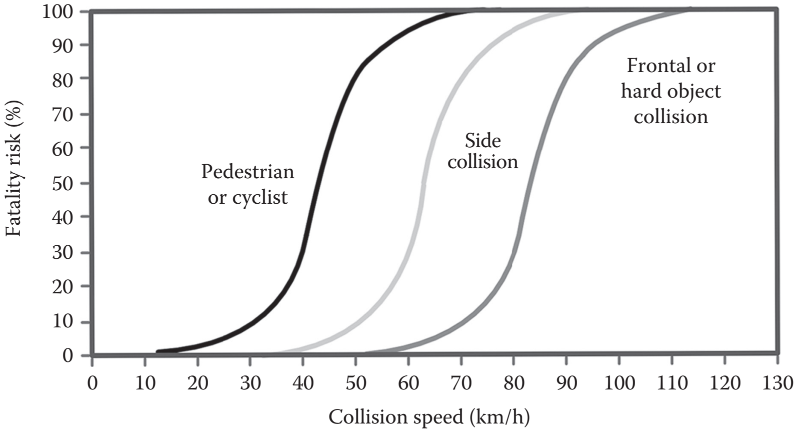

FIGURE 3.2 Collision speed–fatality relationships. (Reprinted from Wramborg, P., A new approach to a safe and sustainable traffic planning and street design for urban areas, in: *Road Safety on Four Continents Conference Proceedings*, Warsaw, Poland, 2005. With permission.)

Elements of this approach may appear utopian, but the approach lays the principles for the management of kinetic energy, the fundamental part of injury reduction.

Within this energy system, the imbalance of *kinetic mass* is such that pedestrians of 80 kg traveling at 5 km/h cannot harm a driver and 1500 kg car traveling at 90 km/h. The onus of responsibility is therefore on the driver to avoid causing injury. Sweden has demonstrated the crucial role that infrastructure can play in creating a safe and efficient road network. By developing roads that are inherently safe (e.g., using safety barriers to mitigate the risk of head-on and run-off-road collisions), Sweden has been able to increase safely the speed limits on many of its major roads. In fact, many of Sweden's safest roads are also those where speeds are the highest (Johansson 2006). Recent work (Turner et al. 2009) promotes greater use of what have been termed "primary" road safety treatments. These are treatments more likely to eliminate death and serious injury than produce only mild reductions. Examples include barriers to prevent run-off-road and head-on collisions, properly designed roundabouts at junctions, and raised platforms at junctions or locations where pedestrians cross. *Supporting* treatments such as signing and line marking plus many others may reduce collisions, but not as effectively as Safe System levels require, and generally have only limited impact on severity outcomes.

3.11 CONCLUSION

The greatest successes in public health have resulted from cultural change (Ward and Warren 2007). For example, smoking was once considered harmless and part of a healthy and active lifestyle. In the 1930s, cigarette advertisements in the United States often showcased physicians and athletes as spokespersons. With mounting scientific evidence on the hazards of smoking and a shift from emphasizing dangers to the smoker to dangers to the nonsmokers, the public began to view smoking negatively, and the health culture was permanently changed. Likewise, creating a safety culture will require a shift in how we think about traffic hazards, personal risky behaviors, and the value of prevention. Following Sleet et al. (2007), public health can contribute to this shift by the following:

- Including road safety in health promotion and disease prevention activities
- Incorporating safety culture into health education activities for adolescents so that they associate safety with all aspects of life
- Requiring safety impact assessments similar to environmental impact assessments (i.e., before new roads are built)
- Using public health tools to help the transportation sector in conducting safety audits to identify unsafe roads and intersections
- Incorporating safety and mobility into healthy aging, for example, by focusing on the mobility needs of older adults, especially as they relinquish their driving privileges
- Applying modern evaluation techniques to measure the impact of road safety programs and injury prevention interventions
- Measuring health-care costs and public health consequences of traffic injuries
- Assisting states and communities with local injury data collection and traffic injury surveillance systems
- Reducing health disparities by assuring equal access to community preventive services such as child safety seats, bicycle helmets, and neighborhood sidewalks for poor or underserved populations
- Strengthening pre-hospital and hospital care for trauma victims by supporting comprehensive trauma care systems, nationwide

It is clear from the data that the most consistent road injury information is derived from high-income countries and focuses on the benefits for vehicle occupants. However, this group forms a small proportion of road users at the global level. There must be prioritization toward the data collection, analysis, and implementation in middle- and lower-income countries. One of the remaining obstacles is the public's misconception that injuries are accidents that occur by chance. It has been difficult to summon popular sentiment for motor vehicle injury because there is no single cause or cure. It is not widely recognized as a public health problem, and most people consider injury the result of an uncontrollable *accident*. For many, road traffic injuries and death are simply the price we pay for mobility. While some progress has been made toward changing public perception about the predictability of injury and its preventable nature, more must be done. Public health professionals have been relatively successful in framing motor vehicle injuries in the context of other preventable causes of death and disease as we have seen in this chapter. The medical professions have been quick to recognize their role as advocates for motor vehicle safety with patients and policy makers, and the importance of emphasizing lifestyle changes that include safety behaviors. By framing motor vehicle injury as predictable and preventable, health practitioners will have a tool to educate the public and influence policy makers about a serious public health problem that can be reduced, just like many diseases. A culture of safety that provides for safe and accessible transportation can prevent injury and death, and improve the overall quality of life for populations. By improving traffic safety, we also improve public health.

