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Pedestrian safety: a road safety manual for decision-makers and practitioners

Pedestrian safety

A ROAD SAFETY MANUAL FOR DECISION-MAKERS AND PRACTITIONERS

World Health Organization
FIA Foundation for the Automobile and Society
Global Road Safety Partnership
The World Bank

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Preface

Each year, more than 270 000 pedestrians lose their lives on the world's roads. Many leave their homes as they would on any given day – to school, work, places of worship, homes of friends – never to return. Globally, pedestrians constitute 22% of all road deaths, and in some countries this proportion is as high as two thirds. Millions more people are injured in traffic-related crashes while walking, some of whom become permanently disabled. These incidents cause much suffering and grief as well as economic hardship for families and loved ones.

The capacity to respond to pedestrian safety is an important component of efforts to prevent road traffic injuries. Pedestrian collisions, like other road traffic crashes, should not be accepted as inevitable because they are, in fact, both predictable and preventable. The key risks to pedestrians are well documented, and they include issues related to a broad range of factors: driver behaviour, particularly in relation to speeding as well as drinking and driving; infrastructure in terms of a lack of dedicated facilities for pedestrians such as sidewalks, crossings and raised medians; and vehicle design in terms of solid vehicle fronts that are not forgiving to pedestrians should they be struck. Poor trauma care services in many settings also thwart efforts to provide the urgent treatment needed to save pedestrian lives in the event of a collision.

Pedestrian safety: a road safety manual for decision-makers and practitioners describes: the magnitude of pedestrian deaths and injuries; key risk factors; ways of assessing the pedestrian safety situation in a given setting and prepare an action plan; and how to select, design, implement and evaluate effective interventions. The manual stresses the importance of a comprehensive, holistic approach that includes engineering, legislation and enforcement as well as behavioural measures. It also draws attention to the benefits of walking, which should be promoted as an important mode of transport given its potential to improve health and preserve the environment.

We hope that this manual, which is designed for a multidisciplinary audience including engineers, planners, police, public health professionals and educators, will contribute towards strengthening national and local capacity to implement pedestrian safety measures in settings worldwide. We encourage all to bring this manual to the attention of those who will use it to save pedestrian lives.

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Executive summary

Road traffic crashes kill about 1.24 million people each year. More than one fifth of these deaths occur among pedestrians. Pedestrian collisions, like all road traffic crashes, should not be accepted as inevitable because they are, in fact, both predictable and preventable. Key risk factors for pedestrian road traffic injury are vehicle speed, alcohol use by drivers and pedestrians, lack of safe infrastructure for pedestrians and inadequate visibility of pedestrians. Reduction or elimination of the risks faced by pedestrians is an important and achievable policy goal. Proven interventions exist, yet in many locations pedestrian safety does not attract the attention it merits.

This manual provides information for use in developing and implementing comprehensive measures to improve pedestrian safety. The extent of pedestrian fatalities and injuries, and the importance of addressing the key associated risk factors for pedestrian injury, are examined. The steps outlined for conducting a situational assessment to help with prioritizing interventions and preparing a related plan of action, are intended to assist with the implementation of effective interventions, and evaluation of pedestrian safety measures. While the focus of the manual is on sub-national administrative units, the strategies presented can be applied at the national level. It is hoped that the modular structure of this manual enables adoption to suit the needs and problems of individual countries. The manual is applicable worldwide but specifically targets decision-makers and practitioners in low- and middle-income countries.

Introduction

Introduction

Implementation of good practices in road safety

The World Health Organization (WHO), the World Bank, the FIA Foundation for the Automobile and Society and the Global Road Safety Partnership (GRSP) have been collaborating on a project over the past six years to produce a series of good practice manuals covering key issues identified in the *World report on road traffic injury prevention* (*1*). The project arose out of the numerous requests made to WHO and the World Bank by road safety practitioners around the world, especially those working in low- and middle-income countries, asking for information to assist with implementing the report's six recommendations.

Recommendations of the *World report on road traffic injury prevention*

1. Identify a lead agency in government to guide the national road traffic safety effort.
2. Assess the problem, policies, institutional settings and capacity relating to road traffic injury.
3. Prepare a national road safety strategy and plan of action.
4. Allocate financial and human resources to address the problem.
5. Implement specific actions to prevent road traffic crashes, minimize injuries and their consequences, and evaluate the impact of these actions.
6. Support the development of national capacity and international cooperation.

This collaboration has so far produced good practice manuals on helmets, seat-belts and child restraints, speed, drinking and driving, and data systems. These manuals are available on the website of the United Nations Road Safety Collaboration (UNRSC).[1] In addition to specific risk factors that have formed the content of the manuals so far, research shows the need to address several risk factors facing specific road users, such as pedestrians. The current manual is a response to this need, which exists in many countries around the world.

[1] United Nations Road Safety Collaboration: http://www.who.int/roadsafety

Pedestrian safety manual

Why was the manual developed?

Studies show a disproportionate involvement of pedestrians, cyclists and motorized two-wheelers in road traffic injuries. For instance, the first *Global status report on road safety* revealed that nearly half (46%) of those killed in road traffic crashes are pedestrians, cyclists or users of motorized two wheelers (*2*). More recently, the second *Global status report on road safety 2013: supporting a decade of action* examined pedestrians independently from other vulnerable road users, and showed that 22% of those killed on the world's roads are pedestrians (*3*). As shown in both the *Global status report on road safety* (*2,3*) and *World report on road traffic injury prevention* (*1*), there are regional and national differences in the distribution of road-user mortality.

Countries must address the problem of pedestrian safety by implementing effective measures. There are several recommendations that call on governments to take into consideration the needs of all road users, including pedestrians and cyclists, when making decisions about road design and infrastructure, land-use planning and transport services (*3*). This manual supports countries in achieving this objective with a specific focus on pedestrians.

Who is the manual for?

This manual will benefit a variety of users, but the primary target audiences are engineers, planners, enforcement professionals, public health professionals and educators and other such people who have responsibility to improve pedestrian safety at the local and sub-national levels. Though the application of this manual can be at the national level, the settings envisaged are sub-national geographical and administrative units such as provinces or states, districts, cities, towns, neighbourhoods and communities. A secondary target audience are decision-makers and leaders in government and nongovernmental organizations, who provide overall policy support on road safety, transport and land-use planning.

What does the manual cover?

The manual provides information to use in designing and implementing interventions that can improve pedestrian safety in local and sub-national settings around the world. A summary of the content of each module is presented below:

Module 1 stresses the need to promote pedestrian safety in transport planning and presents data on the magnitude of pedestrian fatalities and risk factors.

Module 2 examines the extent of pedestrian consideration and inclusion in land-use, transport and public space planning.

Module 3 outlines steps for prioritizing interventions and preparing a pedestrian safety plan of action.

Module 4 presents key principles and examples of interventions related to roads, vehicles and users from around the world.

Module 5 presents key principles for evaluating pedestrian safety interventions and advocating for pedestrian safety.

Case studies from a range of countries and settings are included throughout the modules.

How should the manual be used?

This manual provides information and examples to meet pedestrian safety planning needs in different local settings. Users are expected to be creative and innovative in adapting the content to the needs of particular situations. Each module contains tools, research findings and references to help readers determine the current status of pedestrian safety issues in their settings, to prioritize the best options for action to improve pedestrian safety, and to take steps that offer the greatest potential for improvement.

Individual sections of the manual may be more relevant to some settings than others, but users are advised to read the entire manual. It may be especially appropriate for all users to look at Module 3, which guides users on assessing the pedestrian safety situation, and then proceed to select particular actions to undertake as indicated in other modules. While the importance of adapting the content to local situations – and choosing the appropriate level to begin at – cannot be overstated, users who oversee the local adaptation of the content must also ensure that the fundamental principles are not radically changed or misrepresented.

What are the limitations of this manual?

This manual provides key information and examples of measures that can be implemented to improve pedestrian safety around the world. The manual does not provide an exhaustive 'state-of-the-art' review and case studies on pedestrian safety. The references and case studies offered are designed to provide key information that illustrates the issues being considered. There are several comprehensive reviews of the literature and case studies on pedestrian safety that the reader who wishes to know more may consult. Some of these reviews and studies are indicated in the reference lists in the modules.

While every attempt has been made to draw on experiences and lessons learned from countries implementing pedestrian safety programmes, there might be a need for readers to consult national or sub-national guidelines to ensure that decisions made take into account and are consistent with the local context.

How was the manual developed?

This manual is a result of three years of work by experts from public health, transport, psychology, planning and implementation, coordinated by WHO. An outline of the content of the manual, based on a standard format developed for the good practice manuals, was produced by a team of writers. A literature review was conducted to gather evidence and examples for preparing the manual. Two international experts conducted the review by assembling published and grey literature, extracting the information and preparing a literature review summary. The summary was used to provide information for different sections of the manual as well as categorize the examples of good practice provided in Module 4 into proven, promising or those with insufficient evidence at this time. Randomized controlled trials and case–control studies were used as the gold standard. A team of experts prepared a draft of the manual, which was reviewed by experts from health, transport, planning and implementation backgrounds. The review comments were used to revise the manual. An advisory committee of experts from the various partner organizations oversaw the process of further developing the manual, as has been the case with the other good practice manuals on helmets, speed, drinking and driving, seat-belts and child restraints, and data systems.

Dissemination of the manual

The manual will be translated into various major languages, and countries are encouraged to translate the document into local languages. The manual will be disseminated widely through the distribution channels of all four organizations involved in the series.

The manual is also available for downloading in PDF format from the websites of all four partner organizations. This manual is downloadable from http://www.who.int/roadsafety, for example.

How to obtain more printed copies

Further copies can be requested by e-mailing traffic@who.int, or by writing to:

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1. Peden M et al., eds. *World report on road traffic injury prevention.* Geneva, World Health Organization, 2004.
2. *Global status report on road safety: time for action.* Geneva, World Health Organization, 2009.
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1

Why is addressing pedestrian safety necessary?

Why is addressing pedestrian safety necessary?

MORE THAN one fifth of the people killed on the world's roads each year are not travelling in a car, on a motorcycle or even on a bicycle – they are pedestrians. Pedestrian deaths and injuries are often preventable, and proven interventions exist, yet in many locations pedestrian safety does not attract the attention it merits.

Successful interventions to protect pedestrians and promote safe walking require an understanding of the nature of risk factors for pedestrian crashes. This module provides the reader with background information on the problem of pedestrian injuries and risk factors worldwide. The information may be used to persuade political leaders to develop, implement and support pedestrian safety measures.

NOTE

A **pedestrian** is any person who is travelling by walking for at least part of his or her journey. In addition to the ordinary form of walking, a pedestrian may be using various modifications and aids to walking such as wheelchairs, motorized scooters, walkers, canes, skateboards, and roller blades. The person may carry items of varying quantities, held in hands, strapped on the back, placed on the head, balanced on shoulders, or pushed/pulled along. A person is also considered a pedestrian when running, jogging, hiking, or when sitting or lying down in the roadway.

The content of this module is organized as follows:

1.1 Guiding principles: Two of the principles that guide work on pedestrian safety and shape this manual are presented. The first is the concept of 'safe walking'. Walking is a basic and common mode of transport with benefits to health and the environment. Measures must be taken to improve the safety of walkers. The second guiding principle is the 'Safe System' approach, discussed here as a framework for understanding and addressing pedestrian safety.

1.2 Magnitude of pedestrian road injury problem: This section presents data on the number of pedestrians killed in road traffic crashes worldwide. It also presents information on the demographic and socioeconomic characteristics of people who are injured or killed as pedestrians, and the costs of pedestrian road traffic crashes.

1.3 What happens in a pedestrian collision? This section briefly describes the sequence of events and typical injuries arising from pedestrian–car collisions. It provides a useful background for understanding the risk factors discussed in Section 1.4.

1.4 Risk factors: This section discusses the key risk factors for pedestrian injury, particularly speed, alcohol, lack of road infrastructure for pedestrians and inadequate visibility of pedestrians on roads. Other risk factors are also outlined.

1.1 Guiding principles

1.1.1 The importance of safe walking

We are all pedestrians. Walking is a basic and common mode of transport in all societies around the world. Virtually every trip begins and ends with walking. Walking comprises the sole means of travel on some journeys, whether a long trip or a short stroll to a shop. In other journeys, a person may walk for one or more portion of the trip, for example, walking to and from bus stops, with a bus trip in between.

Walking has well established health and environmental benefits such as increasing physical activity that may lead to reduced cardiovascular and obesity-related diseases, and many countries have begun to implement policies to encourage walking as an important mode of transport (*1–3*). Unfortunately, in some situations increased walking can lead to increased risk of road traffic crashes and injury. Due to the dramatic growth in the number of motor vehicles and the frequency of their use around the world – as well as the general neglect of pedestrian needs in roadway design and land-use planning – pedestrians are increasingly susceptible to road traffic injury (*4*). Pedestrian vulnerability is further heightened in settings where traffic laws are inadequately enforced (*5*).

NOTE

A road traffic crash is a collision or incident involving at least one road vehicle in motion, on a public road or private road to which the public has right of access, resulting in at least one injured or killed person. Included are: collisions between road vehicles; between road vehicles and pedestrians; between road vehicles and animals or fixed obstacles or with one road vehicle alone. Included are collisions between road and rail vehicles (6).

Reduction or elimination of the risks faced by pedestrians is an important and achievable policy goal. Pedestrian collisions, like other road traffic crashes, should not be accepted as inevitable because they are, in fact, both predictable and preventable (*7*). There is a close association between the walking environment and pedestrian safety. Walking in an environment that lacks pedestrian infrastructure and that permits use of high-speed vehicles increases the risk of pedestrian injury. The risk of a motor vehicle colliding with a pedestrian increases in proportion to the number of motor vehicles interacting with pedestrians (*8,9*).

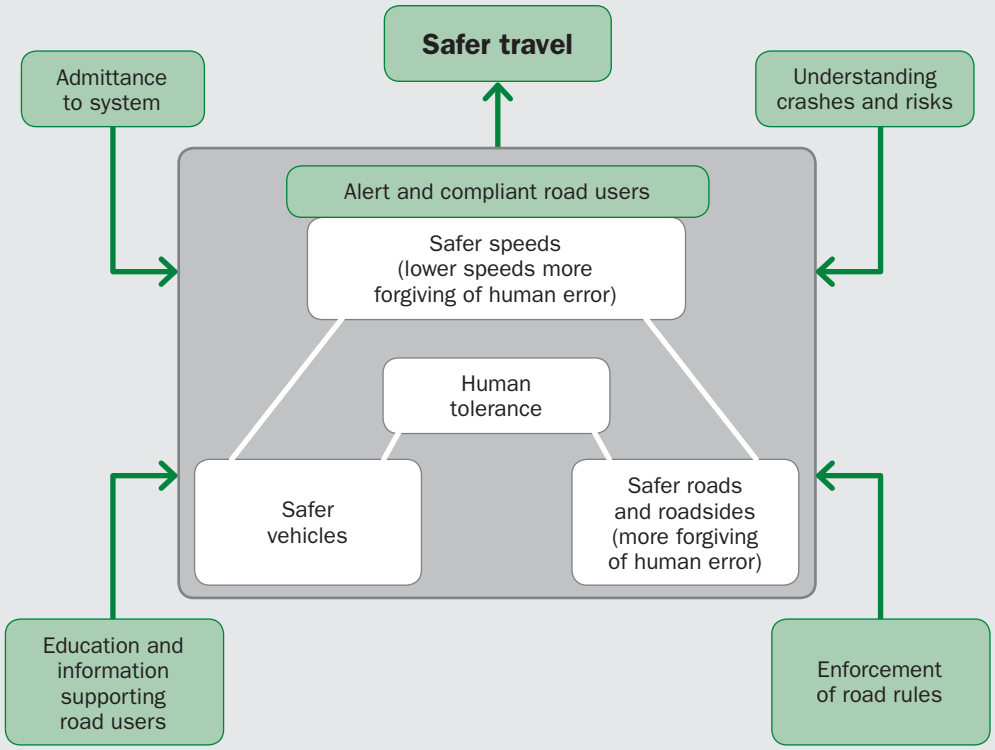
Pedestrian safety measures improve walking environments and contribute to urban renewal, local economic growth, social cohesion, improved air quality and reduction in the harmful effects of traffic noise (*10–13*). They also have supplementary benefits for other road users, such as motorists and cyclists. Implementation of safety measures requires commitment and informed decision-making by government, industry, nongovernmental organizations and international organizations. Effective measures to improve pedestrian traffic safety are described in Module 4.

1.1.2 The Safe System approach and pedestrian safety

Conventional analysis of road traffic injury risk has considered road users, vehicles and the road environment separately (*14*). There is also a tendency among researchers and practitioners to focus on one or few factors, when in reality several interacting factors typically define any specific road traffic context (*14,15*). This uneven focus can limit the effectiveness of road traffic injury prevention efforts and may lead to an emphasis on interventions that leave pedestrians at risk.

The Safe System approach (see Figure 1.1) addresses risk factors and interventions related to road users, vehicles and the road environment in an integrated manner, allowing for more effective prevention measures (*16, 17*). This approach has been shown to be appropriate and effective in several settings around the world, in some cases facilitating road safety gains where further progress had proved to be a challenge (*18*).

