UNIT 2

Risk factors for road traffic injuries

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Overview

A road traffic crash results from a combination of factors related to the components of the system comprising roads, the environment, vehicles and road users, and the way they interact. Some factors contribute to the occurrence of a collision and are therefore part of crash causation. Other factors aggravate the effects of the collision and thus contribute to trauma severity. Some factors may not appear to be directly related to road traffic injuries. Some causes are immediate, but they may be underpinned by medium-term and long-term structural causes. Identifying the risk factors that contribute to road traffic crashes is important in identifying interventions that can reduce the risks associated with those factors.

This unit is devoted to discussing risk factors for road traffic injuries. The first part of the unit provides frameworks that can be used to identify and analyse risk factors. The second part discusses the key risk factors.

Objectives

By the end of this unit, the trainee should be able to:

- discuss the basic elements of the public health approach and Haddon matrix;
- apply the principles of a systems approach to the analysis of risk factors for road traffic injuries;
- discuss the key risk factors for road traffic injuries;
- relate these risk factors to the trainee's own country, region and city.

Analytical frameworks

Various analytical frameworks can be used to identify the risk factors involved in road traffic injuries. In this section, we present three frameworks or approaches: the public health approach; the Haddon matrix; and the systems approach.

Public health approach

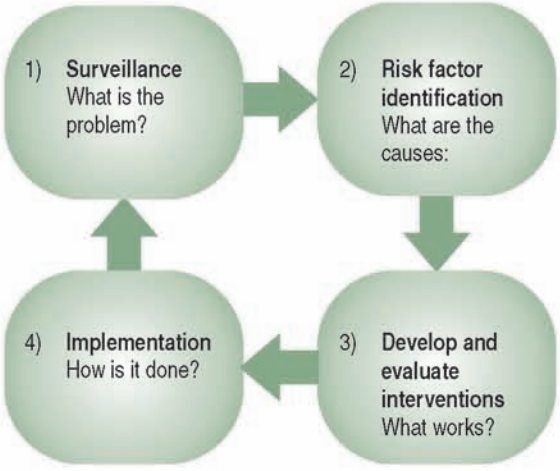
The public health approach is a generic analytical framework that has made it possible for different fields of public health to respond to a wide range of health problems and diseases, including injuries and violence *(1, 2)*. This approach is not only helpful in the analysis of risk factors, but also provides a framework that guides decision-making throughout the entire process, from identifying a problem to implementing an intervention. Analysis of risk factors is one of the components of this approach, and that is why we have included it here for application to road traffic injuries.

The public health approach involves four interrelated steps (Figure 2.1):

- The first step is to determine the magnitude, scope and characteristics of the problem. Defining the problem goes beyond simply counting cases: it includes delineating mortality, morbidity, and risk-taking behaviour. In the case of road traffic injuries, this step includes obtaining information on the demographic characteristics of the people involved, the temporal and geographical features of the incident, the circumstances under which it occurred, and the severity and cost of the injuries. Quantitative (for example, surveys) and qualitative (for example, focus group

FIGURE 2.1

The public health approach



discussions) research methods drawn from the behavioural and social sciences are increasingly being used to identify and characterize problems.

- The second step is to identify the factors that increase the risk of disease, injury or disability, and to determine which factors are potentially modifiable. Whereas the first step looks at "who, when, where, what and how", the second step looks at "why". It may also be used to define populations at high risk for injuries and violence and to suggest specific interventions.
- The third step is to assess what measures can be taken to prevent the problem by using the information about causes and risk factors to design, pilot test and evaluate interventions. This step aims at developing interventions based upon information obtained from the previous steps and testing these or other extant interventions. Methods for testing include randomized controlled trials, controlled comparisons of populations for occurrence of health outcomes, cohort studies, time series analyses of trends in multiple areas, and observational studies such as case control studies. An important component of the evaluation step is to document the processes that contribute to the success or failure of an intervention, in addition to examining the impact of interventions on health outcomes.
- The final step is the implementation of interventions that have been proven or are highly likely to be effective on a broad scale. In both instances it is important that data are collected to evaluate the programme's effectiveness in actually reducing road traffic injuries and fatalities, particularly since an intervention that has been found effective in a clinical trial or a small study may perform differently at the community level, or when expanded to target broader populations or geographical areas. Another important component is determining the cost-effectiveness of such programmes. Balancing the costs of a programme against the cases prevented by the intervention can be helpful to policy-makers in determining optimal public health practice. Implementation also implies health communication, the formation of partnerships and alliances as well as developing methods for community-based programmes.

Though each of the four steps is presented separately, it is important to remember that in reality these steps may overlap in terms of the timing in which they are implemented.