REFERENCES

Bhalla, K., S. Shahraz, D. Bartels, and J. Abraham. 2009. Methods for developing country level estimates of the incidence of deaths and non-fatal injuries from road traffic crashes. *International Journal of Injury Control and Safety Promotion* 16 (4): 239–248. http://www.tandfonline.com/.

Bishai, D., A. Quresh, P. James, and A. Ghaffar. 2006. National road casualties and economic development. *Health Economics* 15 (1): 65–81.

Chen, C., H. Lin, and B. P. Y. Loo. 2012. Exploring the impacts of safety culture on immigrants' vulnerability in non-motorized crashes: A cross-sectional study. *Journal of Urban Health* 89 (1): 138–152.

Elvik, R. and A. B. Mysen. 1999. Incomplete accident reporting: A meta-analysis of studies made in thirteen countries. *Transportation Research Record* 1665 (1): 133–140.

Gururaj, G. 2008. Road traffic deaths, injuries and disabilities in India: Current scenario. *The National Medical Journal of India* 21: 14–20.

Institute of Medicine (IOM). 1999. *To Err Is Human: Building a Safer Health System*. Washington, DC: National Academy Press.

International Federation of Red Cross and Red Crescent Societies. 1998. World disasters report 1998. Geneva, Switzerland: IFRC.

International Transport Forum. 2011. IRTAD database coverage. http://internationaltransportforum.org/irtadpublic/coverage.html (accessed November 13, 2011).

Jacobs, G. D., A. Aeron-Thomas, and A. Astrop. 2000. Estimating global road fatalities. Transport Research Laboratory, Crowthorne, U.K.

Johansson, R. 2006. European Union issue 11 Transport: A new vision. http://www.vv.se/PageFiles/12660/eu11_roger_johansson_atl%5B1%5D.pdf?epslanguage=sv (accessed February 15, 2012).

Khayesi, M. and M. Peden. 2005. Road safety in Africa. *British Medical Journal* 331: 710–711.

Kopits, E. and M. Cropper. 2005. Traffic fatalities and economic growth. *Accident Analysis & Prevention* 37 (1): 169–178.

Loo, B. P. Y., W. S. Cheung, and S. Yao. 2011. The rural-urban divide in road safety: The case of China. *The Open Transportation Journal* 5: 9–20.

Loo, B. P. Y., W. T. Hung, H. K. Lo, and S. C. Wong. 2005. Road safety strategies: A comparative framework and case studies. *Transport Reviews* 25 (5): 613–639.

Loo, B. P. Y. and K. L. Tsui. 2007. Factors affecting the likelihood of reporting road crashes resulting in medical treatment to the police. *Injury Prevention* 13 (3): 186–189.

Mathers, C. D. and D. Loncar. 2005. Updated projections of global mortality and burden of disease, 2002–2030: Data sources, methods and results. Projected DALYs for 2005, 2015, and 2030 by country income group under the baseline scenario. Geneva, Switzerland: World Health Organization, October 2005, http://www.who.int/healthinfo/global_burden_disease/projections2002/en/ (accessed November 13, 2011).

Odero, W., M. Khayesi, and P. M. Heda. 2003. Road traffic injuries in Kenya: Magnitude, causes and status of intervention. *Injury Control and Safety Promotion* 10 (1–2): 53–61.

Peden, M., R. Scurfield, D. Sleet, D. Mohan, A. Adnan, E. Jarawan, and C. Mathers, eds. 2004. World report on road traffic injury prevention. Geneva, Switzerland: World Health Organization.

Sleet, D., T. Dinh-Zarr, and A. Dellinger. 2007. Traffic safety in the context of public health and medicine. In *Improving Traffic Safety Culture in the United States*, pp. 41–58. Washington, DC: AAA Foundation for Traffic Safety.

Turner, B., M. Tziotis, P. Cairney, and C. Jurewicz. 2009. Safe system infrastructure: National roundtable report. Research Report ARR 370. ARRB Group Ltd., Vermont South, Victoria, Australia.

Vasconcellos, E. A. 1999. Urban development and traffic accidents in Brazil. *Accident Analysis & Prevention* 31 (4): 319–328.

Ward, J. W. and C. Warren, ed. 2007. *Silent Victories: The History and Practice of Public Health in Twentieth-Century America*. New York: Oxford University Press.

Watkins, K. and D. Sridhar. 2009. Road traffic injuries: The hidden development crisis. In *Policy Briefing for the First Global Ministerial Conference on Road Safety*, Moscow, Russia, November 19–20, 2009.

Wramborg, P. 2005. A new approach to a safe and sustainable traffic planning and street design for urban areas. In *Road Safety on Four Continents Conference Proceedings*, Warsaw, Poland.

World Health Organization. 2008. The global burden of disease: 2004 update. Geneva, Switzerland: WHO.

World Health Organization. 2014. Road traffic deaths: Data by country, Global Health Observatory Data Repository. http://apps.who.int/gho/data/node.main.A997?lang=en (accessed October 29, 2014).