Figure 1.1 Safe system approach



Source: *16*

The Safe System approach to road safety recognizes that transport is important to society, and advances the view that travel should be safe for all road users as they interact with roads and vehicles to facilitate movement. The aim of the Safe System approach is the elimination of fatal crashes and reduction of serious injuries through provision of a safe transport system that is forgiving of human error and takes into account people's vulnerability to serious injury. This is done through a policy focus on road infrastructure, vehicles and travel speeds, supported by a range of activities in education, behaviour change, regulation, enforcement and penalties.

The key principles of the Safe System approach are summarized as follows (*16*):

- *Recognition of human error in the transport system*: People will make mistakes in traffic that can easily lead to injuries and death. The Safe System approach does not ignore road user behaviour interventions but emphasizes that behaviour is just one of many necessary elements to promote safety on the road.
- *Recognition of human physical vulnerability and limits*: People have a limited tolerance to violent force, beyond which serious injury or death occurs.
- *Promotion of system accountability*: Responsibility for traffic safety must be shared between road users and system designers. While road users are expected to comply

with traffic regulations, system designers and operators have a responsibility to develop a transport system that is as safe as possible for users.

- *Promotion of ethical values in road safety*: The ethical value underlying the Safe System approach is that any level of serious trauma arising from the road transport system is unacceptable. Humans can learn to behave more safely, but errors will inevitably occur on some occasions. The errors may lead to crashes, but death and serious injury are not inevitable consequences.
- *Promotion of societal values*: In addition to ensuring safety, the road transport system is expected to contribute to overall societal values, particularly in three areas – economic development, human and environmental health, and individual choice.

The Safe System approach has several benefits as a framework for pedestrian safety:

- *Examination of a range of risk factors.* Pedestrian safety should be researched from a systems point of view to allow for consideration of the many factors that expose pedestrians to risk, such as vehicle speed, poor road design, and inadequate enforcement of traffic laws and regulations. Effective planning for pedestrian safety requires a comprehensive understanding of the risk factors involved. It is difficult to achieve this understanding, however, when research focuses only on one or two risk factors. The Safe Systems framework moves pedestrian safety research away from a narrow focus on a single or a few risk factors. Module 3 describes the development of data sources in Addis Ababa, Ethiopia, which together provide a thorough picture of the extent of injuries and risk factors for pedestrians and other road users.
- *Integration of comprehensive interventions*. Improving pedestrian safety requires attention to vehicle design, road infrastructure, traffic controls such as speed limits, and enforcement of traffic laws and regulations – the focus areas that comprise the Safe System approach. A narrow focus on any single aspect is less effective than taking an integrated approach to the multiple factors involved in pedestrian safety.
- *Assimilation of lessons learned.* The Safe System approach provides a basis for low- and middle-income countries to avoid mistakes that were made by a number of high-income countries that designed roads mainly with motor vehicles in mind, and without adequate attention to pedestrian needs. As countries witness increasing numbers of motor vehicles, improvements are needed to infrastructure for pedestrians as well as for vehicles, rather than focusing solely on pedestrian behaviour as the key factor influencing pedestrian safety. A common feature of pedestrian travel environments in low- and middle-income countries is mixed traffic where pedestrians, vehicles and bicycles share the same road space, with few or no dedicated infrastructural facilities for pedestrians. Some progress in addressing the neglect of pedestrians in road design has been observed in China and India (*4*). Modules 2 and 4 provide examples of road design measures aimed at improving pedestrian safety in low- and middle-income countries.

- *Collaboration with partners.* Pedestrian safety is a multi-dimensional problem that requires a comprehensive view when examining determinants, consequences and solutions. While different agencies may have responsibility for specific aspects of pedestrian safety, the reality is that a coordinated approach – involving collaboration among policy-makers, decision-makers, researchers, political leaders, civil society and the public – is required in order to improve pedestrian safety, especially in low- and middle-income countries. Collaboration may take many forms, one of them being sharing responsibilities or activities in a pedestrian safety programme (see Box 1.1). Collaboration among various agencies and sectors is a cornerstone of the Safe System approach.

BOX 1.1: **Sharing responsibilities in a pedestrian safety programme in São Paulo**

In 2010, *Companhia de Engenharia de Tráfego* (CET), the agency responsible for managing transport in the Brazilian city of São Paulo, launched a pedestrian safety programme aimed at reducing the number of pedestrians killed by 50% by the end of 2012. Interventions included media campaigns and awareness raising, engineering measures and traffic law enforcement. To coordinate implementation, various agencies were brought together and assigned responsibility for specific activities: The City Transportation Secretariat coordinated the overall implementation of the programme; CET was responsible for engineering, education and enforcement measures; the Municipal Government of São Paulo, through the Department of Communication, was responsible for media campaigns; the Labour Secretariat was in charge of supervisors at pedestrian crossings; the traffic police was responsible for law enforcement; and *São Paulo Transporte* (SPTrans) – the company that manages bus transportation – was responsible for supervising and training bus drivers.

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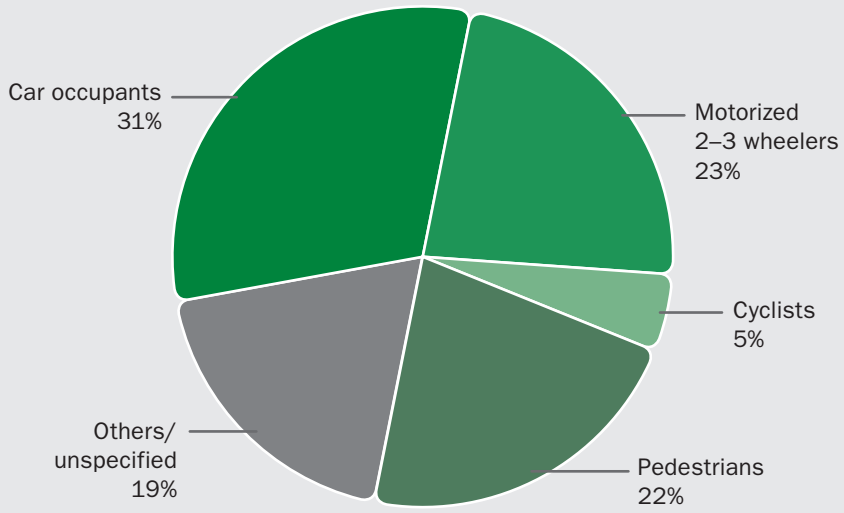
1.2 Magnitude of the pedestrian injury problem

This section describes the global magnitude of the pedestrian injury problem, including the proportion of pedestrian fatalities in relation to other road users, the demographic and socioeconomic characteristics of people who are killed or injured as pedestrians, and the places and times that pedestrian collisions occur.

1.2.1 Pedestrians killed in road traffic crashes

Based on estimated global road traffic fatalities, about 273 000 pedestrians were killed in road traffic crashes in 2010 (*19*). This represents around 22% of all road traffic deaths (see Figure 1.2 and Table 1.1). There is a clear geographic distribution of pedestrian mortality, with the proportion of pedestrians killed in relation to other road users being highest in the African Region (38%) and lowest in the South-East Asia Region (12%).

Figure 1.2 Distribution of road traffic deaths by type of road user, global, 2010



Source: *19*

NOTE

In many countries, crashes involving pedestrians are poorly reported in official road traffic injury statistics. The actual number of pedestrian fatalities and injuries is probably higher than what the official statistics show. Global data on injured pedestrians are not readily available. For this reason, this section presents only data on pedestrian fatalities. It should be noted that the data on pedestrian fatalities represent only a part of the problem. Pedestrian collisions also result in non-fatal injuries, some slight and some serious, and some requiring long-term care and rehabilitation.

Table 1.1 Road users killed in various modes of transport as a proportion (%) of global road traffic deaths, 2010*

World Health Organization Region		Road users (%)				
		Car occupants	Motorized 2–3 wheelers	Cyclists	Pedestrians	Other/ unspecified
African	LIC	35	11	7	38	9
	MIC	51	4	4	37	4
	All	**43**	**7**	**5**	**38**	**7**
Americas	MIC	31	16	3	27	23
	HIC	70	13	2	12	3
	All	**42**	**15**	**3**	**23**	**17**
Eastern Mediterranean	MIC	36	14	3	28	19
	HIC	63	3	2	27	5
	All	**37**	**14**	**3**	**28**	**18**
European	LIC	32	0	2	26	40
	MIC	52	7	3	32	6
	HIC	49	19	7	19	6
	All	**50**	**12**	**4**	**27**	**7**
South-East Asia	LIC	25	19	6	34	16
	MIC	15	34	4	11	36
	All	**15**	**33**	**4**	**12**	**36**
Western Pacific	LIC	12	66	4	12	6
	MIC	22	38	8	24	8
	HIC	33	18	10	33	6
	All	**23**	**36**	**8**	**25**	**8**
World	LIC	31	15	6	36	12
	MIC	27	25	4	22	22
	HIC	56	16	5	18	5
	All	**31**	**23**	**5**	**22**	**19**

Note: The World Bank (Atlas method) gross income per capita for 2010 was used to categorize countries into: LIC (low-income countries) = US $1005 or less; MIC (middle-income countries) = US $1006 to 12 275; and HIC (high-income countries) = US $12 276 or more. Source: *19*.

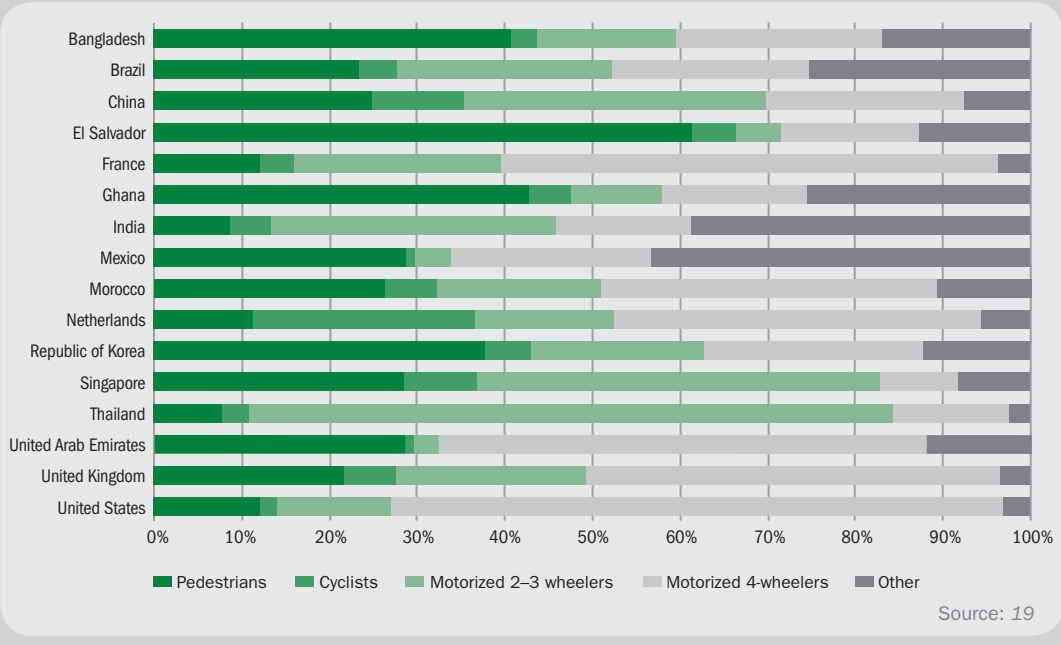
* These data were not provided by all countries in the survey.

Figure 1.3 shows data from selected countries on the distribution of road traffic deaths by road user category, and highlights the variation between countries. Pedestrians are disproportionately represented in road traffic fatalities in Bangladesh, El Salvador, Ghana and the Republic of Korea, while they form a smaller proportion in the Netherlands, Thailand and the United States, for example. Although Table 1.1 shows that the proportion of pedestrians killed is lowest in South-East Asia, Bangladesh – a country in this region – has a substantially higher share of pedestrian fatalities indicating intra-regional differences.

With the exception of the Eastern Mediterranean and Western Pacific Regions, pedestrians tend to account for a much greater proportion of road traffic injury deaths in low- and middle-income countries than in high-income countries (see Table 1.1). City-level studies further confirm that pedestrians form a high proportion of those killed in road traffic crashes in countries. For example, in India, pedestrians comprise 78% of people killed in road traffic crashes in Mumbai, and 53% in Delhi but only 10% at country level (*20*). While official statistics suggest that pedestrians account for around 29% in Mexico, other studies have placed this as high as 48% (*21*).

The wide variation in pedestrian deaths between and within countries underscores the need for a comprehensive analysis of existing road traffic injury data at country, city and institutional (e.g. hospital) level to generate an accurate picture of the magnitude of pedestrian fatalities and injuries in the local setting (see Module 3).

Figure 1.3 Road users killed by different modes of transport as a proportion of national road traffic deaths, 2010



Source: *19*

NOTE

Some pedestrian risks and challenges are not necessarily included in the definition of a road traffic collision and are therefore omitted from official road incident data, for example, obstructions on roads, falls, trips and slips, stumbling, animal bites and personal security. These hazards can lead to serious injury and even death. For example, in Sweden, pedestrians who are seriously injured following falls in the road traffic environment are not reported in official road traffic injury statistics (22). However, in 2011, the number of seriously injured pedestrians in the country was estimated to be 4500. If pedestrians who were seriously injured due to falling in the road environment had also been considered, the number of seriously injured would have been more than 8400. One in every two people seriously injured in the road transport system in 2011 in Sweden was a pedestrian who fell. In this light, it is evident that several aspects of safe walking are omitted from official road traffic crash data.

1.2.2 The cost of pedestrian fatalities and injuries

Pedestrian collisions, like other road traffic collisions, have psychological, socioeconomic and health costs. Road traffic injuries consume financial resources that are needed for countries' development. There is no global estimate of the economic impact of pedestrian road traffic crashes, but road traffic crashes in general are estimated to cost between 1 and 2% of gross national product (7). Survivors of pedestrian crashes, their families, friends and other caregivers often suffer adverse social, physical and psychological effects (see Box 1.2).

BOX 1.2: **Effect of a pedestrian death on a family, friends and community**

The incident described shows the impact of a pedestrian fatality on the victim's immediate family members and also on their friends and the broader community:

"Deana is my daughter. She was 17 years old when her life was cut short. The crash occurred on 9 October 2003, at 22:30. Deana was with four friends going to a birthday party. They had just got out of a taxi and were trying to cross the Nile Corniche in Maadi. The taxi driver had let them off on the wrong side of the road. It is an extremely busy street. The traffic is heavy, chaotic. There are no traffic lights, no pedestrian crossings, just a constant stream of speeding weaving cars, trucks and buses. There is really nowhere to cross. You have to dart across several lanes of traffic to get to the other side. Deana was hit and killed by a speeding bus as she tried to cross the road. The bus driver didn't even slow down.

I was in Damascus at the time, travelling for my work. My brother-in-law called me to tell me the terrible news that my baby girl had been hit. You can imagine my guilt. I should have been in Cairo. I could have driven her to the party.

Deana was beautiful. She had an infectious smile. She always had time for other people more than for herself. She had so many friends I could not count them all. She enjoyed life so much. Many of her friends still stay in touch with us. Everyone was deeply affected by her death: her family, her friends, the entire community, even people we didn't know. I think of ripples of pain, an ever-widening circle of those who were affected."

Source: 23.

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1.2.3 Who are killed and injured as pedestrians?

Pedestrians form a mixed group of people with respect to age, gender and socioeconomic status. Characteristics of killed or injured pedestrians vary widely across countries and sub-national areas, underscoring the necessity of local data collection and analysis to develop a thorough understanding of the problem at the local level (see Module 3).

Age

Pedestrian crashes affect people from different age groups, though some age groups may be represented more than others in certain settings. For example:

- About 57% of pedestrians killed in road traffic crashes in four South African cities were found to be aged from 20 to 44 years (*24*).
- In the United States in 2009, the fatality rate for pedestrians older than 75 years was 2.28 per 100 000, higher than the fatality rate of any other age group (*25*).
- In Hyderabad, India, 61% of pedestrians involved in road traffic crashes were between 21 and 40 years (*26*).
- In New South Wales, Australia, in 2010, 20% of pedestrians killed were less than 21 years old, and 29% were aged between 21 and 40 years (*27*).
- A study of road traffic injuries among children and adolescents in urban Africa found that 68% of the cases were pedestrians (*28*).
- A survey conducted in Dar es Salaam, Tanzania, found that 45% of those injured as pedestrians were adults (*29*).

Sex

Male pedestrians, both children and adults, have been found to be over-represented in pedestrian collisions. For example, a study conducted in the United States found that males accounted for 70% of pedestrian deaths, with a fatality rate of 2.19 deaths per 100 000 population, compared to a female fatality rate of 0.91 per 100 000 (*30*). A study conducted in Mexico found the pedestrian mortality rate to be higher among males (10.6 per 100 000 population) than females (4 per 100 000) (*31*). A study of alcohol-impaired pedestrian patients in a South African hospital showed a male: female ratio of 2.3:1 (*32*).

Socioeconomic status

Socioeconomic status is a significant determinant of pedestrian injury. In general, people from poorer communities tend to be at a higher risk of pedestrian injuries. For example:

- The risk of pedestrian injury for children in the lowest socioeconomic stratum was more than twice that of children of higher socioeconomic status categories in the United Kingdom (*33*).
- Pedestrian crashes were four times more frequent in poor neighbourhoods of Orange County in California, United States (*34*).