Haddon matrix

William Haddon *(3)* developed a matrix that identifies risk factors before the crash, during the crash and after the crash, in relation to the person, vehicle and environment (Table 2.1). Haddon

TABLE 2.1

The Haddon matrix

		FACTORS		
PHASE		HUMAN	VEHICLES AND EQUIPMENT	ENVIRONMENT
Pre-crash	Crash prevention	Information Attitudes Impairment Police enforcement	Roadworthiness Lighting Braking Handling Speed management	Road design and road layout Speed limits Pedestrian facilities
Crash	Injury prevention during the crash	Use of restraints Impairment	Occupant restraints Other safety devices Crash protective design	Crash-protective roadside objects
Post-crash	Life sustaining	First-aid skill Access to medics	Ease of access Fire risk	Rescue facilities Congestion

Source: reference *3.*

described road transport as an ill-designed "man-machine" system in need of comprehensive systemic treatment. Each phase – pre-crash, crash and post-crash – can be analysed systematically for human, vehicle, road and environmental factors. The Haddon matrix is an analytical tool to help in identifying all factors associated with a crash. Once the multiple factors associated with a crash are identified and analysed, countermeasures can be developed and prioritized for implementation over short-term and long-term periods. For the pre-crash phase, it is necessary to select all countermeasures that prevent the crash from occurring. The crash phase is associated with countermeasures that prevent injury from occurring or reduce its severity if it does occur. Finally, the post-crash phase involves all activities that reduce the adverse outcome of the crash after it has occured.

Systems approach

Traditionally, analysis of risk has examined the road user, vehicle and road environment separately. Furthermore, there is a tendency by researchers and practitioners to look for one or a few factors, when in actual fact they should be analysing multiple factors. Building on Haddon's insights, the systems approach (where interactions between different components are taken into account) seeks to identify and rectify the major sources of error, or design weaknesses, that contribute to fatal crashes or crashes that result in severe injury, as well as to mitigate the severity and consequences of injury. The essence of using a systems approach is to consider not only the underlying factors, but also the role of different agencies and actors in prevention efforts. Road traffic injuries are a multi-dimensional problem that require a comprehensive view when examining the determinants, consequences and solutions.

Any road traffic system is highly complex and can be hazardous to human health. Elements of the system include motor vehicles, roads, and road users along with their physical, social and economic environments. Making a road traffic system less hazardous requires a systems approach — understanding the system as a whole and the interaction between its elements, and identifying where there is potential for intervention. In particular, it requires recognition that the human body is highly vulnerable to injury, and that humans make mistakes. A safe road traffic system is one that accommodates and compensates for human vulnerability and fallibility *(4)*.

Each crash and its consequences can be represented by its system of interlinked factors (Figure 2.2). As the components of the road and transport system interact, linkages appear between crash and trauma factors. For example, some road features or vehicle characteristics may have influenced particular aspects of road users' behaviour, and the effects of some vehicle defects may have been compounded by particular road characteristics. For the purpose of planning measures to avoid collisions, it is essential to