- Children from the highest household income quartile were significantly less likely to sustain pedestrian road traffic injuries in Hyderabad, India (*35*).
- Low income and poverty were associated with the largest numbers of child pedestrian crashes in the city of Memphis, United States (*36*).

1.2.4 Where do pedestrian collisions occur?

Overall, there is wide variation in locations of pedestrian collisions from one country to another. While pedestrian collisions occur more in urban areas than rural settings in high-income countries, the opposite is true in some low- and middle-income countries. For example, about 70% of all pedestrian fatalities in the European Union and 76% in the United States occur in urban areas (*25,37*). In the United Kingdom, young pedestrians from urban areas were involved in crashes five times more frequently than those in rural areas, and their death rate was twice as high (*38*). This is in contrast to a Chinese study, which found that pedestrians who commute in rural areas were more likely to suffer injuries than pedestrians who commuted in urban areas (*39*). A study of university students in Cairo, Egypt, found that participants who resided in rural areas were significantly more likely to suffer pedestrian injuries than those who resided in urban areas (*40*).

Most pedestrian collisions occur when pedestrians are crossing the road (*41*). For example, a study in Ghana found that 68% of the pedestrians killed were knocked down by a vehicle when they were in the middle of the roadway (*42*). Information provided by 73 pedestrians in a study in Kenya showed that 53 (72.6%) were injured when crossing the road, 8 (11%) when standing by the road, 6 (8.2%) while

walking along the road and 6 (8.2%) while engaging in other activities, including hawking (*43*). The reasons for the patterns summarized in this section are covered in Section 1.3 on risk factors and Module 2 on roadway design and land-use planning factors.

1.2.5 When do pedestrian collisions occur?

Night-time travel is one of the greatest risk factors for pedestrians (*44,45*). Twilight and the first hour of darkness typically see a high frequency of pedestrian collisions in the United States and in most other countries (*46*).

In some countries, more pedestrian collisions occur during weekdays than weekends, while in others, there may be more fatal pedestrian collisions on weekends (*47*). During the month of December in the United States, collisions are concentrated around twilight and the first hour of darkness throughout the week. In June, however, collisions are concentrated around twilight and the first hours of darkness on Friday and Saturday (*46*).

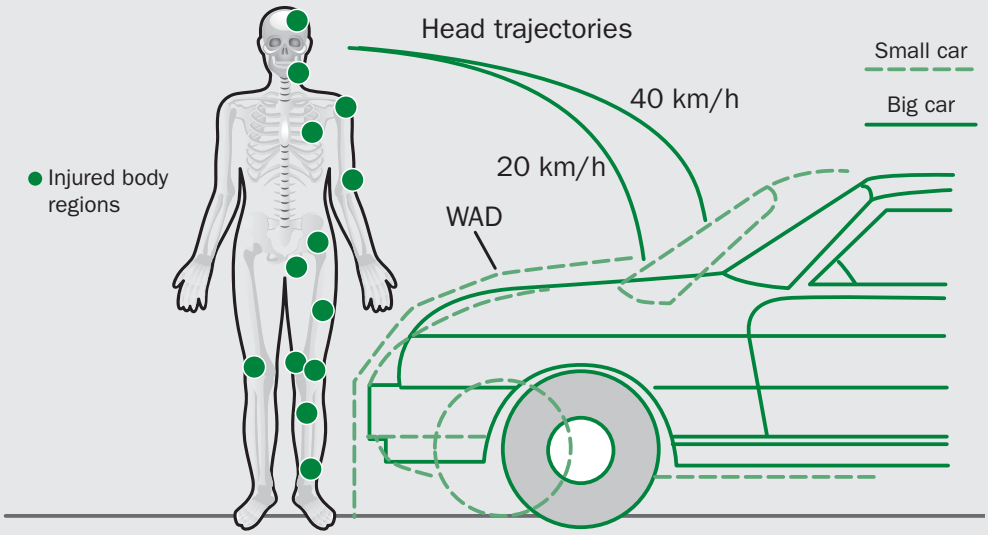
1.3 What happens in a pedestrian collision?

Most pedestrian–vehicle crashes involve frontal impacts (*48*). Figure 1.4 summarizes the contact points between the pedestrian and the car during a crash. It should be noted that in the course of car–pedestrian contact, the whole body wraps around the front of the car. An adult pedestrian is typically 'run under' rather than 'run over' by the striking car.

The sequence of events in a frontal impact is fairly well summarized in studies (*49*). The starting point assumes a standing adult pedestrian who is struck by a car front:

- The first contact occurs between the bumper and either the leg or knee-joint area, followed by thigh-to-bonnet edge contact.
- The lower extremity of the body is accelerated forwards, and the upper body is rotated and accelerated relative to the car.
- Consequently, the pelvis and thorax are struck by the bonnet edge and top, respectively.
- The head will hit the bonnet or windscreen at a velocity that is at, or close to, that of the striking car.
- The victim then falls to the ground.

Figure 1.4 Distribution of injuries on the body of a pedestrian in a frontal car–pedestrian collision



WAD: wrap-around distance

Source: 49

NOTE The point at which a vehicle hits a pedestrian will vary depending on the height of the car as well as the height of a pedestrian (50). For example, a modern raised vehicle may hit the head of a child pedestrian because he or she is short.

The most serious injuries are usually caused by the direct impacts with the striking car rather than when the pedestrian is thrown to the road. The severity of injuries occurring to the head, brain, thorax, pelvis and extremities is influenced by:

- car impact speed;
- type of vehicle;
- stiffness and shape of the vehicle;
- nature of the front (such as the bumper height, bonnet height and length, windscreen frame);
- age and height of the pedestrian; and
- standing position of the pedestrian relative to the vehicle front (*49*).

Motorcycles also contribute to pedestrian injuries. For example, in Brazil in 2007, motorcycles were involved in 22.8% of all fatal pedestrian crashes and were responsible for the deaths of 85 pedestrians (10% of the total) (*51*). The mechanism of motorcycle–pedestrian collision has not been studied as extensively as the car–pedestrian one.

1.4 Risk factors for pedestrian traffic injury

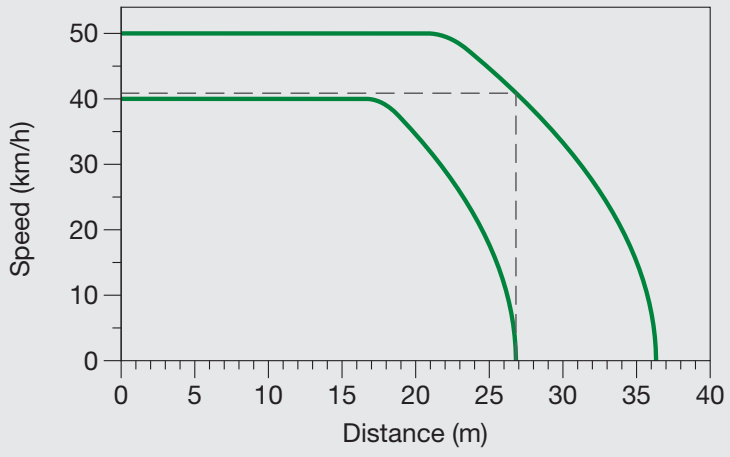
The discussion in this section concentrates on key factors that influence the risk of pedestrian traffic injury: speed, alcohol, lack of pedestrian facilities, inadequate visibility of pedestrians and inadequate enforcement of traffic laws. These factors align well with the focus areas of a Safe Systems approach (see section 1.1.2), and correspond to the intervention measures described in Module 4.

1.4.1 Speed

Travelling speed and the risk of a pedestrian crash

The speed at which a car is travelling influences both crash risk and crash consequences. The effect on crash risk comes mainly via the relationship between speed and stopping distance. The higher the speed of a vehicle, the shorter the time a driver has to stop and avoid a crash, including hitting a pedestrian (*52*) (see Figure 1.5). Taking into account the time needed for the driver to react to an emergency and apply the brakes, a car travelling at 50 km/h will typically require 36 metres to stop, while a car travelling at 40 km/h will stop in 27 metres.

Figure 1.5 Speed and stopping distance for emergency braking



Source: 52

Figure 1.5 is based on a physical representation of an average situation in which a driver takes 1.5 seconds to realize there is a risk of a collision with a pedestrian and apply the brakes. The car will then stop under braking with a deceleration of 0.7g after an initial latency period of 0.2 seconds for the brakes to be fully applied. In some situations the driver may react more quickly and the car stop more rapidly, but

in other situations, if the driver is not concentrating fully on the road ahead or the road is wet, the opposite will occur.

If a car is travelling unusually fast, other road users such as a pedestrian waiting to cross the road may misjudge the speed of the approaching vehicle. The pedestrian may mistakenly assume it is safe to cross the road, attempt to do so and get struck by the vehicle.

Impact speed and pedestrian injury severity

The probability that a pedestrian will be fatally injured if hit by a motor vehicle increases markedly with impact speed (*50,53,54*). Research in the 1990s showed that pedestrians had a 90% chance of surviving car crashes at speeds of 30 km/h or lower, but less than a 50% chance of surviving impacts at 45 km/h (*55*). After adjusting for sampling and statistical analysis bias in that research, a more recent study shows an adult pedestrian has approximately a 20% risk of dying if struck by a car at 60 km/h (*54*). It is important to note that this risk analysis is a work in progress and has not yet been corroborated by other researchers but the undisputed issue is that speed is an important risk factor for pedestrian injury and that impacts of above 30 km/h increase the likelihood of severe injury or death.

Impact speed is influenced by travelling speed and braking. Most speed is lost in the last few metres of braking, so that when a car travelling at 40 km/h has stopped, a car that was travelling at 50 km/h is still travelling at 41 km/h. Thus, a difference of 10 km/h in initial travelling speed can result in a difference of 41 km/h in impact speed.

Factors influencing vehicle speed reveal how the interaction between the vehicle, road environment and road user create risks for pedestrians. The key aspects include (*7*):

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

Speed management is important for addressing pedestrian safety around the world. Key measures for managing speed include setting speed limits to 30–40 km/h in residential and high pedestrian traffic areas, enforcing traffic rules on speed limits and implementing traffic-calming measures. These measures are examined in detail in Module 4.

1.4.2 Alcohol

Impairment by alcohol is an important factor influencing both the risk of a road traffic crash as well as the severity and outcome of injuries that result from it (*7,56*). Alcohol consumption results in impairment, which increases the likelihood of a crash because it produces poor judgement, increases reaction time, lowers vigilance and decreases visual acuity (*56*). Alcohol consumption is also associated with excessive speed (*57,58*). It is important to note that alcohol impairment as a risk factor is not limited to drivers of vehicles but is also important for pedestrians. Like motor vehicle drivers, a pedestrian's risk of crash involvement increases with increasing blood alcohol content (BAC) (*58*).

Alcohol impairment and pedestrian injury is a problem in several countries. For example:

- Approximately one third of all fatally injured adult pedestrians in Australia have a BAC exceeding 0.08 to 0.1 g/dl (*59*).
- Thirty-five per cent of fatally injured pedestrians in the United States in 2009 had a BAC above 0.08g/dl, compared to 13% of drivers involved in fatal pedestrian crashes (*25*).
- Data from the United Kingdom show that 46% of fatally injured pedestrians had BAC in excess of 0.09g/dl in 1997 compared with 39% a decade earlier (*47*).
- Twenty per cent of injured pedestrians treated in hospital emergency departments in Eldoret town in Kenya (n=30) had BAC exceeding the legal limit (i.e. for drivers) of 0.05g/dl (*60*).
- Fifty-nine per cent of pedestrian patients in a hospital in South Africa were impaired above the legal limit of 0.08g/dl (*32*). Recent data from South Africa indicate that fatally injured pedestrians were more likely than fatally injured drivers to be blood alcohol positive. According to the South African National Injury Mortality Surveillance System, there were 31 177 fatal injuries registered in 62 medico-legal laboratories in 2008. Of the 9153 cases that were fatally injured in traffic collisions, BAC values were available in 3062 (33.5%) of them. Pedestrians had the highest proportion (63%) of those who had positive BAC, followed by drivers (58%), passengers (45%), railway cases (43%) and cyclists (43%). Pedestrians also had the highest mean BAC (0.21 g/dl) – more than four times the legal limit of 0.05g/dl (*61*).

Controlling impaired driving and walking is an important road safety strategy. Details on implementation of this strategy through setting and enforcing traffic laws, raising awareness and implementing infrastructural measures are provided in Module 4.

1.4.3 Lack of pedestrian facilities in roadway design and land-use planning

Pedestrian risk is increased when roadway design and land-use planning fail to plan for and provide facilities such as sidewalks, or adequate consideration of pedestrian access at intersections (*4,62–64*). Infrastructure facilities and traffic control mechanisms that separate pedestrians from motor vehicles and enable pedestrians to cross roads safely are important mechanisms to ensure pedestrian safety, complementing vehicle speed and road system management. These factors, along with the policy and planning reforms that support pedestrian safety, are discussed in detail in Module 2 and examples of their implementation are given in Module 4.

1.4.4 Inadequate visibility of pedestrians

The issue of pedestrians not being properly visible is frequently cited in literature as a risk for pedestrian injury. Inadequate visibility of pedestrians arises from (*7*):

- inadequate, or lack of, roadway lighting;
- vehicles and bicycles not equipped with lights;
- pedestrians not wearing reflective accessories or brightly coloured clothes, especially at night and at dawn or dusk; and
- pedestrians sharing road space with fast-moving vehicles.

Measures for improving pedestrian visibility are discussed in Module 4.

1.4.5 Other risk factors

Several other factors that contribute to pedestrian injury include (*4,7,9,48,51,65*):

- inadequate enforcement of traffic laws;
- unsafe driving practices;
- driver distraction, including mobile phone use;
- driver fatigue;
- pedestrian–vehicle conflict at pedestrian crossing points;
- reduced reaction time and reduced walking speed for the elderly;
- inability of children to gauge vehicle speed and other relevant information in order to cross the street safely alone;
- lack of supervision of children who are too young to make safe judgements;
- pedestrian distraction, including mobile phone use (see Box 1.3);
- attitudes of drivers and pedestrians;

- failure of drivers to respect right-of-way for pedestrians, including failure to yield at pedestrian crossings;
- vehicle condition and defects (e.g. brakes, lighting, windscreen); and
- quiet (electric) vehicles, whose presence cannot be detected by normal auditory means.

BOX 1.3: **Talking and walking: an emerging problem**

The use of mobile phones and other smartphones is growing exponentially worldwide. An estimated 77% of the world's population owns a mobile phone (66). While the risk of talking and texting while driving a vehicle is now well documented (67) much less is known about walking and distraction.

Since 2005, a number of studies, conducted primarily in the United States and among young adults, have been published that suggest pedestrians who are distracted by phone conversations, or other distracting activities such as listening to music or texting, take greater risks when crossing roads (*66,68–72*). These results can probably be generalized to pedestrians in other high-income countries.

The contribution of distracted walking will most likely be higher in countries where there is a greater mix of traffic, less controlled crossings or where awareness of the risks is low because these pedestrians are at greater risk in the first place. A concerted, combined approach needs to be used in all countries. Hard-hitting social marketing campaigns are needed to educate pedestrians, while policy-makers and engineers need to consider alternative ways to protect those 'talking and walking', including modifying the environment.

1.5 Summary

The information presented in this module can be summarized as follows:

- Pedestrian fatalities comprise about one fifth of the annual global road traffic injury deaths.
- Male pedestrians tend to be over-represented in pedestrian collisions.
- The characteristics of pedestrians killed in collisions – and the proportion of pedestrian traffic fatalities out of all road traffic fatalities – vary widely between and within countries. Effective interventions require collection and analysis of local data.

- The Safe System approach provides a viable, comprehensive framework to examine risk factors for pedestrians and to develop integrated interventions that address the road environment, road users and vehicles, and that maximize pedestrian safety.
- The key risk factors for pedestrian road traffic injury are speed, alcohol, lack of infrastructure facilities for pedestrians and inadequate visibility of pedestrians.

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2

Pedestrian safety in roadway design and land-use planning

Pedestrian safety in roadway design and land-use planning

PEDESTRIAN SAFETY requires that road design and land-use planning include safe, accessible and comprehensive facilities prioritizing the needs of pedestrians. This module examines the ways in which the design of roadways and the entire built environment can either prevent pedestrian traffic injuries or magnify pedestrian risk.

The sections in this module are structured as follows:

2.1 How roadway design contributes to pedestrian injury: This section discusses how inadequate consideration of pedestrian safety needs in roadway design can contribute to pedestrian traffic injury and provides examples of design features that improve pedestrian safety.

2.2 How land-use planning contributes to pedestrian injury: This section discusses how land-use planning can contribute to pedestrian traffic injury and presents land-use plans that can reduce dangers to pedestrians.

2.3 Policy and planning reforms that support pedestrian safety: This section summarizes policy and planning approaches that improve pedestrian safety.