Activity

Task

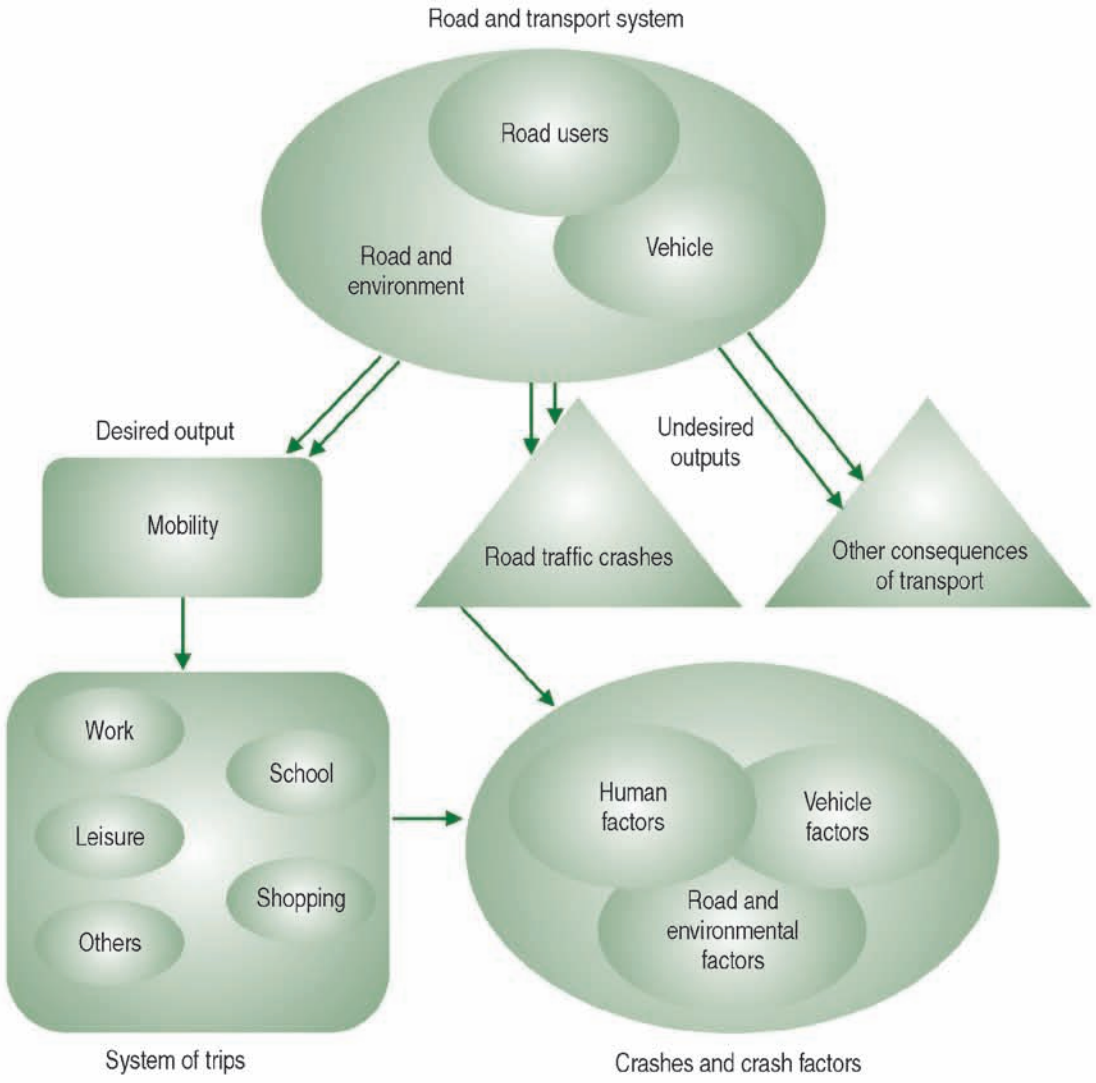
Read carefully this description of a road traffic collision scene. A speeding motorist who is late for a meeting approaches a road junction and goes through a traffic light that has just turned red. He hits a motorcyclist, for whom the lights had just turned green. The motorcyclist, who is not wearing a helmet, suffers severe head injuries. The motorist suffers facial injuries. The police find out that the motorist had not put on his seat-belt. Using the Haddon matrix shown in Table 2.1, identify the pre-crash, crash and post-crash risk factors related to the driver and the motorcyclist.

Expected results

This exercise is meant to assist trainees in identifying the chain of events involved in road traffic injury causation. The exercise seeks to identify a few risk factors in this scene and classify them under the three phases of the Haddon matrix (pre-crash, crash, and post-crash) and by group (human, vehicle and equipment, and environment). In addition to identifying the risk factors, this exercise should lead trainees to look at the interaction among different elements of the broader system of road, road user, vehicle and environment, in the case presented.

FIGURE 2.2

The systems approach



Source: reference 5.

understand the full complex causation process, as it provides vital information, and usually leads to a wide scope of possible areas of preventive action. There is an opportunity for intervention in all aspects of the transport system, and related systems indicated in Figure 2.2, to reduce the risk of road traffic injuries and deaths. The key message to take from Figure 2.2 is that a road traffic crash or collision is the outcome of interaction among a number of factors and subsystems.

If road traffic crashes are reduced to one "cause" only, it is obvious that the components of the system – human, infrastructure and vehicle factors – are necessarily considered as independent. Measures addressing any one component can thus be implemented separately, which makes things easier as the decision-makers responsible for each area of intervention do not have to coordinate with the others. However, opportunities to influence one type of

factor through another (for example, to obtain more appropriate driver behaviour through changes in road design) are entirely ignored. Moving away from the simplified model for road safety action to a systems approach requires that considerable effort be put into acquisition of knowledge of the nature of crashes. This effort is rewarded by the larger range of opportunities opened up for preventive action and by the more appropriate design of measures. Getting sufficient knowledge of the factors generating hazards in the road and transport system implies analysing the chain of events leading to crashes and injuries. As crash factors relate to human as well as to physical and technical components of the road and transport system, detailed analysis of road crashes may require a multidisciplinary approach.

What are the main risk factors?

Research has identified a number of risk factors for road traffic injuries and these are discussed in the recently published *World report on road traffic injury prevention (4)*. Box 2.1 provides a summary of these factors.

Factors influencing exposure to risk

Movement of people and goods on the road is necessary for social, economic and political reasons, but this need to travel leads to a risk of road traffic injuries. A range of factors determine who uses different parts of the transport system, how they use them and why, and at what times. It may not be possible in practice to completely eliminate all risk, but it is possible to reduce

BOX 2.1

The main risk factors for road traffic injuries

Factors influencing exposure to risk

— economic factors such as level of economic development and social deprivation;
— demographic factors such as age and sex;
— land-use planning practices which influence length of trip and mode of travel;
— mixture of high-speed motorized traffic with vulnerable road users;
— insufficient attention to integration of road function with decisions about speed limits, road layout and design.

Risk factors influencing crash involvement

— inappropriate and excessive speed;
— presence of alcohol, medicinal or recreational drugs;
— fatigue;
— being a young male;
— having youths driving in the same car;
— being a vulnerable road user in urban and residential areas;
— travelling in darkness;
— vehicle factors – such as braking, handling and maintenance;
— defects in road design, layout and maintenance, which can also lead to unsafe behaviour by road users;
— inadequate visibility because of environmental factors (making it hard to detect vehicles and other road users);
— poor eyesight of road users.

BOX 2.1 (continued)

Risk factors influencing crash severity

— human tolerance factors;
— inappropriate or excessive speed;
— seat-belts and child restraints not used;
— crash-helmets not worn by users of two-wheeled vehicles;
— roadside objects not crash-protective;
— insufficient vehicle crash protection for occupants and for those hit by vehicles;
— presence of alcohol and other drugs.

Risk factors influencing post-crash outcome of injuries

— delay in detecting crash and in transport of those injured to a health facility;
— presence of fire resulting from collision;
— leakage of hazardous materials;
— presence of alcohol and other drugs;
— difficulty in rescuing and extracting people from vehicles;
— difficulty in evacuating people from buses and coaches involved in crash;
— lack of appropriate pre-hospital care;
— lack of appropriate care in hospital emergency rooms.

Source: reference *4.*

exposure to the risk of severe injury and to minimize its intensity and consequences. The specific modes and issues of importance when examining exposure to risk are fully discussed in the *World report on road traffic injury prevention (4)*. A brief summary is given here.

Growth in number of motor vehicles

One of the main factors contributing to the increase in global road crash injuries is the growing number of motor vehicles. The problem is not just the growth in numbers and increase in exposure to the risk but also ensuring that appropriate road safety measures accompany this growth. The motor vehicle, along with the subsequent growth in the number of motor vehicles and in road infrastructure, has brought societal benefit but it has also led to societal cost, to which road traffic injury contributes significantly. Without proper planning, growth in the number of motor vehicles can lead to problems for pedestrians and cyclists. In fact, where there are no facilities for pedestrians and cyclists, increasing numbers of motor vehicles generally lead to reductions in walking and cycling.

At present, motor vehicle growth in low-income and middle-income countries is taking place against a background of associated problems. Only a small number of people in these countries can afford cars, while the costs of roads, parking spaces, air pollution and road traffic injuries are borne by the whole society. Despite the rapid growth in motorized traffic, most families in low-income and middle- income countries are unlikely to own a car within the next 25 years.

In terms of exposure to risk, the main modes of travel in these countries in the foreseeable future are likely to remain walking, cycling and public transport. This emphasizes the importance of planning for the needs of these road users, who, as was seen in Unit 1, bear a high proportion of the burden of road traffic injuries. Buses and trucks are a major mode of travel in low-income and middle-income countries. High volumes of passengers being transported have an impact on the safety, not only of the passengers themselves, but also of vulnerable road users.

Motorized two-wheeled and three-wheeled vehicles

The substantial growth in the use of motorized two-wheelers, particularly in low-income and middle-income countries, is being accompanied by an increase in the number of head and traumatic brain injuries. This is of particular concern in Asia where, for many commuters, the motorized two-wheeler is used as a family vehicle. Use of such vehicles increases exposure to the risk of road traffic injuries. Like other motor vehicles, motorized two-wheelers and three-wheelers also cause injuries to other road users as noted in their collisions with buses, cars and pedestrians.

Non-motorized traffic

Non-motorized vehicles predominate in both rural and urban areas in low-income and middle- income countries. Overall in developing countries, pedestrian and cyclist traffic has grown without accompanying improvements in facilities for these road users. The high number of pedestrian and cyclist casualties in these countries reflects not only the inherent vulnerability of these road users, but also insufficient attention to their needs in policy-making.

Demographic factors

Different groups of people have different exposures to risk. As populations change over time, so their overall exposure will change. Fluctuations in the relative sizes of different population groups will have a strong effect on the road traffic toll. For instance, in high-income countries, young drivers and riders – at increased risk of involvement in road crashes – are currently overrepresented in casualty figures. Demographic changes in these countries over the next 20–30 years, however, will result in road users over 65 years of age becoming the largest group of road users. The physical vulnerability of older people places them at high risk for fatal and serious injuries. Despite the rising number of older people holding driving licences in high-income countries, their declining driving ability as well as possible financial constraints will mean that many of them will have to give up driving. This may differ from many low-income countries where older people may never have driven in the first place. In low-income countries in general, the expected demographic evolution suggests that younger road users will continue to be the predominant group involved in road traffic crashes. Worldwide, a large proportion of older people will be dependent on public transport or will walk. This illustrates the importance of providing safe and short pedestrian routes, and safe and convenient public transport.