2.1 How roadway design contributes to pedestrian injury

Roadway design has generally catered for the needs of motorized traffic, neglecting the needs of pedestrians (*1–3*). Roadway designs in which facilities such as sidewalks and signalized crossings are missing, inadequate or in poor condition create risk for pedestrians (*4–6*). The provision of arterial roadways, intersections and fast-speed lanes without adequate attention to pedestrian facilities results in increased likelihood that pedestrians will be killed or injured when walking alongside or crossing the road (*7–9*). An assessment conducted in New Delhi showed that footpaths are either non-existent or poorly maintained (*10*). This study also revealed that road network designs did not include approaches on roads to bus shelters, bus priority lanes, continuous pedestrian paths, or lanes for slow vehicles like bicycles and rickshaws. There has been a recent effort to improve roadway design to cater for the safety needs of pedestrians in New Delhi (see Box 2.1).

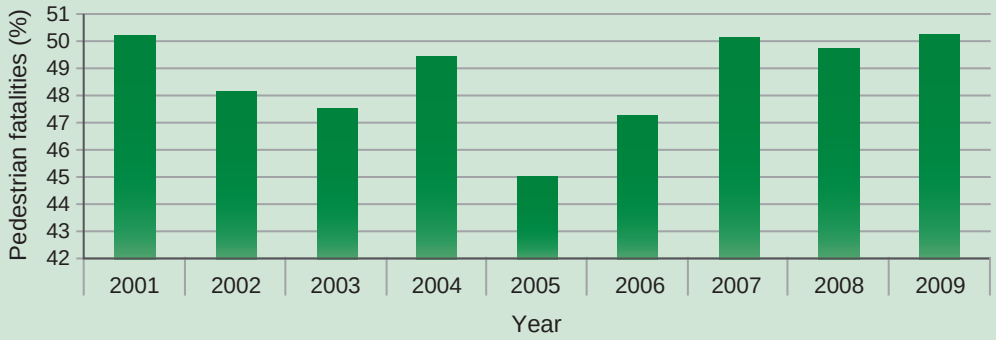
NOTE

An assessment of roads in low- and middle-income countries in Asia, Africa, Eastern Europe and Latin America revealed that 84% of the roads surveyed had no pedestrian footpaths though they carried motor vehicle traffic moving at 40km/h or more (*11*).

BOX 2.1: **Road design and pedestrian safety in New Delhi**

New Delhi has an approximate area of 1500 km^2 and a population of more than 14 million people. Nearly one third of all daily trips in New Delhi are made on foot (*10*). A similar proportion of trips are made by bus, and only about 9% of trips are on the bus rapid transit system. Though pedestrians and public transport users together form the largest group of road users, pedestrians have the largest share in road traffic fatalities, varying between 45% and 51%. From 2001 to 2009, an estimated 36 376 crashes involving pedestrians occurred in New Delhi, resulting in 8697 pedestrian deaths.

Pedestrian fatalities as a proportion of all road traffic deaths, New Delhi, India, 2001–2009



One of the features of the pedestrian travel environment in New Delhi and several cities in low- and middle-income countries is the existence of 'mixed traffic' where pedestrians, bicycles and vehicles share the same road space, with no or very few facilities for pedestrians. Recommendations on how to improve road design in order to ensure safety of pedestrians in New Delhi were made for several years (*11–13*). In 2006, the New Delhi City Government introduced a 5.8-kilometre bus rapid transit system with detailed designs for exclusive bicycle lanes and pedestrian-friendly raised crossings and markings on the road, with the aim of reducing conflicts between pedestrians, cyclists and buses.

The following features were introduced:

- Using automatic signals to control all traffic movements at intersections.
- Providing continuous footpaths, wide enough to support existing pedestrian traffic, on both sides of the road.
- Providing adjoining footpaths at marked crossings at intersections, maintaining a continuous path for pedestrians.
- Providing pedestrian holding areas at the roadside, at each intersection, where pedestrians can wait before crossing the road. This area is also designed for street vendors.
- Providing a five-metre wide zebra strip across all intersection arms at pedestrian crossings. This is preceded by a stop line three metres away, providing a safe zone for pedestrians to cross in front of the stopped vehicular traffic.
- Installing 'rumble strips' to reduce the speed of buses.
- Providing parking bays for bicycles, bicycle rickshaws, three-wheelers and other vehicles.

Preliminary analyses of pedestrian crashes and travel behaviour show the following (*13*):

- The number of pedestrians freely crossing the road at any point was only reduced marginally, especially after installing the pedestrian fences. This finding shows that the fences did not make much difference.
- The speed of buses was lowered after installing rumble strips in December 2008, and pedestrian incidents involving speeding buses have been reduced.
- A 60–90% reduction in pedestrian fatalities was observed in 10 high-risk locations after installing traffic signals and rumble strips in 2011.

- About 80% of bus commuters and bicycle users are satisfied with the bus rapid transit corridor design and would like the corridor to be extended.

In addition to improving safety and the walking environment for pedestrians along the bus rapid transit corridor, there is an ongoing effort by researchers and practitioners to revise urban road standards for New Delhi, paying attention to the safety of pedestrians. The proposed revisions include guidelines for urban roads, intersections and roundabouts, and dedicated facilities for pedestrians, bicycles and buses (*13*). In 2012, the Unified Traffic and Transportation Infrastructure Planning and Engineering Centre, part of the Delhi Development Authority, released pedestrian and street design guidelines to ensure safety for pedestrians when planning road infrastructure.

Specific aspects of roadway design that are most likely to influence pedestrian risk are discussed below.

2.1.1 Traffic mix

The risk of pedestrian injury is high when pedestrians share the road with vehicles travelling at fast speeds (*14–16*). Increased vehicle speeds are associated with increased injury severity and death for pedestrians and cyclists (*17,18*). Vehicle–pedestrian collisions are 1.5 to 2 times more likely to occur on roadways without sidewalks (*19*). In low- and middle-income countries, mixed use of the road space is common in both rural and urban areas. People stand and walk on the road carriageway, cross the street

at many points, and pedestrian facilities are lacking on many roads and/or ignored by vehicle drivers. In high-income countries, separation of slow and fast modes of transport and implementation of traffic-calming measures have become common practices in roadway design since the 1970s and 1980s. Some low- and middle-income countries face a serious problem where settlements flourish along national roads. Many of these settlements and roads lack sidewalks and other measures for pedestrian safety (see Box 2.2). Improving pedestrian safety in mixed traffic environments may utilize several measures such as sidewalks, raised crossings, reducing legal speed limits and road narrowing. These measures are discussed in Module 4.

BOX 2.2: **Planning for safety of settlements along national roads**

Road infrastructure is important for the economic development of low- and middle-income countries. Movement of goods and people within and between these countries requires a road network. These countries are building and improving roads to facilitate this movement, but inter-urban roads often pass through villages, towns and cities without adequate traffic-calming measures and sufficient separation of residential roads from fast-speed, inter-urban road networks. Inadequate foresight and safety planning in road network development creates risks for settlements along national roads.

The mixing of human settlements and roads of various speeds increases the road traffic injury risk in villages and towns. In some cases, existing roads that pass through settlements are widened, often taking up the space meant for sidewalks. In other cases, human settlements and commercial activities commonly develop along inter-urban roads. The planning of these settlements does not often take into consideration the safety of pedestrians and other road users. Beginning with small markets along the road for agricultural products, these settlements grow into cottages and shops, and finally large buildings along both sides of the road. Commerce, residences and the road network combine in a way that increases risk as outlined below:

- Intersections between local and national roads that create hazardous spots in a village. All types of road users, travelling at widely varying speeds, converge on a single intersection, causing conflicts and hazards.

- Shops and other businesses generate traffic that further complicates the traffic flow.
- Mini-buses worsen the situation by stopping wherever passengers and drivers desire, without due regard to safe pedestrian crossing.

It is necessary to address road traffic injury risk at locations where residential areas and businesses develop along inter-urban roads. Master plans for appropriate land use and urban development need to be coordinated among different governmental and private agencies. Specific measures to improve road safety – in particular, pedestrian safety – in these situations include:

- *Separating traffic:* Placing local distributor or agricultural roads alongside or parallel to high-speed roads effectively separates cyclists and pedestrians from dangerous traffic.
- *Reducing speed:* Reducing the number of lanes to slow down vehicles when entering a settled

area, for example, narrowing from a four-lane road to a two-lane road through the settlement. Other measures to slow traffic entering a settlement include speed bumps and rumble strips, which can be installed at the village entrance. Posting and enforcing speed limits for driving in settlements is also necessary.

- *Stopping buses and mini-buses:* Bus stops generate flows of pedestrians and tend to be in places that are convenient to passengers and shoppers, rather than safe for pedestrians. Bus stops should be well marked and there should be a designated place for the bus or mini-bus to stop, with footpaths and safe pedestrian crossings nearby.

Source: *20,21.*

2.1.2 The width of roads and lanes, and road design speed

Road widening increases pedestrian injury risk (*22–25*). Wider lanes and roads, and higher design speed tend to increase motor vehicle traffic speed, which increases pedestrian risk. Wider roads with more traffic lanes and higher traffic speeds are also more dangerous for pedestrians to cross.

NOTE

Road design speed is the initial speed limit for a section of road at the planning stage. Factors considered when determining design speed are sight distance, radius, elevation and friction of the road (*26*). The design speed is determined before the road is built, implying that it may have to be adjusted to take into account the actual conditions when the road becomes operational, for example, adjacent land-uses and traffic mix.

Reducing the number of lanes appears to improve traffic safety, particularly for pedestrians and cyclists (*27,28*). Vehicles travel more slowly on single lane roads or when streets are narrow (*29,30*). Drivers may drive less aggressively and generally feel less safe and thus drive more cautiously on narrow streets (*31,32*).

In general, slow and main streets experience low rates of vehicle–pedestrian crashes, while downtown areas with wide travel lanes and higher operating speeds experience higher rates (*33*). For this reason, a number of European cities have moved towards designing roads for lower vehicle operating speeds (*31*). For example, Freiburg in southern Germany has lowered the speed limit to 30 km/h on 90% of its streets and provided car-free residential areas for 15 000 people. The effect of this strategy is that 24% of trips every day are on foot, 28% by bicycles, 20% by public transport and 28% by car (*34*).

The Lancashire County Council in the United Kingdom, where approximately 1.2 million people live (*35*), has also recently decided to implement a 30 km/h speed limit in all residential areas as well as outside of all schools. The 30 km/h speed limit

programme was approved in February 2011 at an estimated cost of US$ 14.9 million. It involves working with schools and communities to change driver attitudes and, if necessary, enforcement of the 30 km/h limit by working with the police. The first stage of the programme involving the introduction of 30 km/h speed limits with the associated sign and speed limit orders will be completed by December 2013. The programme has only commenced implementation and thus it is too early to evaluate it thoroughly. However, early indications are that the overall approach to road safety is working since deaths and serious injuries fell by 4% between 2010 and 2011 and the proportion of children killed and seriously injured fell by over 11% during the same period.

The Freiburg and Lancashire comprehensive approaches to speed limits for entire geographical areas is likely to be more effective than the fragmented approach of home zones or individual streets where one car trip can involve streets with three or four different speed limits. Consistency, complete geographical coverage and total commitment to pedestrian safety are essential. Furthermore, design features such as narrow lanes or traffic-calming enhance roadway safety performance for all road users when compared to more conventional roadway designs (*36*).

2.1.3 Pedestrian crossings

Pedestrians cross one or more roads at some point in their journey, whether at an intersection or not. In many situations, crossing the road increases their risk of traffic injury. Intersections are associated with high rates of pedestrian collisions and injuries because they include a large number of pedestrian and vehicle conflict points (*37,38*). Uncontrolled intersections exacerbate such conflicts, as pedestrians may encounter oncoming vehicles travelling at elevated speeds that are not required to stop or yield. In some situations, the only way pedestrians can signal their intent to cross is to stand in the pedestrian crossing (*39,40*). Situations where drivers must yield to pedestrians *in*, rather than *at* an intersection, tend to be more risky for pedestrians.

The place where two or more roads meet or cross each other is called a **junction** or **intersection**. Intersections with traffic controls such as stop signs, markings or managed by authorized personnel are referred to as **controlled intersections**. Intersections controlled by automatic traffic signals are called **signalized intersections**. Intersections that are not controlled by traffic signs, markings, authorized personnel or automatic traffic signals – leaving priority and traffic flow at the discretion of the road user – are referred to as **uncontrolled intersections**.

Although signalized intersections appear to be safer for pedestrians than uncontrolled intersections, they are still dangerous environments for pedestrians. A major issue at signalized intersections is the conflict between left- or right-turning vehicles, which require a larger turning radius, as well as the fact that crossing pedestrians, may be obscured from the driver's view. The length of time allowed for pedestrians to complete crossing is also a factor. Though motorists are required to give priority to pedestrians at signalized intersections, vehicles sometimes start turning while pedestrians are still crossing (*41*).

NOTE

A **pedestrian crossing** is a point on a road where pedestrians traverse the road. Pedestrian crossings, sometimes referred to as crosswalks, may be found at intersections or along road stretches. Marked crossings are designated by markings on the road, commonly white stripes. Signalized crossings include automatic traffic signals that indicate to pedestrians when they should cross.

Evidence to date indicates that marked pedestrian crossings should not be implemented without additional safety measures. Pedestrians may falsely believe they are safer – that motorists are more likely to see them and stop – at marked pedestrian crossings, and therefore attempt crossing without due caution increasing their chance of being hit by a motor vehicle (*42*). A study of 1000 marked crossings and 1000 unmarked comparison sites, all at uncontrolled crossings, found no significant difference in safety performance unless additional safety features such as automatic signals were used (*43*). This study also found that on multi-lane roads carrying over 12 000 vehicles per day, a marked crossing was more likely to increase pedestrian risk compared to a similar unmarked crossing, unless safety features such as raised median refuge islands or pedestrian beacons were also installed. On multi-lane roads carrying over 15 000 vehicles per day, marked crossings were more likely to increase pedestrian risk even if raised median refuges were provided (*43*).

2.1.4 High traffic volume roads

Road environments with high traffic volume and inadequate attention to pedestrian safety have been found to exacerbate pedestrian collisions. One study in Ontario, Canada, found that the probability of a pedestrian collision with a left-turning vehicle was influenced by traffic volume (*44*), while another in a town in China found that high volumes of traffic, the presence of bus stops and high volumes of pedestrians crossing all led to increased collision risk for pedestrians (*45*).

Studies show that the number of pedestrian crashes increases with the volume of traffic, but the relationship is not always linear (*5,46*). Crash rates relative to exposure may actually decline with higher traffic volumes, and the severity of injury may also decline. In addition, in environments where there are many pedestrians or cyclists, motorists may be more aware of them and adjust their driving behaviour, thereby reducing risk (*5,46*).

2.1.5 Perception of safety and security of the travel environment

Understanding people's perceptions of security in the walking environment is an important element for improving pedestrian safety (*47*). People may choose to avoid walking altogether if they perceive too great a risk of traffic injury or other threats to personal security. Pedestrians' perceptions of risk in the broader environment influence their road use behaviour, including whether or not they choose to use certain roads and pedestrian facilities.

Pedestrians will generally avoid both well known and unfamiliar streets, deserted public spaces and dark underpasses if they believe they will be at risk of harm, such as assault, in these locations. They might choose to cross a road in a location with higher traffic risk to avoid the risk of interpersonal violence. For example, a Colombian study found that the use of pedestrian bridges was influenced by the quality of illumination and pedestrians' perception of security; bridges or road segments with traffic-calming treatments were avoided in areas where muggings were more prevalent (*48*). In both Mexico and South Africa, for example, reasons for avoiding the use of crossing facilities included lack of lighting at night and the perceived risk of assault (*16,49*).

Pedestrian-friendly road design is necessary but not sufficient to ensure pedestrian safety. Other aspects related to perceived risk and road use behaviour must be considered and addressed, such as making streets more aesthetically pleasing, widening sidewalks, separating pedestrians from motor vehicles, providing street lighting, lowering vehicle speeds, and making streets safer from interpersonal violence.

2.2 How land-use planning factors affect pedestrian safety

Beyond design elements of the roadway itself, the design and use of the broader land for commercial, industrial, recreational, transport, conservation, agricultural, or a mix of purposes, can contribute to the occurrence of pedestrian injuries and fatalities (*4,5*). The extent to which land-use planning provides facilities and services to ensure continuous, safe pedestrian access constitutes a major influence on pedestrian traffic risk.

Land-use planning factors that affect pedestrian traffic risk include the following:

- *Population density:* The frequency of pedestrian crashes in a given area is strongly influenced by the density of the resident population and the total population exposed to risk (*50*).
- *Land-use mix*: Land-use planning policies and strategies that encourage a greater mix of land-uses and shorter trip distances make walking more feasible, and safer, if measures for safe walking have been considered (*51,52*).
- *City structure*: There are wide variations in road traffic fatality rates, including pedestrian rates, across cities with different income levels and even within cities with similar income levels, implying that city structure, modal share and exposure of motorists and pedestrians may have a significant role in determining fatality rates, along with road design, vehicle design and income (*2*).

NOTE

Modal share is the proportion of travellers using different modes of transport: walking, bicycle, motorcycle, car, bus, tram and train.

2.3 Policy and planning reforms that support pedestrian safety

Land-use planning and roadway design should accommodate the specific needs of pedestrians not only to improve their safety, but also to increase pedestrian access to local services including shops, schools, hospitals, farms, neighbours, public transportation stops and social meetings (*34*). Worldwide, pedestrian needs are increasingly recognized in land-use, public space and transport planning, with an increasing number of countries making substantial investments in pedestrian safety in recent years. While some countries, such as China and India, are beginning to increase their efforts to address pedestrian safety, others such as the Netherlands and Denmark have already invested in pedestrian safety and walking for a relatively long time (*18*).