Transport, land use and road network planning

Planning decisions regarding transport, land use and road networks have significant effects on public health – as they affect the amount of air pollution by vehicles, the degree of physical exercise undertaken by individuals, and the volume of road traffic crashes and injuries. The development of a network of roads – or indeed of other forms of transport, such as railways – has a profound effect on communities and individuals. It influences such things as economic activity, property prices, air and noise pollution, social deprivation and crime – in addition to health. Long commuting times degrade the quality of life and therefore health. Sedentary travel directly and adversely affects health. In the absence of proper land use planning, residential, commercial and industrial activity will evolve in a haphazard pattern, and road traffic will evolve similarly to meet the needs of these various activities. This is likely to produce heavy flows of traffic through residential areas, vehicles capable of high speed sharing space with pedestrians, and heavy, long-distance commercial traffic using routes not designed for such vehicles. The consequent exposure to road traffic injury may be high for car occupants, and even more so for vulnerable road users, such as pedestrians, cyclists and motorized two-wheeler users.

Choice and use of less safe forms of travel

Of the four main modes of travel, road travel presents the highest risk in most countries – using almost any measure of exposure – compared with rail, air and marine travel. Within this mode of road

travel, major variations exist between pedestrians, cyclists, riders of motorized two-wheelers, car occupants, and bus and truck passengers. The risks for these road users also vary greatly according to the traffic mix and hence vary greatly from country to country. In general, in high-income countries, riders of motorized two-wheelers have the highest levels of risk.

Factors influencing crash involvement

This section provides a summary of selected factors presented in the *World report on road traffic injury prevention (4).*

Speed

The speed of motor vehicles is at the core of the road traffic injury problem. Speed influences both crash risk and crash consequence (Box 2.2). The physical layout of the road and its surroundings can both encourage and discourage speed. Crash risk increases as speed increases, especially at road junctions and while overtaking – as road users underestimate the speed and overestimate the distance of an approaching vehicle.

Drivers' speed choice is influenced by a number of factors that can be considered as:

- driver-related factors (age, sex, alcohol level, number of people in the vehicle);
- factors relating to the road and the vehicle (road layout, surface quality, vehicle power, maximum speed);
- traffic-related and environment-related factors (traffic density and composition, prevailing speed, weather conditions).

Alcohol

Impairment by alcohol is an important factor influencing both the risk of a road crash as well as the severity of the injuries that result from crashes

BOX 2.2

Effects of speed on crashes and crash severity

- The higher the speed of a vehicle, the shorter the time a driver has to stop and avoid a crash. A car travelling at 50 km/h will typically require 13 metres in which to stop, while a car travelling at 40 km/h will stop in less than 8.5 metres.
- An average increase in speed of 1 km/h is associated with a 3% higher risk of a crash involving an injury.
- In severe crashes, the increased risk is even greater. In such cases, an average increase in speed of 1 km/h leads to a 5% higher risk of serious or fatal injury.
- Travelling at 5 km/h above a road speed limit of 65 km/h results in an increase in the relative risk of being involved in a casualty crash that is comparable with having a blood alcohol concentration of 0.05 g/dl.
- For car occupants in a crash with an impact speed of 80 km/h, the likelihood of death is 20 times what it would have been at an impact speed of 30 km/h.
- Pedestrians have a 90% chance of surviving car crashes at 30 km/h or below, but less than a 50% chance of surviving impacts at 45 km/h or above.
- The probability of a pedestrian being killed rises by a factor of 8 as the impact speed of the car increases from 30 km/h to 50 km/h.

Source: reference *4.*

(Boxes 2.3 and 2.4). The frequency of drinking and driving varies between countries but it is almost universally a major risk factor for road traffic crashes. The extent to which alcohol contributes to road traffic crashes varies between countries, and direct comparisons are difficult to make. In many high-income countries, about 20% of fatally injured drivers have excess alcohol in their blood (i.e. above the legal limit). Studies in low-income countries have shown alcohol to be present in between 33% and 69% of fatally injured drivers.

Driver fatigue

Fatigue or sleepiness is associated with a range of factors. Some of these factors with relevance to road traffic are long-distance driving, sleep deprivation and the disruption of circadian rhythms. Three high-risk groups have been identified:

— young people, particularly males, aged 16–29 years;

— shift workers whose sleep is disrupted by working at night or working long, irregular hours;

BOX 2.3

Effects of alcohol on risk of crashes and of crash injury

- Drivers and motorcyclists with any blood alcohol content greater than zero are at higher risk of a crash than those whose blood alcohol content is zero.
- For the general driving population, as the blood alcohol content increases from zero, the risk of being involved in a crash starts to rise significantly at a blood alcohol content of 0.04 g/dl.
- Inexperienced young adults driving with a blood alcohol content of 0.05 g/dl have 2.5 times the risk of a crash compared with more experienced drivers.
- If a blood alcohol content limit is fixed at 0.10 g/dl, this will result in three times the risk of a crash than that at 0.05 g/dl, which is the most common limit in high-income countires. If the legal limit stands at 0.08 g/dl, there will still be twice the risk than at 0.05 g/dl.
- Alcohol consumption by drivers puts pedestrians and riders of motorized two-wheelers at risk.

Source: reference *4.*

BOX 2.4

What factors affect alcohol-related road crashes?

- The risk of a road crash when a driver is alcohol-impaired varies with age. Teenagers are significantly more likely to be involved in a fatal crash than older drivers. At almost every blood alcohol level, the risk of crash fatality decreases with increasing driver age and experience.
- Teenage drivers who are alcohol-impaired are at increased risk of having a road crash if they have passengers in the vehicle, as compared with those driving alone.
- A low expectation of getting caught with a blood alcohol content above the legal limit has been shown to lead to an increased risk of a crash.

Source: reference *4.*

— people with untreated sleep apnoea syndrome or narcolepsy.

Factors that substantially increase the risk of a fatal crash or a crash with serious injuries are:

— driving while feeling sleepy;

— driving after five hours of sleep;

— driving between 02:00 and 05:00.

Commercial transport

Surveys of commercial and public road transport have revealed that owners of public transport vehicles, in pursuit of increased profits, frequently force their drivers to drive at excessive speeds, to work unduly long hours and to work when exhausted.

Hand-held mobile telephones

The use of hand-held mobile telephones can adversely affect driver behaviour – as regards physical tasks as well as perception and decision-making. The process of dialling influences a driver's ability to keep to the course on the road. Results of studies on distraction and mental load show that driver reaction times are increased by 0.5–1.5 seconds when talking into a mobile telephone. Studies have shown that driver performance is particularly affected in maintaining the correct lane position and the headway between two vehicles travelling one behind the other, in keeping to an appropriate speed, and in judging and accepting safe gaps in the traffic. There is some evidence from studies that drivers who use mobile telephones while driving face a risk of a crash four times higher than the risk for drivers who do not use mobile telephones.

Inadequate visibility

In motorized countries, inadequate visibility plays a key role in three types of crashes:

— a moving vehicle running into the rear or side of a slowly moving or stationary vehicle located ahead on the roadway, at night-time;

— angled collisions or head-on collisions in daytime;

— rear-end collisions in fog, in daytime and at night.

In low-income and middle-income countries, the phenomenon of pedestrians and vehicles not being properly visible is frequently a serious problem. In many places, there are fewer roads with adequate illumination and some may not be lit at all. In addition, it is more common for large numbers of bicycles and other vehicles to have no lights or reflectors and for road space to be shared by fast-moving and slow-moving road users.

Road-related factors

Road crashes are not evenly distributed throughout the network. They may occur in clusters at single sites, along particular sections of road, or scattered across whole residential neighbourhoods, especially in areas of social deprivation. While road engineering can greatly help in reducing the frequency and severity of road traffic crashes, it can also contribute to crashes. The road network has an effect on crash risk because it determines how road users perceive their environment, and it provides instructions for road users, through signs and traffic controls, on what they should be doing. Many traffic management and road safety engineering measures work through their influence on human behaviour.

Road engineering factors include those where a road defect directly triggers a crash, where some element of the road environment misleads a road user and thereby creates error, or where some feasible physical alteration to the road would have made the crash less likely. In the planning, design and maintenance of the road network, the following four particular elements affecting road safety have been identified:

- safety-awareness in the planning of new road networks;
- the incorporation of safety features in the design of new roads;
- safety improvements to existing roads;
- remedial action at high-risk crash sites.

Factors influencing crash severity

Factors influencing crash severity are presented in this section.

Lack of in-vehicle crash protection

In the past decade, the crashworthiness of private cars for their occupants has improved considerably in many high-income countries, though there is still considerable room for further improvement. In low-income and middle-income countries, regulation of motor vehicle safety standards is not as systematic as in high-income countries. Many engineering advances to be found in vehicles available in high-income countries are not standard fittings in vehicles in low-income and middle-income countries. In addition, the majority of road casualties in low-income and middle-income countries occur outside the car, affecting pedestrians, cyclists, motorized two-wheeled vehicle riders, or passengers in buses and trucks. As yet, there are no requirements to protect vulnerable road users by means of crashworthy designs of the fronts of trucks or buses.