A wide range of land-use planning and road design strategies to improve pedestrian safety have been developed and implemented in different countries (*18,53,54*). Effectiveness of these, and other measures, is discussed and examples of implementation provided in Module 4 but they generally include:

- controlling vehicle speed;
- developing traffic-calming measures;
- restricting vehicle traffic in residential areas;
- building sidewalks;
- enforcing traffic laws;
- pedestrianizing city centres;
- installing pedestrian signals;

- constructing under- and over-passes;
- creating a road network that separates access roads from through-roads and ensures that traffic volume on access roads is as small as possible;
- reducing unnecessary travel;
- encouraging walking and cycling;
- designing pedestrian pathways to facilitate movement of people with mobility impairments;
- locating roads, residential areas, workplaces and other industries in such a way that traffic volume and travel distances are minimized;
- redesigning public spaces to cater for pedestrian safety needs, and to encourage walking;
- integrating transportation planning with health issues, for example, active transport and design programmes; and
- developing and implementing pedestrian safety policies.

NOTE

Pedestrianization is the process of removing vehicular traffic from city streets or restricting vehicular access to streets for use by pedestrians. Pedestrianization improves not only safety and accessibility for pedestrians but also contributes to reducing noise and air pollution, and creates more livable environments. Pedestrianization schemes have also been associated with economic benefits with reported increases in visitors to commercial establishments.

There are four main pedestrianization schemes:

a) full-time pedestrian streets in which vehicular traffic is excluded or prohibited except for emergency vehicles;
b) part-time pedestrian streets in which vehicular traffic is eliminated for certain hours of the day or certain days of the week;
c) partial pedestrian streets that restrict vehicle access to slow public transport vehicles only; and
d) partial pedestrian streets or traffic-calming measures that allow a mix of pedestrians and motor vehicles moving at a low speed (55).

When many of the above-listed strategies are implemented in an integrated manner, the effect is to create healthy, efficient and sustainable communities where people may choose to walk in safety (see Figure 2.1). The eight strategic principles guiding this framework – increased inclusive mobility, well designed and managed spaces and places for people, improved integration of networks, supportive land-use and spatial planning, reduced road danger, less crime and fear of crime, more supportive authorities and a culture of walking – are described in Appendix 1. Developing and implementing these measures require planning and policy reforms from vehicle-dependent to a multi-modal and inclusive roadway design, land-use and public space planning approach (*3,56–58*).

Figure 2.1 A comprehensive framework for safe walking

Source: 59.

2.4 Summary

The content of this module is summarized as follows:

- Roadway design can both increase and reduce traffic risk for pedestrians through presence or absence of pedestrian facilities such as sidewalks and signalized crossings. Land-use development factors such as population density, land-use diversity or mix and the location of activities can affect pedestrian accessibility and risks.
- Several strategies exist to incorporate specific attention to pedestrian safety needs in road design and land-use planning.

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3

Prioritizing pedestrian safety interventions and preparing a plan of action

Prioritizing pedestrian safety interventions and preparing a plan of action

Modules 1 and 2 provided a global picture of pedestrian traffic injury, discussed several factors that influence pedestrian traffic risk, and underscored the necessity of understanding the local situation when planning and adapting effective interventions. This module provides information on how to assess the pedestrian safety situation, with the aim of prioritizing interventions as well as how to prepare a corresponding plan of action. The content in this module is organized according to three themes:

3.1 Why assess pedestrian safety? This section shows that assessing the pedestrian safety situation provides vital information to guide decision-making on prioritizing interventions.

3.2 How to assess pedestrian safety: This section discusses assessment of the magnitude and pattern of pedestrian traffic injuries, the risk factors, stakeholders, and existing initiatives and policy environment. The section provides essential details on aspects to be assessed and methods for conducting assessments.

3.3 Preparing a plan of action: This section explains the preparation of a plan of action to address the pedestrian safety problems identified in the situational assessment.

3.1 Why assess the pedestrian safety situation?

As discussed in Modules 1 and 2, the characteristics of pedestrian crashes vary tremendously across different communities and countries. A situational assessment constitutes an essential step to facilitate understanding of the local pedestrian safety situation. The information gathered during a situational assessment is used to make decisions on priority focus areas, the best approaches to improve pedestrian safety, and whether to strengthen existing plans and programmes or develop new initiatives. A situational assessment should be conducted prior to initiating a new pedestrian safety programme. A community cannot assume another community's solutions will be effective for its specific pedestrian safety problems. Effective interventions depend on the dynamics relevant to the local situation, and understanding this local situation is important for planning appropriate solutions.

NOTE

Although a situational assessment is typically conducted prior to initiating a programme, emphasis also needs to be given to occasional assessments of the pedestrian safety situation as the transport, socioeconomic and environmental situation changes in a given setting.

3.2 How to assess the pedestrian safety situation

The pedestrian safety situational assessment should cover a range of topics related to the magnitude of the problem, risk factors and existing policies and programmes (see also Modules 1 and 2). The assessment must take care to identify issues that are hidden or require deeper analysis, as well as those that are obvious or easy to discover (*1*). This section provides information on how to conduct a situational assessment by suggesting methods for specific aspects to be assessed.

A situational assessment of pedestrian safety entails the following activities:

- describing the magnitude, trends and patterns of pedestrian fatalities and injuries;
- analysing risk and protective factors for pedestrian injuries and fatalities;
- examining the times and places where pedestrian injuries and fatalities occur;
- describing the modes of transport involved in conflicts with pedestrians;
- identifying and assessing existing pedestrian safety programmes and institutions to identify gaps and areas to improve as well as those to maintain; and
- identifying contextual factors related to politics, environment, economics and capacity that may facilitate or hinder the implementation of pedestrian safety measures.

Key contributions to the situational assessment will come from various existing data sources, including from agencies responsible for roads and transportation, law enforcement, urban and regional planning, public health, finance, as well as from road safety nongovernmental organizations. Additional data in the form of observational studies, surveys and/or road safety audits may be required to supplement existing data sources.

3.2.1 Assessing the magnitude, trends and patterns of pedestrian fatalities and injuries

Accurate data on the extent of the pedestrian safety problem are essential to define the problem and develop appropriate measures. The types of data needed for the assessment can be grouped into minimum and complementary data (see Table 3.1). The minimum data set includes information on the what, where, when and why dimensions of pedestrian injuries (*2*). In addition, it is important to have background information on population, transport and socioeconomic indicators of the setting under investigation. These additional data provide information needed for computing indicators for comparison.

Police departments and health facilities provide most of the data used in pedestrian injury analysis and prevention. There may be other data sources such as vital registration records, insurance companies, nongovernmental organizations, academic institutions, scientific studies, hospital-based injury surveillance systems or the ministry of health, each with its own type of data and quality issues. The situational

assessment should identify all data sources for the minimum data requirements and make some assessment of their quality and reliability. Discrepancies in the number, severity and patterns of pedestrian injuries across data sources should be explored and, if possible, explained.

For further information on assessing data quality and data systems, please consult *Data systems: a road safety manual for decision-makers and practitioners,* a companion document in this series (*2*).

Table 3.1 Minimum and complementary data for assessing the pedestrian safety situation

Minimum data	Complementary data
How big is the problem? • Number of crashes involving pedestrians. • Number of pedestrians killed in road traffic crashes. • Number of pedestrians injured in road traffic crashes. • Total number of road traffic fatalities and injuries, preferably disaggregated by road user types.	*How many people live in the area being assessed?* • Total number of people in the population under study (including disaggregation by urban and non-urban, by age and income).
What type of traffic conflicts lead to pedestrian crashes? • Involvement of cars, trucks, motorcycles, bicycles and animal-drawn carts, etc. • Vehicle manoeuvres (e.g. turning).	*How and why do people typically travel around the area?* • Origins and destinations of trips. • Transport modes used. • Trip distances. • Trip purposes.
On what day of the week and at what time do pedestrian collisions occur? • Date and time of injuries.	*What is the socioeconomic condition of the area under assessment?* • Gross domestic product. • Proportion of adults employed. • Household income.
How serious are the injuries? • Severity of pedestrian injuries.	
Which type of crashes lead to disability or life-threatening outcomes? • Outcome following collisions.	
Who is involved in pedestrian collisions? • Age and sex of those killed or injured as pedestrians.	
Where do pedestrian crashes occur? • Place of crash (specific location such as urban, rural and type of road). • Dangerous road locations.	

In many settings, the minimum data components listed in Table 3.1 can be found in an official road traffic injury database that draws on police reports, and possibly other data sources. Data sources other than police statistics generally do not include information about crash location, crash type and vehicle involvement. Police data, on the other hand, may not include reliable information regarding injury severity. The questions posed in Table 3.1 should be answered using the best available data sources. In countries where there are no official national statistics on a given complementary data indicator, most recent estimates or projections by the national census or

statistical authority can be used. Gathering all the data proposed usually requires examination of multiple data sources.

If there are no official road safety statistics, or if official statistics do not cover the minimum points fully or with adequate reliability, additional data collection such as a hospital-based study (see Box 3.1) or a road safety audit (see Box 3.2) may be considered. However, it is important to assess the costs of additional data collection and the value added by the information obtained.

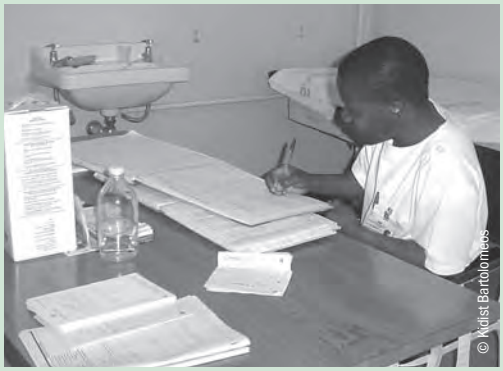
BOX 3.1: **The Addis Ababa Hospital Injury Surveillance System**

Ethiopia is an African country that has made significant investment in improving its injury surveillance capacity. Initial work on injury surveillance started in 2000 with the support of WHO, followed by the government's efforts to strengthen the Traffic Police Department's road traffic injury data management capacity and to expand data collection nationally.

The hospital injury surveillance system was established in 2000. It was implemented in all six government hospitals in the capital city, Addis Ababa. At the start of the project, detailed data on all injury cases were collected using a pre-defined data collection form. Data collection has since been integrated into the national health information system, and data on injury cases are collected and recorded as part of routine health statistics. The hospital injury surveillance system collects the following data for road traffic injury cases:

- age and sex of injured people;
- where the injury happened;
- date and time of injury;
- type of road user(s) involved;
- types of vehicles colliding with pedestrians;
- pre-hospital care received; and
- injury severity.

Traffic police data system strengthening efforts started in Addis Ababa in 2002. Previously the traffic police documented information about crashes using a paper data collection form. The information was then transferred to a log book for manual tabulation and reporting. The strengthening effort, supported by WHO, revised data collection and entry procedures



so that data are collected in the field using a pre-designed form and later entered into a computer database for further analysis. In later years the government expanded the system to six major regions in the country. The traffic police data system captures the following data for road traffic crashes:

- site and location of collision;
- vehicles/road users involved;
- number of people injured or killed at the scene;
- demographic data of casualties (for example, name, age, sex, occupation);
- known factors contributing to the crash; and
- whether pre-hospital care was provided.

Data from these systems have been used by the national road safety council to identify high risk areas and to inform a policy development process around interventions for pedestrians and other road users, as well as other risk factors such distracted driving and access to care for victims of road traffic crashes.

Source: *2,3.*

BOX 3.2: **Assessing pedestrian risk using a road safety audit**

A road safety audit is a formal systematic road safety assessment or 'checking' of a road or a road scheme (4). The audit is generally conducted by an independent, multidisciplinary team. A pedestrian safety audit can be conducted as part of the broader road safety audit. It can also be conducted only for pedestrians. Whatever the scope, the essence of conducting a road safety or pedestrian safety audit is to examine the potential safety issues for any type of road, throughout the construction period, and on completed roads (5). A road safety audit seeks to ensure safety to all users, including pedestrians, by proactively and continuously identifying safety issues and making suggestions on measures and facilities to improve road safety.

There is no standard method or approach for conducting pedestrian or road safety audits but the following questions are key for checking the safety of vulnerable road users, including pedestrians, on new projects and existing roads (6):

- Have the requirements of pedestrians and cyclists been considered?
- Have the needs of public transport and its users been taken into consideration?
- Are public transport stops planned at intersections?
- Are stops easily accessible by pedestrians?
- Are further crossing aids required to reach the public transport stops?
- Are public transport stops easily recognizable?
- Are special measures required for particular groups, e.g. for young people, older people, sick people, physically handicapped, hearing-impaired or blind people?
- Is lighting required and, if so, is it appropriately designed?
- Is sight obstructed, for example, by safety barriers, fences, road equipment, parking areas, traffic signs, landscaping, greenery, bridge abutments, buildings?
- Is cyclist routing safely designed in the area near public transport stops?
- Are vulnerable road users separated from motorized traffic?
- Have pedestrian crossings been designated in such a way that collective use is guaranteed and pedestrians will not cross the road at other points?
- Are crossings safe?
- Are the pedestrian crossings located where they are most required by pedestrian traffic?
- Is there a risk of pedestrian underpasses and bridges being bypassed?
- Are crossings over special railway structures of a safe design?
- Is two-way visual contact ensured between pedestrians and motorists?
- Have cyclists' requirements been considered (e.g. route across central refuges, bottlenecks)?
- Is the transition safely designed if footpaths and cycle paths end on a road or are directed across the road?
- Are further crossing aids required?
- Are areas for pedestrians and cyclists sufficiently large and wide enough for them to stand and wait before crossing a street?
- Are the islands clearly visible and of a suitable design?

The following eight steps are generally followed in conducting a road safety audit (5):

1. Identify a project or an existing road for road safety audit.
2. Select a multidisciplinary road safety audit team.
3. Conduct a start-up meeting to exchange information.
4. Perform field reviews under various conditions.
5. Conduct a road safety analysis and prepare a report of findings.
6. Present road safety audit findings to project owner or design team.
7. Prepare a formal response.
8. Incorporate findings into project when appropriate.

Continued...

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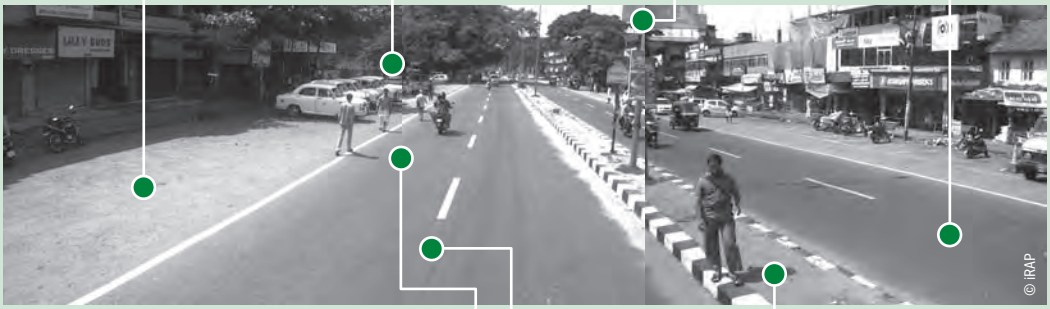
A recent assessment of pedestrian facilities of a 24-kilometre road in the state of Kerala in India revealed a glaring absence of pedestrian facilities in road design (7). The picture below shows the situation at one of the sites that were assessed.

No footpaths
Without footpaths it is more likely that pedestrians will walk on the road, especially when it is raining

Parked cars
'Side friction' means that pedestrians need to walk on the road to go around parked cars

Street lights
Pedestrians are more visible at night with street lighting

Skid resistance
In an emergency, vehicles can stop faster on skid-resistant roads



No crossing facilities
Pedestrians who need to cross the road have no choice but to share the space with motorized traffic

Two lanes in each direction
A pedestrian's risk increases with each additional lane they must cross

Narrow median
Pedestrians are offered some opportunity to cross the road in two stages when there is a median

3.2.2 Assessing risk factors for pedestrian injury

Several factors influence pedestrian traffic risk. In most cases it is impossible to identify and include every risk factor in the situational assessment. This section describes key questions about risk factors and suggested methods for obtaining answers to them. This process of assessment yields information on the role of roadway design, pedestrian facilities, speed, alcohol and visibility of pedestrians in the local travel environment. Further information on sources of data for analysing risk factors is available in *Data systems: a road safety manual for decision-makers and practitioners* (2).

What are the available pedestrian facilities and general road transport infrastructure?

The influence of various roadway design elements on pedestrian risk was described in Module 2. While the situational assessment may not be able to cover all of these elements, it should at least address the following points (*8–10*):

- *Roadway design characteristics*: For roads in the area under assessment, describe road classifications, design speeds, posted speed limits, and number and width of lanes. Describe the presence or lack of medians, traffic control devices, pedestrian crossings, kerb ramps, and pedestrian-directed signs and signals. Describe the presence or lack of streetlights, bicycle lanes, parked cars adjacent to the traffic lane, and other hazards to safe walking.