The main injury risks for car occupants arise from the way vehicles interact with each other and with the roadside in frontal and side-impact crashes. In fatal and serious crashes, head, chest and abdominal injuries are predominant. Among injuries that cause disability, those to the legs and neck are important. Determinants of the degree of severity of injuries include:

— contact by occupant with the car's interior, exacerbated by intrusion into the passenger compartment of the colliding vehicle or object;

— mismatch in terms of size and weight between vehicles involved in a crash;

— ejection from the vehicle;

— inadequate vehicle safety standards.

Bus and truck occupants

Buses with passengers, minibuses and trucks are frequently involved in crashes in low-income countries. The use of open-backed vehicles for transporting passengers, particularly widespread in rural areas, presents a risk of ejecting passengers. In many low-income and middle-income countries, second-hand trucks and buses are imported without the crash-protective features – such as occupant restraints – that are present in high-income countries. Such vehicles have low crashworthiness. They also have poor stability when fully laden or over-loaded, as they frequently are.

The urban centres of low-income and middle-income countries typically contain a great mix of vehicles. Incompatibility of size between different types of road vehicles is a major risk factor, especially in impacts between cars and large trucks. The power of the larger vehicle – its mass, geometry and structural properties – increases rates of injury and death many times compared with an equivalent car-to-car collision.

Non-use of crash helmets by two-wheeled vehicle users

The main risk factor for motorized two-wheeler users is the non-use of crash helmets (Box 2.5). The lack or inappropriate use of helmets has been shown to increase the risk of fatalities and injuries resulting from road crashes involving motorized two-wheelers. Head injuries are a major cause of death, injury and disability among users of motorized two-wheel vehicles. Many of these head injuries could have been prevented or their severity reduced through the use of simple and inexpensive helmets.

Non-use of seat-belts and child restraints in motor vehicles

The lack or inappropriate use of seat-belts and other safety restraints (child seats and booster seats) are risk factors for the fatalities and injuries that result from road crashes (Box 2.6). The most frequent and most serious injuries occurring in frontal impacts to occupants unrestrained by seat-belts are to the head (Box 2.6).

Roadside objects

Impacts between vehicles leaving the road and solid roadside objects such as trees, poles and road signs are a major road safety problem worldwide. These collisions are usually single-vehicle crashes and frequently involve young drivers, excess or inappropriate speed, the use of alcohol or driver fatigue. Another problem related to impacts with objects off the road is the occurrence of crashes caused by restricted visibility, resulting from the poor siting of these objects.

BOX 2.5

Helmet wearing

- Non-helmeted users of motorized two-wheelers are three times more likely to sustain head injuries in a crash compared to those wearing helmets.
- Helmet-wearing rates vary from slightly over zero in some low-income countries to almost 100% in places where laws on helmet use are effectively enforced.
- Although helmets have generally been widely worn in most high-income countries, there is evidence of a decline in usage in some countries.
- More than half of adult riders of motorized two-wheelers in some low-income countries do not wear their helmets properly secured.
- Child passengers rarely wear helmets, or wear adult helmets that do not adequately protect them.
- Helmet use does not have adverse effects on neck injuries, visibility or the ability to drive safely in traffic.

Source: reference *4.*

BOX 2.6

Safety restraints

Seat-belt wearing

- Rates of seat-belt use vary greatly among different countries, depending upon the existence of laws mandating their fitting and use and the degree to which those laws are enforced. In low-income and middle-income countries, usage rates are generally much lower.
- Seat-belt usage is substantially lower in fatal crashes than in normal traffic.
- Young male drivers use their seat-belts less often than other groups and are also more likely to be involved in crashes.
- The effectiveness of seat-belts depends upon the type and severity of the crash and the seating position of the passenger.
- Seat-belts are most effective in roll-over crashes and frontal collisions, and in lower speed crashes.
- Correctly used seat-belts reduce the risk of death in a crash by approximately 60%.

Child restraint use

- The use of child restraints (child seats and booster seats) in motor vehicles varies considerably between countries and is mainly confined to high-income countries.
- The use of child restraints can reduce infant death in car crashes by 71% and toddler deaths by 54%.
- Child restraints work in the same way as adult seat-belts.
- The use of appropriate restraint depends on the age and weight of the child: rear-facing seats are particularly effective for young infants, forward-facing restraints are appropriate for younger children, and booster seats used with seat-belts are effective for older children.
- The potential hazard of combining air bags with rear-facing seats in the front seat of a vehicle is well documented.
- There is a substantial amount of incorrect use of both adult seat-belts and child restraints, which markedly reduces their injury-reducing potential.

Source: reference *4.*

The linkage between vehicle crash protection and roadside crash protection needs to be strengthened. The road environment needs to be designed so as to eliminate head-on collisions – into trees, poles and other rigid objects – at high speeds, where the car itself cannot offer sufficient protection.

Factors influencing post-crash injury outcomes

Death is potentially preventable in a proportion of cases of people who die as a result of road crashes before they reach hospital. The potential help towards recovery that victims can receive may be viewed as a chain with several links:

- actions, or self-help, at the scene of the crash, by the victims themselves, or more frequently by bystanders;
- access to the emergency medical system;
- help provided by rescuers of the emergency services;
- delivery of medical care before arrival at the hospital;
- hospital trauma care;
- rehabilitative psychosocial care.

There are risk factors in both pre-hospital and hospital settings. Post-crash care is covered in detail in Unit 5.

Key points

- A road traffic collision is the outcome of interaction among a number of factors, some of which may not appear to be directly related to road traffic injuries.
- The public health approach is not only helpful in the analysis of risk factors, but also provides a framework that guides decision-making for the entire process, from identifying a problem to implementing interventions.
- Main risk factors can be categorized into four groups:
  - factors influencing exposure to risk, such as demographic and economic factors, level of motorization, and land use planning practices;
  - factors influencing crash involvement, such as inappropriate and excessive speed, drinking and driving, unsafe road design, and lack of effective law enforcement and safety regulations;
  - factors influencing crash and injury severity, such as the non-use of seat belts, child restraints or crash helmets, insufficient vehicle crash protection for occupants and for those hit by vehicles, and presence of alcohol;
  - factors influencing post-crash injury outcomes, such as delay in detecting the crash and providing life-saving measures and psychological support.

Definitions of key concepts

- Public health approach: a generic analytical framework that has made it possible for different fields of public health to respond to a wide range of health problems and diseases, including injuries and violence.
- Risk: probability of an adverse health outcome, or a factor that raises this probability.
- Determinant: a factor which contributes to or explains the occurrence and prevalence of a phenomenon.
- Systems approach: a perspective that takes into account the various parts and their relationships as they contribute to the totality of a phenomenon. In the case of road traffic injury prevention, this calls for a comprehensive understanding of the risk factors, determinants, impacts and interventions, as well as consideration of the role of different agencies and stakeholders in prevention.

Questions to think about

- Why is the public health approach a useful framework in dealing with road safety issues?
- What are the most important risk factors for road traffic injuries in your local setting?

References

1. Krug EG, Sharma GK, Lozano R. The global burden of injuries. *American Journal of Public Health*, 2000, 90:523–526.
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3. Haddon Jr W. Advances in the epidemiology of injuries as a basis for public policy. *Public Health Report*, 1980, 95:411–421.
4. Peden M et al. *World report on road traffic injury prevention*. Geneva, World Health Organization, 2004.
5. Muhlrad N, Lassarre S. Systems approach to injury control. In: Tiwari G, Mohan D, Muhlrad N, eds. *The way forward: transportation planning and road safety.* New Delhi, Macmillan India Ltd., 2005:52–73.

Further reading

Haddon W, Baker SP. Injury control. In: Clark DW, MacMahon B, eds. *Preventive and community medicine*. Boston, Little-Brown and Company, 1981:109–140.

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Tiwari G. Transport and land-use policies in Delhi. *Bulletin of the World Health Organization*, 2003, 81(6):444–450.

Trinca G et al. *Reducing traffic injury: the global challenge*. Melbourne, Royal Australasian College of Surgeons, 1988.

Notes

Trainee's evaluation of Unit 2: Risk factors for road traffic injuries

This form is to be completed by the trainee at the end of this unit to assess the content and approach used. This evaluation is helpful to the trainee, trainer and developer of this manual.

1. To what extent did you achieve the objectives set for this unit? (Please check once using "X" for each objective)

Objectives	Completely successful	Generally successful	Completely unsuccessful
Discuss the basic elements of the public health approach and Haddon matrix.			
Apply the principles of a systems approach to the analysis of risk factors for road traffic injuries.			
Discuss the key risk factors for road traffic injuries.			
Relate these risk factors to your country, region and city.			

2. What is your overall rating of the content presented in this unit? (Please check one using "X")

Scale	Excellent	Better than expected	Satisfactory	Below average
Rating				

3. How do you rate the balance between theoretical and practical content in this unit? (Please check one using "X")

Scale	Good balance	Too theoretical	Too practical
Rating			

4. a) Did you find the activities presented in the unit helpful? (Please check one)

   Yes_____ No_____

b) If yes, in what ways were they helpful? What improvements do you suggest?

_____

_____

c) If no, what were the shortcomings? What suggestions do you have to make them helpful?

_____

_____

5. What did you like most about the unit?

_____

_____

6. What did you like least about the unit?

7. What did you learn most from this unit?

8. Explain how your organization, community, city and country, and other interested parties will benefit from your having read this unit.

9. What do you think should be added to this unit?

10. What do you think should be dropped from this unit?