- *Sidewalks*: Describe the presence and quality of sidewalks, including width, surface condition, separation from motorized traffic and accessibility as well as whether these are dedicated for pedestrians or shared, for instance, with cyclists or hawkers.
- *Pedestrian traffic-generating and attracting sites*: Identify and map sites such as health facilities, parks, libraries, religious buildings, museums, educational institutions, community centres, residential areas, shops and resorts, that generate and attract pedestrian and other traffic.

Data on pedestrian facilities and general road infrastructure may come from the following sources (*8–10*):

- roadway or street inventories or road safety audits (see Box 3.2);
- pedestrian facility inventories or audits;
- road infrastructure audits and field reviews;
- analysis of aerial photographs of streets; and
- public feedback on conditions of roads or pedestrian facilities.

Additional data collection, for example conducting a pedestrian safety audit, is advisable if none of these sources are available at the time of the situational assessment.

What is the travel behaviour of pedestrians and other road users?

The travel behaviour of pedestrians and other road users is useful in understanding local pedestrian traffic activity and associated risk. The situational assessment needs to establish (*8*):

- the number of pedestrians in a given area, on specific streets or in key pedestrian zones;
- pedestrian speeds;
- pedestrian road-crossing behaviour, including running or hesitating;
- pedestrian–motorist interaction, including pedestrian–vehicle conflicts;
- profile of vehicle fleet;
- vehicular traffic volumes and speeds, including assessment of compliance with speed limits;
- alcohol involvement for both pedestrians and motorists (see Box 3.3); and
- pedestrian use of clothes or materials to enhance visibility, especially at dawn, dusk and dark night-time hours.

Information on pedestrian and other road user behaviour can be collected using the following methods (*8,11*):

- pedestrian counts;
- vehicle counts;
- observational studies;
- surveys, for example, on risk factor or knowledge, attitudes and perceptions;
- speed cameras and speed measuring radar units; and
- continuous video recording at intersections.

BOX 3.3: **Assessing the alcohol-relatedness of crashes**

Data on alcohol-involved (i.e. positive blood alcohol content (BAC)) or alcohol-impaired (i.e. BAC above a predetermined limit, e.g. 0.05 g/dl) vehicle–pedestrian crashes give an indication of the role of alcohol impairment in pedestrian traffic risk, though this information does not necessarily function as a proxy for impaired walking and driving in the general road user population. To address alcohol-related crashes, it is important to establish the locations where impaired driving and walking occur most frequently, the time of day and day of week when impaired driving and walking are most likely to occur, and the age, sex and socioeconomic status of impaired drivers and pedestrians. However, since in most jurisdictions testing for BAC has privacy and legal rights implications, routine monitoring is not always possible.

The following methods may be used to gather information on alcohol and pedestrian traffic risk:

- Review police statistics on alcohol-related vehicle–pedestrian crashes. Depending on the legal requirements for alcohol testing in the jurisdiction under consideration, data may be available only for fatal crashes or only for drivers.
- Examine admission data from hospital emergency departments.
- Review data from random breath-testing operations or sobriety checkpoints.
- Conduct a roadside survey (self-reported behaviour).
- Review research reports and papers on BAC analysis.

Source: *12*.

What is the current enforcement of traffic regulations?

A number of interventions that are known to reduce pedestrian injuries and deaths depend on effective enforcement of the traffic rules and regulations (see also Module 4). Driver violations include speeding, alcohol-impaired driving, mobile phone use while driving, and traffic signal violations (such as failing to stop at a red light). Pedestrian violations include crossing against the signal or outside of designated crossing points, alcohol impairment and distracted walking. Both driver and pedestrian compliance with traffic laws is critical to pedestrian safety, and effective law enforcement is a key aspect of ensuring compliance.

A situational assessment should gather information on both traffic law compliance and traffic law enforcement. The assessment needs to gather information on:

- pedestrian understanding and compliance with traffic control devices;
- motorist behaviour at pedestrian crossings, for example, do they yield if required by law to do so?
- motorist compliance with speed limits;
- driver compliance with drink–driving laws; and
- law enforcement methods and their effectiveness, for example, speed radars, random breath testing and/or sobriety checkpoints, ticketing, fines and licence suspension.

Information on levels of enforcement and compliance of pedestrians, motorists and cyclists with traffic regulations (e.g. speeding, alcohol-impaired driving) can be gathered by the following methods:

- Review police statistics on pedestrian safety regulation violations.
- Review court records for violations of pedestrian safety regulations, noting the types and number of violations and fines or other punishments issued.
- Review media reports and public complaints about enforcement and compliance with pedestrian safety regulations.
- Review reports, studies and even conduct surveys or interviews to identify types of traffic law enforcement strategies in use in the setting under consideration.
- Conduct observational studies and surveys on compliance with pedestrian safety regulations.
- Review existing studies on enforcement and compliance with pedestrian safety regulations.

3.2.3 Assessing the policy environment and existing initiatives on pedestrian safety

The first two components of the situational assessment (Sections 3.2.1 and 3.2.2) provide information about the magnitude and patterns of pedestrian traffic injury in the area under assessment, as well as an understanding of the key risk factors involved. This information naturally leads to ideas for interventions. To avoid duplication of efforts and to maximize impact, it is important to take stock

of existing policies and programmes, roles of stakeholders, and the wider policy environment before prioritizing interventions and creating a plan of action.

The main methods to obtain the relevant information include (*2,13*):

- Review government policy documents in the areas of transport and road safety.
- Conduct interviews with representatives of agencies affected by or committed to pedestrian safety.
- Conduct interviews with members of communities where pedestrian safety interventions have been implemented or where pedestrian injuries are most frequent. Include drivers, cyclists and pedestrians in these interviews.
- Conduct a stakeholder analysis.
- Review research reports and papers assessing pedestrian safety in the setting under consideration.
- Investigate pedestrian crashes at the scene of the crash, as resources permit.

Leadership and stakeholder engagement

The following issues should be examined to identify the focus areas, interests, resources and relationships of various stakeholders, and their current and potential roles in pedestrian safety (*2*):

- *Government leadership*: Is there a lead agency responsible for road safety? What is it and what is its main function? Does its mandate include a clear focus on pedestrian safety?
- *Government stakeholders*: What government agencies have a road safety function, including broad activities in road design and land-use planning? Do any of these agencies have a specific pedestrian safety focus? How is responsibility for road safety shared among government ministries? What is the relationship between the various government agencies involved in road safety and health?
- *Nongovernmental stakeholders*: What other people or institutions (nongovernmental) are working on pedestrian safety? What are their main activities? What is the nature of the collaboration between these stakeholders and government agencies?
- *Partnerships*: What are the foci, interests and resources of different agencies and individuals working on pedestrian safety?

Existing plans, policies and programmes

It may not be possible to identify every pedestrian safety programme currently being implemented in the jurisdiction, but it is important to identify the major initiatives. The following questions can help to clarify the situation:

- Is there an official pedestrian safety **plan of action or strategy** for the jurisdiction under assessment, or are there multiple plans? What resources are dedicated to the implementation of this plan?
- Do the transport, land-use and public space **policies** promote safe walking?

- Do road safety audits of major new **road infrastructure** projects include pedestrian needs and ensure that pedestrian safety measures are taken into account? Do road safety audits of existing road infrastructure and planned repairs/modifications include pedestrian needs and ensure that pedestrian safety measures are taken into account?
- Does the transport and/or road safety **budget** have dedicated segments for pedestrian safety?
- Are the local authorities allowed to modify **laws** such as speed limits or drink–driving laws, which give additional protection to pedestrians, e.g. reducing speed limits around schools?
- What pedestrian **safety programmes** are currently implemented, including those conducted by nongovernmental organizations? What agency is responsible for each programme, and what are its strengths and weaknesses?
- Are existing pedestrian safety programmes **evaluated**? Is there evidence of impact?
- Do local and national government agencies have sufficient **human capacity** to implement pedestrian safety programmes?

The information described in this section assists with the identification of gaps in policy, programming and decision-making about action needed to move pedestrian safety policy forward. For example, is there a need for a new initiative or can existing initiatives be strengthened? What strategies can maximize available resources and reduce duplication of effort? The stakeholder analysis provides information regarding the roles of key people and institutions currently involved in pedestrian safety. This information is valuable for identifying which agencies must be involved, could be involved, and which may resist action for pedestrian safety. It can also help with identification of possibilities to combine resources, as well as potential conflicts of interest and ways to minimize them.

3.3 Preparing a pedestrian safety action plan

The situational assessment described in section 3.2 provides an understanding of the local pedestrian safety situation – the extent and pattern of pedestrian traffic injuries, relevant risk factors, and the people, institutions, policies, programmes and resources that are currently (or could be) involved in pedestrian safety initiatives. The information helps prioritize risk factors and target groups, and to identify gaps in existing initiatives. The next step in improving pedestrian safety is to use this information, alongside the information on effective interventions presented in Section 4.1 of Module 4, to create a plan of action.

A plan of action sets out a strategy for improving pedestrian safety in the setting under consideration. It provides a framework to organize interventions in a strategic manner that minimizes duplication of work and facilitates evaluation

of progress over time. It may be part of a broader road safety plan or it may stand alone. It may focus on different geographical units, ranging from a specific street, to a neighbourhood, to a district or be countrywide. The plan may be developed to strengthen existing pedestrian safety initiatives or to create something new. Whatever the nature and focus of the plan, it should be tailored to the specific problems and needs of the local setting (*8*).

Once the focus of the plan is agreed, planned actions need to be prioritized in a way that is both systematic and locally relevant. The data gathered through the situational assessment, together with information on the effectiveness of various interventions (see Module 4), provides the evidence to inform the prioritization process. Relevant considerations include what risk factors or issues to address, public support, funding, safety benefits and responsible agency (*8*). In addition to strategies to influence the key risk factors and address gaps in programming, the plan might include strategies to address gaps in data needed to measure the burden of pedestrian traffic injury and evaluate the impact of interventions.

3.3.1 Mobilizing stakeholders

The preparation and subsequent implementation of a pedestrian safety plan requires input and support from a variety of stakeholders. The stakeholder and institutional analysis indicated in Section 3.2 should help with identification of the lead agency responsible for road safety in the setting under consideration. Ideally, this agency should convene a working group and coordinate the development of the pedestrian safety plan. If there is no lead agency, a multisectoral working group or committee on pedestrian safety can be established to coordinate the preparation and implementation of the action plan. If road safety working groups or committees already exist, advocacy work may be required to ensure a specific pedestrian safety focus.

NOTE

"Stakeholder involvement is an essential element in creating publicly supported and trusted policies, programmes, and projects that reduce pedestrian crashes while creating liveable, walkable communities" (*8*).

Who should be involved in the working group?

Pedestrian fatalities and injuries, as shown in Modules 1 and 2, have multiple determinants, affect diverse people, and require action by several sectors. The working group should consist of representatives from government and other agencies that have a common interest in improving pedestrian safety. These may include agencies or people that have political and economic interests in the issue, not just

those that have administrative responsibility for safety. The working group should also include members who are not convinced about the importance or desirability of safe walking and pedestrian safety measures. The goal is to create a diverse group that draws on varying – even opposing – perspectives and strengths. Composition of the working group may vary depending on whether the plan will be set at the national, provincial or municipal level.

The key stakeholders identified in the situational assessment should constitute a core working group. Working groups function best when they are smaller, but it is also important to develop a mechanism to facilitate involvement of as wide a group of stakeholders as possible, even if it is just for information sharing. High-level political commitment from the government facilitates successful implementation of the planned activities and high-level government representation may thus be important for the working group. Government ownership of the action plan creates opportunities for implementation and sustainability.

What should the working group do?

The working group should define its duties early in the process, in order to increase the effectiveness of its operations. Basic issues the group will address as soon as it is created include identifying a coordinator, defining an operational framework for the group, creating a management committee and specific sub-groups as necessary, and assigning responsibilities to members.

The critical strategic duties of the working group include the following (*8*):

- Setting the goals and objectives of the pedestrian action plan.
- Examining data or information available and prioritizing concerns.
- Coordinating the development and possibly implementation of the pedestrian safety action plan. In some cases the working group may be tasked with development of the action plan but not responsibility to oversee its implementation. In other cases the working group may be assigned responsibility to oversee both the development and implementation of the action plan.
- Mobilizing support and resources for the pedestrian safety action plan. The working group should design strategies for raising funds and garnering financial and human resources to provide some working capital to undertake planned activities.
- Coordinating and integrating the action plan into government road safety, transport and/or urban development programmes at the national and local levels. A pedestrian safety initiative has jurisdictional, resource and infrastructural issues that require involvement of government.
- Defining performance measures and targets for implementation.

3.3.2 Core components of an action plan

Strong plans of action have several components in common:

A well-defined problem

The main purpose of the situational assessment is to provide a comprehensive picture of the local pedestrian traffic injury situation. Without this assessment, the plan of action may not be focused on the most important issues and solutions.

Clear objectives

The action plan may be comprehensive, addressing a wide range of risk factors, or it may start with a more focused approach, covering a few very specific objectives. The experience of cities such as Curitiba, Brazil, and Copenhagen, Denmark, shows that even action plans with only a few goals, such as creating a pedestrian street or implementing speed control measures on a busy street, can yield significant results (*14*). Plans can be expanded over time to include other issues if resources and political commitment permit.

General principles to consider in defining objectives include:
- Objectives should be clear and specify a measurable outcome in a defined time period. Keep the objectives SMART: specific, measurable, achievable, relevant and time-bound.
- Objectives should be evidence-informed, deriving from the situational assessment as well as available literature.
- Objectives should include pedestrian fatality and injury reductions and also reductions in other risks that may result from improving conditions for walking. Changing attitudes of the public towards the rights of pedestrians and the need to protect their safety, and incorporating pedestrian safety into decision-making processes should also be considered.
- Both short-term and medium- to long-term objectives are desirable.

Realistic targets

Targets specify the improvements expected within a certain time period, and setting targets has been shown to strengthen commitment to improve road safety (*15*). Targets provide a benchmark to monitor ongoing progress in achieving objectives. They enable better use of resources and better management of road safety programmes by providing an opportunity to adjust activities along the way and therefore increase the likelihood of achieving specified objectives (*15,16*).

Targets can be set based on the objectives of the plan and/or the historical experience of results achieved during the implementation of pedestrian safety measures. General principles to consider in setting targets include the following:
- Set specific and realistic targets.
- Set quantified targets as much as possible.

- Targets should be set in consultation with government agencies responsible for taking action on pedestrian safety.
- Baseline measures for targets should be indicated and/or collected.

Ambitious targets may sometimes be appropriate, for example, to raise public awareness of the road safety problem in order to increase pressure on stakeholders to strengthen their efforts (*16*).

Performance indicators

Performance indicators are used to measure progress towards the objectives. They indicate changes and improvements in the baseline conditions being addressed, for example, the number of pedestrian fatalities and injuries or the amount of funding allocated to pedestrian safety. Performance indicators help to define key activities, deliverables and outcomes for the action plan. Each performance indicator should have specific targets, either quantitative or qualitative.

A realistic timeline and milestones

A plan of action needs to indicate the timeline for executing different activities and milestones that can be used to measure progress. Some flexibility is required, however, to adjust the timeline as needed to accommodate changes that may occur during implementation.

Adequate resources

Successful implementation of the action plan depends on adequate resource allocation. The plan should identify and when possible allocate funding for each component. Resources may come from reallocation of existing funds or mobilization of new funds at the local, national and/or international levels.

A monitoring and evaluation system

Continuous assessment of progress requires definition of a monitoring and evaluation system that incorporates the performance indicators and targets. The plan should specify data collection and analysis methods, dissemination channels, and a framework for utilization of the results to adjust pedestrian safety activities.

Sustainability

In addition to considering immediate resource allocation priorities, the plan will be most effective if it includes mechanisms to ensure adequate funding levels on an ongoing basis. Public demand for pedestrian safety can put pressure on politicians and government officials to demonstrate long-term political and financial commitment, which can in turn strengthen the sustainability of the action plan. The plan might therefore include some indicators to gauge public demand for pedestrian safety and government response.

An example of a pedestrian safety plan of action is presented in Box 3.4.

BOX 3.4: **Pedestrian safety plan, Montgomery County, Maryland, USA**

In 2007, the Montgomery County City Council prepared a pedestrian safety strategic plan to address the problem of pedestrian fatalities and injuries: 14 pedestrian deaths and 430 collisions involving pedestrians per year in the period 2003–2006 (*17*). The objectives of the plan were to reduce pedestrian-related crashes, injuries, fatalities, and their associated social and economic costs; and to ensure that all areas of the county provide safe and convenient travel options for pedestrians.

The plan focused on seven strategic areas: improving pedestrian safety in high incidence areas; assessing and improving pedestrian network and connectivity needs; increasing emphasis on pedestrians and cyclists in the planning process; identifying and implementing intersection modifications and traffic calming treatments; upgrading pedestrian signals; assessing and enhancing street lighting; and modifying pedestrian and driver behaviour through enhanced enforcement and educational efforts (*17*). The plan included a budget, showing the amount of funding required, the source and whether the funds which existed were one-time or recurring funds.

The plan defined several performance indicators:

- Reduce pedestrian collisions in each of the targeted high incidence areas by 20% following completion of improvements.
- Reduce average traffic travel speeds in targeted high incidence areas.
- Increase perception of pedestrian safety and 'walkability' in targeted high incidence areas using an annual county survey of residents and visitors to assess results.
- Increase the annual sidewalk construction effort to 17 kilometres of new sidewalks each year.
- Complete 'Safe Routes to Schools' improvements at 29 schools per year, completing the remainder of county schools in a six-year timeframe.
- Review and update pedestrian signal timings at a rate of 250 per year for three years.
- Upgrade all county-owned traffic signals to current accessible pedestrian signal standards, adding pedestrian countdown features, at a rate of five per year.
- Complete improvements to 13 identified lighting projects within six years.

3.4 Summary

The content of this module is summarized as follows:

- A comprehensive understanding of the local pedestrian safety situation is essential to effective action.
- The situational assessment should cover the magnitude and nature of pedestrian traffic injuries, the key risk factors, stakeholders in pedestrian safety, existing programmes and the current policy environment.
- Development of an action plan for pedestrian safety requires collaboration across a wide range of stakeholders and different levels of government.
- Core components of the action plan include a well-defined problem, clear objectives, realistic targets, performance indicators, timeline and milestones, adequate resources, monitoring and evaluation, and sustainability options.

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4

Implementing pedestrian safety interventions

Implementing pedestrian safety interventions

MODULE 3 provided guidance on conducting a situational assessment and preparing an action plan for pedestrian safety. This module discusses various pedestrian safety measures and key issues to consider regarding their implementation.

The module is divided into two sections:

4.1 An overview of effective pedestrian safety interventions: This section provides a summary of key interventions that can be implemented to improve pedestrian safety, and provides principles to guide decision-making regarding the optimal choice of interventions.

4.2 Implementing effective pedestrian safety interventions: This section provides details on specific pedestrian safety interventions and examples of their implementation.

4.1 An overview of effective pedestrian safety interventions

Institutions and people working in pedestrian safety may tend to favour either engineering measures or behaviour-change measures, depending on their training and experience, but significant improvement to pedestrian safety requires a balanced approach that includes both perspectives (*1*).

NOTE

"Many pedestrian safety problems cannot be solved simply by addressing one of the 'three Es' (engineering, education, enforcement) in isolation. Engineers, law enforcement, designers, planners, educators, and citizens should all play a role in identifying and implementing effective countermeasures for improving pedestrian safety" (*2*).

Several engineering and behavioural interventions have been evaluated and found to be effective in improving pedestrian safety. A summary of the key pedestrian safety measures is presented in Table 4.1. Each broad category of measures is associated with a number of specific interventions. While some interventions have been found to be effective in multiple settings, others have insufficient evidence regarding their effectiveness.

Effectiveness of the measures is assessed by reduction of fatalities and injuries, as well as changes in behaviour, attitudes and knowledge. Table 4.1 categorizes pedestrian safety strategies as follows:

- **Proven**: Evidence from robust studies such as randomized controlled trials, systematic reviews or case–control studies show that these interventions are

effective in reducing pedestrian fatalities and injuries, or in bringing about desired behaviour change.

- **Promising**: Evidence from robust studies show that some pedestrian safety benefits have resulted from these interventions, but further evaluation from diverse settings is required and caution is thus needed when implementing these interventions.
- **Insufficient evidence**: Evaluation of an intervention has not reached a firm conclusion about its effectiveness (*2*).

Table 4.1 Focal measures and specific interventions for improving pedestrian safety

Key measures	Examples of interventions	Effectiveness		
		Proven	Promising	Insufficient evidence
Reduce pedestrian exposure to vehicular traffic	Provide sidewalks	■		
	Install and/or upgrade traffic and pedestrian signals	■	■	■
	Construct pedestrian refuge islands and raised medians	■		
	Construct enhanced marked crossings		■	
	Provide vehicle restriction/diversion measures	■	■	
	Install overpasses/underpasses	■		
	Improve mass transit route design	■		
	Reduce traffic volumes by switching journeys from the car to public transport, walk and cycle for distances and purposes where these options work well	■		
Reduce vehicle speeds	Reduce speed limit	■		
	Implement area-wide lower speed limit programmes, for example, 30 km/h	■		
	Implement road-narrowing measures		■	
	Install speed management measures at road sections	■	■	
	Install speed management measures at intersections	■	■	
	Provide school route improvements		■	
Improve sight distance and/or visibility between motor vehicles and pedestrians	Provide crossing enhancements	■	■	
	Implement lighting/crossing illumination measures	■		
	Reduce or eliminate obstruction by physical objects including parked vehicles		■	
	Install signals to alert motorists that pedestrians are crossing		■	■
	Improve visibility of pedestrians		■	

Key measures	Examples of interventions	Effectiveness		
		Proven	Promising	Insufficient evidence
Improve pedestrian and motorist safety awareness and behaviour	Provide education, outreach and training	■		
	Develop and/or enforce traffic laws on speed, drinking and driving, pedestrian right-of-way, red light disobedience, commercial roadside activity and traffic control	■		
	Implement 'walking school bus' programmes		■	
Improve vehicle design for pedestrian protection	Develop vehicle safety standards and laws for pedestrian protection		■	■
Improve vehicle design for pedestrian protection	Enforce vehicle safety standards and laws for pedestrian protection			■
	Publicize consumer information on pedestrian safety by make and model of car, for example, results of New Car Assessment Programmes		■	
Improve care for the injured pedestrians	Organize pre-hospital trauma care systems	■		
	Establish inclusive trauma care systems	■		
	Offer early rehabilitation services	■		

Note: When the terms 'proven', 'promising' and 'insufficient evidence' appear highlighted in the same line, it shows that there are different measures in the same broad category at different stages of development as already explained above with respect to effectiveness.

Source: *1–7*.

There are several important principles practitioners and decision-makers should be guided by when choosing which pedestrian safety measure(s) to implement:

Conduct a situational assessment and utilize the results

The findings of the situational assessment should inform the selection and prioritization of interventions to address the pedestrian safety problem in a given setting. Other considerations for intervention selection include cost, effectiveness, feasibility and acceptability.

A holistic and multifaceted approach is preferable to a narrow focus

A combination of the measures presented in Table 4.1 will be more effective than implementing a single strategy. Cost and feasibility should not be the only considerations when choosing interventions. Strategies that may be easier to implement may have a smaller impact. For example, installation of pedestrian warning signs may increase pedestrian awareness and reduce some risk, but a more

effective approach would be substantial infrastructure changes such as the provision of sidewalks and speed management strategies. Engineering-related measures may be more expensive and may raise more resistance than behaviour change strategies, but these types of measures are essential to a balanced Safe System approach.

NOTE

Changes in behaviour can also be achieved through land-use planning and road design strategies, not only through the 'traditional' approaches of enforcement and education.

Few jurisdictions in any country have adequate resources and/or political will to implement all, or even most, of the pedestrian safety measures presented in Table 4.1. A jurisdiction may choose to begin with a single strategy or measure while mobilizing resources and political will to implement complementary measures. This is not problematic as long as the responsible agency and/or the action plan take a broader and long-term view that incorporates other measures.

Integrate pedestrian safety as an essential feature of roadway design and land-use planning

A Safe Systems approach to pedestrian safety prevents the development of risky roadway environments rather than relying exclusively on interventions to reduce risk in the existing built environment (see Module 1). When decision-makers, engineers and planners routinely consider pedestrian safety as part of roadway design and land-use planning, pedestrian safety is built into the transport system.

Many strategies that benefit pedestrian safety have been found to benefit other road users as well. Examples include (*4,5*):

- Raised medians on multi-lane roads reduce pedestrian crashes and also head-on vehicle collisions.
- Changing four- and five-lane to three-lane roads reduces pedestrian crashes and total roadway crashes.
- Paved shoulders can reduce 'walking along the road' pedestrian crashes, as well as 'run-off-road' and fixed object crashes involving motor vehicles.
- Providing separate phasing at signalized intersections for left-turning vehicles[2] reduces left-turn vehicle crashes involving pedestrians, and left-turn crashes involving vehicles going straight.

[2] Applies where vehicles drive on the right side of the road. Where vehicles drive on the left, this applies to right-turning vehicles.

Consider the distinct needs of various types of pedestrians

Pedestrians are a group with diverse characteristics, capabilities and needs. The specific needs of children, elderly people and people with disabilities should be considered and prioritized when designing pedestrian safety measures (see Box 4.1). More information on children and people with disabilities is provided later in this module.

BOX 4.1: **Considering older people in pedestrian safety measures**

Age is related to a variety of characteristics and skills that influence the risk of pedestrian traffic injury. These age-related characteristics can also affect the way in which people of different ages interact with pedestrian safety measures and therefore require unique attention when planning interventions.

Several factors work together to increase the risk of older pedestrians:

- Deterioration in visual acuity may have a negative impact on their ability to cross the road safely. In general, older pedestrians look less at traffic and accept significantly smaller gaps in traffic when crossing the road than younger pedestrians (8).
- Reduced mobility can render older pedestrians unable to react quickly in imminent danger to avoid a crash.
- Underlying health conditions or frailty can result in greater injury severity when a crash occurs.
- Reduced speed when crossing the road. The speed of elderly pedestrians does not itself increase risk; the risk comes from the speed of the traffic and, in particular, from automated signals that do not allow sufficient time for slower pedestrians to cross safely. In many municipalities the assumed walking speed used to set crossing times at signalized crossings is faster than an older person can walk, leaving them stranded on the road when the signal phase changes to allow vehicle movement (8).

The following measures can be implemented to improve the safety of elderly pedestrians:

- Increase the time allocated to pedestrians at signalized pedestrian crossings.
- Install high-visibility crossings and advance stop bars.
- Repair broken kerbs and pedestrian ramps.
- Replace missing and/or upgrade existing signs.
- Install pedestrian refuge islands or, preferably, raised medians.
- Narrow roadways with traffic-calming techniques.
- Raise public awareness about the safety needs of elderly pedestrians.
- Reduce legal speed limits.
- Strengthen enforcement of laws on speed limits, and drink–driving.

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Even measures designed to protect pedestrians can have unintended negative impacts and cause harm to pedestrians if they are poorly implemented. For example, transforming a marked, non-signalized crossing into a signalized one might seem positive for pedestrian safety but if the crossing time is too short it can increase pedestrian risk, with pedestrians caught on the crossing when vehicles are signalled to move. Short crossing times put slower-moving pedestrians at risk (*8*).

Adapt proven measures to local conditions

Each local context has its unique political, cultural, financial and road conditions. Measures from high-income countries cannot be simply transferred to low- and middle-income countries, without due consideration of the local context (see also Module 3). Not all of the strategies listed in Table 4.1 are appropriate or necessary for every site; the package of interventions must be tailored to best fit specific site conditions, including traffic speed and volume, number of travel lanes, presence of signs, volume and characteristics of pedestrians (e.g. school children, seniors, pedestrians with disabilities), location type (downtown, suburban or rural), type of land use, and other relevant physical and location factors. Module 3 provides methods for assessing local factors for the purpose of choosing and adapting interventions.

Implement the measures over time

It takes a sustained effort over a period of time to improve pedestrian safety (see Box 4.2). A city or a region may begin with a few measures at the highest risk locations, and over time increase the geographic coverage and number of interventions implemented.

Provide supportive policies and guidelines

Improving pedestrian safety requires supportive policies that may be specifically focused on pedestrian safety or be part of general transport and land use policies. Guidelines that specify design standards for pedestrian facilities help to ensure pedestrian safety in new roadways and correct deficiencies on existing roads (*7*). Various existing guidelines such as the *High capacity manual* (*9*) and *Complete streets* (*10*) can be adapted to the local setting. Generally, pedestrian safety policies and guidelines need to recognize pedestrians as legitimate road users and promote this recognition among planners, engineers and professionals who plan and manage the road transport system; set and enforce traffic laws that ensure safety of pedestrians; encourage an inclusive approach in planning new roads and/or retrofitting existing roads; and pay attention to the specific needs of people with disabilities, children and the elderly.

BOX 4.2: **Improving pedestrian safety in The Hague, the Netherlands**

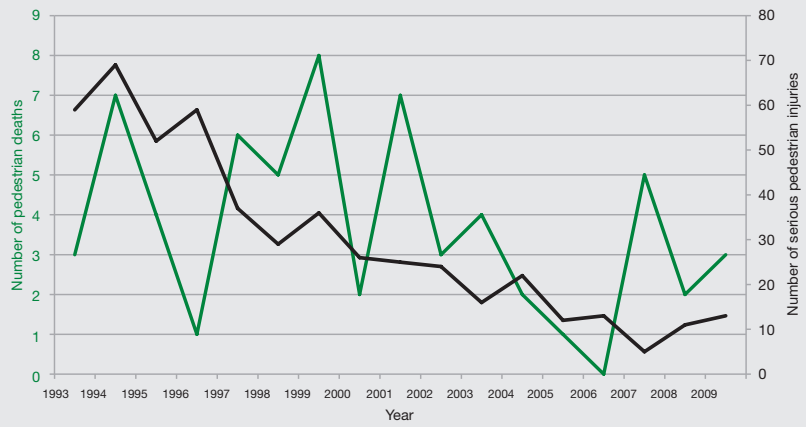
The city of The Hague is located in the west of the Netherlands in the province of Zuid-Holland. It is about 45 kilometres from Amsterdam and 15 kilometres from Rotterdam. Approximately half a million people live in this city, which has a well-developed pedestrian infrastructure network and support services. The network and support services are the result of several years of action taken by different governments, local organizations and the public.

Sustained efforts towards pedestrian safety in The Hague have been characterized by the following features:

- Inclusion of financial resources for pedestrian safety measures in the overall budget for infrastructure development at the local and national government level.
- Decentralization of decision-making on pedestrian safety issues to the local government level. The national Ministry of Infrastructure and Environment does not have administrative responsibility for pedestrian facilities. This role has been delegated to local authorities.
- Integration of pedestrian safety solutions and facilities into overall urban and transport planning at the local level. Local authorities do not see pedestrian safety and infrastructure planning as independent tasks but rather as integral components of general urban management.
- Taking action whenever a need or an issue is identified. For example, local authorities repair and maintain pedestrian infrastructure whenever there is a complaint from a member of the public or a business.
- Reviewing and implementing pedestrian safety policy consistently. As part of the sustained pedestrian safety improvement effort, in 1989 The Hague City Council agreed upon *De Kern Gezond* (a healthy heart for the inner city) plan. The plan provided the framework for the design of public space within the inner city. It outlined a new approach towards public space. In the late 1980s, the inner city of The Hague was car-dominated, with heavy traffic passing through it. *De Kern Gezond* prioritized pedestrians in public space design. Streets and squares were redesigned to favour pedestrians. The municipality began by increasing pedestrian zones. A new design and new materials were used, well adapted to the scale and speed of pedestrians. The central station area was redeveloped and the busy distributor roads were placed underground. The surface level was freed up for pedestrians and cyclists to move freely and safely. In 2011, almost the entire old city was transformed to a pedestrian area. Presently, The Hague has the largest car-free zone in the Netherlands.

Generally, the number of pedestrians killed in The Hague each year does not exceed 10. In some years, there has been only one pedestrian killed. This is largely due to the sustained implementation of pedestrian, transport and urban development programmes in the city. This has been also reflected in the number of serious pedestrian injuries.

Pedestrian deaths and injuries in The Hague (1993–2009)



4.2 Implementing pedestrian safety interventions

This section provides further details on the pedestrian safety measures listed in Table 4.1. It discusses the effectiveness of these measures and issues that should be considered for implementation. Examples are given to illustrate how the interventions have been implemented in different settings around the world, and to highlight opportunities and challenges encountered during the implementation process. Examples range from comprehensive measures to interventions targeting high-risk sites (e.g. pedestrian crossing points) or groups (e.g. people with disabilities) as well as measures focused on specific risk factors (e.g. speed management).

4.2.1 Reducing pedestrian exposure to vehicular traffic

There are a number of specific engineering measures that reduce pedestrian exposure to vehicular traffic. Most of these measures involve separating pedestrians from vehicles or reducing traffic volume. This section discusses sidewalks/footpaths, marked crossings, overpasses and underpasses, and mass transport routes as key strategies to reduce pedestrian exposure to vehicular traffic. These interventions are good starting points for action, but pedestrian safety will be most improved when they are implemented in conjunction with other measures such as reducing vehicle speed (see also Section 4.2.2).

Sidewalks/footpaths

Sidewalks separate pedestrians from motorized vehicles as well as bicycles. They provide space for different types of pedestrians to walk, run, play, meet and talk.

Studies show that sidewalks improve both pedestrian safety and increase walking:

- Pedestrian crashes decrease where there are sidewalks and raised medians. A study conducted in the United States found that pedestrian crashes were more than twice as likely to occur at locations without sidewalks than would be expected on the basis of exposure. Residential areas without sidewalks had 23% of all pedestrian–vehicle crashes but only 3% of pedestrian–vehicle exposures (*3*).
- The presence of a sidewalk has a strong beneficial effect on reducing 'walking along roadway' pedestrian crashes. A study in the United States found that sites with sidewalks were 88% less likely to be pedestrian crash sites than those without sidewalks (*11*).
- Walking increases where tracks for walking are constructed (*5*).

To maximize the benefits of footpaths/sidewalks to pedestrian safety, they should:

- be part of every new and renovated roadway;
- be provided on streets that currently do not have sidewalks (see Box 4.3), including providing shoulders on rural roads;

- be provided on both sides of the road;
- consist of a hard, level surface;
- be designed according to existing local guidelines with regards to width, depth, surface type and placement;
- be separated from other vehicles with a kerb, buffer zone, or both;
- be continuous and accessible to all pedestrians;
- be adequately maintained;
- have adequate width (as narrow sidewalks may be an additional road safety hazard);
- include kerb ramps (as they are important in addressing the needs of people in wheelchairs and pedestrians with mobility impairments);
- be free from obstructions (e.g. lamp posts and road signs), traders and other obstructions; and
- include demarcations by road user type when shared by pedestrians and cyclists.

NOTE While sidewalks and walkways are important facilities for pedestrians to walk safely in urban and suburban areas, in some rural areas having a wide paved shoulder may be suitable for providing a place for pedestrians and cyclists to travel as an alternative to a sidewalk.

BOX 4.3: **Retrofitting sidewalks and other pedestrian safety facilities in Abu Dhabi, United Arab Emirates**

Addressing safe walking and pedestrian traffic safety may require constructing new pedestrian facilities, or improving existing facilities that may not be safe or user-friendly. The Abu Dhabi Urban Planning Council developed a street design manual to provide guidance on addressing the needs of the growing population and improving pedestrian facilities to create more walkable and liveable communities (*12*). The manual was adopted in January 2010 by the Abu Dhabi Executive Council as the primary guide to be used in designing all urban streets in the Abu Dhabi Emirate.

A segment of a major street, known as Salam Street, was redesigned in 2011 according to the *Abu Dhabi Urban Street Design Manual* principles. Before redesign, the street was characterized by significant pedestrian risk, including:

- the presence of obstructions in the pedestrian path, including manholes, utility poles, signage poles, and other ill-placed street furniture;
- the lack of separation between pedestrians and vehicles, in particular the absence of bollards and kerbs; and
- drivers failing to yield to pedestrians at free right turn points, with vehicles sometimes queuing on the raised table.

The redesigned street has improved pedestrian facilities, including wider pedestrian refuge islands and medians, median barriers, raised crossings and traffic controls. The retrofit has generally improved conditions for walking and reduced vehicular speeds by 4–10km/h, relative to a comparable nearby street. The reduced speeds are mostly attributed

Continued…

Continued from previous page

to the smaller roundabouts and narrower lanes on Salam Street, designed according to the new manual guidelines.

In addition to street redesign interventions, the following measures are also included:

- Enforcement of traffic laws in order to ensure that motorists respect pedestrian right-of-way at raised pedestrian crossings.
- Raising awareness and implementing education programmes to inform motorists about the new sequencing of vehicle/pedestrian movement at traffic signals as well as traffic laws for the protection of pedestrians.
- Implementation of other design measures to enhance pedestrian safety such as installing bollards on right turns and redirective kerbs.
- Retrofitting other streets, including sidewalks.
- Evaluation of the measures.

Marked crossings

Crossings separate pedestrians from vehicular traffic for a brief time period while they cross the street. The purpose of a marked crossing is to indicate the optimal or preferred location for pedestrians to cross. Marked crossings help to indicate pedestrian right-of-way and motorists' need to yield to pedestrians at these points. Motorist compliance with yielding at marked crossings can be improved with awareness-raising, education and enforcement. Marked crossings are commonly installed at signalized intersections, as well as other high-volume pedestrian crossing locations such as school zones. They should, however, be installed in conjunction with other physical roadway enhancements that reinforce the crossing and/or reduce vehicle speeds.

There are several important issues for practitioners and decision-makers to consider when installing crossings:

- Crossing markings are unlikely to increase pedestrian safety, without related enhancements such as raised crossing islands and traffic signals.
- Marked crossings are not appropriate where traffic speed is high.
- Marked crossings on roads with more than two lanes may increase the risk of pedestrian–vehicle crashes.
- Crossing locations should be convenient for pedestrians and accessible for pedestrians in wheelchairs. Pedestrian movements and desire lines (most direct/shortest path between two locations) can be analysed to identify optimum locations for crossings.

- Marked crossings should guide pedestrians to cross at locations where there is street lighting at night.
- Detectable warnings should be installed to advise pedestrians with visual impairments where the kerb ramp ends and the street begins. The warnings should also indicate when the traffic light will change.
- There should be adequate visibility between vehicles and pedestrians. For example, night-time pedestrian crossings should be properly illuminated in order to help drivers to see pedestrians.

Overpasses and underpasses

Pedestrian overpasses and underpasses are bridges and tunnels that allow for uninterrupted flow that is separate from vehicular traffic. This measure is used primarily in areas with high pedestrian volumes.

Several issues arise with implementation of overpasses and underpasses:

- The effectiveness of these approaches depends largely upon the likelihood that they will be used by most of the pedestrians crossing the street. In Tokyo, where this does occur, reductions in vehicle–pedestrian crashes of up to 91% were found following the implementation of overpasses and fencing (*3*). The level of use depends on convenience, security, and walking distances compared with alternative crossing locations. Pedestrians generally do not use these facilities if a more direct route is available. Tall fences and other pedestrian barriers may be used to channel pedestrians to the overpass or underpass. These are not always effective, however, since pedestrians find ways to go around the barriers and cross at intersections.
- Overpasses are suitable when the topography allows for a structure without ramps, for example, an overpass over a below-grade freeway. Overpasses with multiple stairs are not user-friendly for the elderly or disabled pedestrians. Underpasses need to be designed in such a way as to offer a sense of being open and accessible.
- Ramps must be designed to accommodate pedestrians in wheelchairs.
- Underpasses can be affected by flooding, and may quickly become dirty without regular maintenance.
- Underpasses are often dark, secluded places. They may be targeted by gangs or other perpetrators of interpersonal violence, and, for this reason, people who perceive a high risk of assault avoid them. Overpasses and underpasses should be well-lit and secure, to maximize personal security and therefore utilization.

Mass transport routes

Pedestrian safety is a key issue to consider in the design of any mass transport system, including routes and stops (see Box 4.4). Mass transport routes are usually located on major arterial roads, which are the most dangerous types of urban streets (*13*). Though travelling by public transport may be one of the safest modes, transit passengers are at a high risk of crashes when walking to and from the station or stop (*14*).

BOX 4.4: **Considering pedestrian safety in the design of mass transport routes**

A study on high capacity bus systems revealed that pedestrians accounted for over half of all fatalities across a sample of 32 bus corridors in five countries in Latin America and Asia-Pacific (*15*). Most conflicts between pedestrians and vehicles occur at stations and terminals. The terminals in particular can easily become dangerous spots on bus corridors.

These findings have been utilized by EMBARQ – the World Resources Institute and partners, to develop key design recommendations for integrating safety into the planning, design and operation of high capacity bus systems. In Mexico City, for example, a pedestrian-friendly public transport route known as Metrobus Line 4 has been designed. This route passes through the historic centre of the city, with some of the streets having very high pedestrian traffic. Many important safety improvements have been made on this route:

- Provision of safe pedestrian access across the route, as well as to and from the stations.
- Addition of medians to reduce crossing distance for pedestrians.
- Protected refuge islands for pedestrians, with bollards and kerbs shielding pedestrians from vehicular traffic.
- Installation of pedestrian 'countdown' signals at signalized intersections in the historic centre. Previously, pedestrians had to rely on the vehicle signals to judge whether they had adequate time to cross the street during the green phase. The yellow light for vehicles lasted less than four seconds, which did not leave pedestrians enough time to finish crossing and consequently put them at risk. The new countdown signals have addressed this problem.

The newly designed bus route became operational in April 2012. The pedestrian safety design improvements indicated above are expected to improve safety and walking conditions for pedestrians. Similar interventions will be implemented in other cities where EMBARQ and local partners are working.

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4.2.2 Reducing vehicle speeds

One of the most effective ways to improve pedestrian safety is to reduce the speed of vehicles (*16*). As discussed above, and in Modules 1 and 2, speed is a key risk factor for pedestrian traffic injury. If possible, speed management measures should be used alongside measures to reduce pedestrian exposure to vehicular traffic. Even if it is not possible to reduce pedestrian exposure to traffic, speed management remains an effective measure to reduce pedestrian traffic risk, and a core component of the Safe System approach.

Speed management is much more than setting and enforcing appropriate speed limits. It employs a range of measures in engineering, enforcement and education with the aim of balancing safety and efficient vehicle speeds on the road network. Detailed guidance on the effectiveness and implementation of speed management strategies can be found in *Speed management* (*17*), and *Speed management: A road safety manual for decision-makers and practitioners* (*18*). As shown in Module 2, there is a growing effort to implement system-wide lower speeds of 30 km/h or even less for entire geographical areas instead of focusing on individual streets (*19*).

The engineering approach to speed management consists of a number of specific traffic calming measures – physical treatments to roads as well as perceptual treatments and speed limit reductions aimed at reducing vehicle speeds and sometimes traffic volume (*20*). Traffic-calming measures are generally of two types:

- those that require motorists to change their direction of travel by moving either to the left or right; and
- those that require motorists to change elevation by either going up or down.

Perceptual design is the use of psychological principles such as patterns painted onto road surfaces that encourage drivers to reduce their speed (*21*).

Traffic-calming measures can vary from a few minor changes, through modifications of local streets, to area-wide changes and major rebuilds (*20*). Their efforts include moderate speed reductions and street design changes, with various degrees of success in reducing pedestrian crashes and traffic volume. A number of studies show a reduction in pedestrian–vehicle conflicts and crashes associated with refuge islands, marked crossings with raised median, road narrowing, staggered lanes, road humps and junction redesign (*3,22–24*). Box 4.5 provides an example of implementation of a variety of traffic-calming measures in a town in China.

BOX 4.5: **Traffic-calming measures in Zhaitang Town, China**

In China, pedestrians constituted the second largest group (25%) of those killed in road traffic crashes in 2010 (*25*). Growth of the economy, increasing urbanization and growth of motorized traffic are underlying factors leading to the increase in travel, and traffic situations that lead to pedestrian–vehicle conflicts in China (*7*). Traffic law violation and inadequate enforcement also contribute to the risks facing pedestrians (*26*). Various provinces and cities in China are implementing measures to improve pedestrian safety.

In Zhaitang town in the Mentougou district, Beijing region, the authorities implemented pilot traffic-calming measures on six roads in 2008 (*27*). The measures were aimed at reducing speed and improving safety and conditions of travel for non-motorized transport users, and consisted of speed humps, raised crosswalks, raised intersections, speed cushions, roundabouts, chicanes, neckdowns,[2] centre island narrowing, lateral shifts, median diverters, boom barrier and pedestrian refuge islands.

A before-and-after evaluation conducted in October 2009 showed that these interventions had an impact on three aspects of road safety (*27*):

- Road traffic injuries: The number of all road users killed reduced from two to zero after the measures were implemented. Similarly, the number of people injured reduced from six to one. It is hoped that data collection will continue for several years to confirm the initial reductions in fatalities and injuries.
- Vehicle speed: Observations at three intersections and four crossings indicated that average vehicle speed was reduced by 9%.
- Non-motorized transport users' travel behaviour: Crossing use increased and 65% of people interviewed felt that the measures had reduced speed and improved safety.


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When choosing traffic-calming measures, it is important to bear in mind the following issues (*20*):

- A combination of traffic-calming measures provides the greatest benefit. Ideally, they should be applied on various streets and area-wide, rather than in one or two isolated spots.
- The design of traffic-calming measures tends to be context-specific, so that different measures are appropriate on different types of roads. It is therefore important to apply measures on the street types and areas (e.g. residential) for which they are designed. Some are appropriate at intersections, some in low-volume residential areas, and others are meant to be applied area-wide. Table 4.2 provides an overview of the application of various calming measures to road types – arterial and local – as well as their anticipated impact on traffic volume.

[3] Neckdowns are kerb extensions that create a narrowing of streets at intersections.

- Different measures are appropriate for addressing either speed or traffic volume. It is therefore important to determine whether the aim is to reduce speed or traffic volume, or both (see Table 4.2).
- Speed humps, traffic circles, and other traffic calming measures are perceived by some traffic engineers, neighbourhood residents, and members of the media as obstacles in the roadway. As a result, there may be opposition to installing these measures. Resident input and consensus may be necessary when planning residential traffic-calming measures.
- Traffic-calming interventions alone do not improve conditions for pedestrians. Other issues need to be addressed, such as law enforcement and provision of adequate street lighting.

Table 4.2 Traffic-calming measures, their application and impact

Type	Speed reduction can be applied to:		Impact on traffic volume
	Arterial roads	Local roads	
Speed hump	No	Yes	Possible
Speed table	With caution	Yes	Possible
Raised crosswalk	Yes	Yes	Possible
Raised intersection	With caution	Yes	Possible
Textured pavements	Yes	Yes	Possible
Speed cushion	With caution	Yes	Possible
Rumble strips	Yes	Yes	No
Traffic (mini) circle	No	Yes	Possible
Roundabout	Yes	Yes	Not likely
Chicanes	No	Yes	Yes
Realigned intersection	Yes	Yes	Possible
Tight radii	Yes	Yes	Possible
Centre island narrowing	Yes	Yes	Possible
Chokers	Yes	Yes	Possible
Road diets (i.e. lane reduction)	Yes	Yes	Yes
Speed limits	Yes	Yes	No
Speed alerts, enforcement	Yes	Yes	No
Perceptual design	Yes	Yes	Possible
Warning signs	Yes	Yes	No
Half closure	Yes	Yes	Yes
Diagonal diverters	Yes	Yes	Yes
Lateral shift	Yes	Yes	No
Median barriers	Yes	No	Yes
Gateway treatments	Yes	No	No
Traffic signal coordination	Yes	No	No
Vehicle-activated signs	Yes	No	No

Note: Most of these treatments are expected to reduce speed. A brief description of selected traffic-calming measures is provided in Appendix 2. These traffic-calming measures need to be accompanied by other measures in order to be effective. For example, speed limits need to be enforced and supported through awareness raising and campaigns.

Source: *20*.

Two of the most commonly used traffic-calming measures are raised pedestrian crossings and road narrowing, discussed below.

Raised pedestrian crossings

There are two key ways to reduce fatal and serious pedestrian injuries: the first is to separate pedestrians from motorized traffic, and the second is to slow vehicle speeds to levels low enough that if a collision does occur, it will not result in fatal or serious injury. Raised pedestrian crossings force vehicles to slow to speeds low enough that a pedestrian would survive a collision. Reductions in pedestrian crashes of around 40% could be expected from the installation of a raised crossing (*5*).

The key considerations for a decision-maker and practitioner with regards to raised pedestrian crossing are as follows:

- Raised crossings should be clearly marked and advance warning provided.
- They are not usually suitable for very high-speed environments.
- Additional benefits are likely if there are other traffic-calming devices in advance of the crossing.

Road narrowing

There are a number of ways to narrow roads, including providing kerb extensions, installing refuge islands, and widening footpaths by narrowing or even removing lanes. Although a high-cost intervention, treatments that include widening footpaths have the additional benefit of providing higher quality facilities for pedestrians. Road narrowing has a double benefit of reducing both vehicular traffic speeds and pedestrian crossing distances. The safety impact of road narrowing varies depending on the treatments used. For example, provision of refuge islands could be expected to reduce crashes by around 40% (*5*).

4.2.3 Improving the visibility of pedestrians

A high percentage of pedestrian collisions and deaths occur when lighting conditions are low (see Module 1). There are a number of engineering and behavioural measures that make pedestrians more visible to motorists, especially during dusk, dawn, and at night (*2–4*). These measures include:

- Providing crossing enhancements such as raised crossing islands and traffic signals.
- Implementing lighting and/or crossing illumination measures. Increasing intensity of roadway lighting increases visibility of pedestrians at night, especially at pedestrian crossings. This intervention has been associated with significant reductions in night-time pedestrian crashes. For example, a study conducted in Australia reported a 59% reduction in pedestrian crashes following improvement in roadway lighting (*3*).
- Removing or repositioning physical objects that affect visibility, such as trees and billboards that make it difficult for drivers to see pedestrians. Alternatively,

kerb extensions can be used to safely place pedestrians in a more visible location prior to crossing and to provide better sight lines to observe traffic. These have the additional advantage of reducing the crossing distance for pedestrians and narrowing the roadway, which may slow vehicle speed.

- Installing signals to alert motorists that pedestrians might be crossing. Pedestrian-activated signals may be appropriate at locations with sporadic pedestrian traffic (*28*).
- Improving conspicuity of pedestrians. Pedestrians need to be aware that drivers may not see them in low light or dark conditions, especially when they are wearing dark clothing. Selecting light-coloured clothing as well as adding reflective materials to backpacks, shoes and clothing are basic measures to increase visibility of pedestrians (see Box 4.6).
- Raising awareness among pedestrians and drivers, through public service announcements and other media, about the importance of pedestrian visibility, especially at night.

BOX 4.6: **Advocating for increased visibility of school children on roads in Ghana and the United Republic of Tanzania**

The nongovernmental organization Amend advocates for increased visibility of children on Africa's roads. At its project sites in Ghana and the United Republic of Tanzania, Amend is involved in the social marketing of its "See & Be Seen" reflector-enhanced school bags. The school bags are made to be durable and affordable while making children more visible as they walk to and from school. Amend advocates that governments and school systems encourage the use of these school bags, and promote their purchase, in particular by parents of school-age children, through social marketing campaigns. Amend manufactures, distributes and retails the school bags, but this life-saving advocacy need not be resource-intensive: any nongovernmental organization can lobby governments, parents and the media to promote the use of reflectors and other visibility enhancements, such as wearing light-coloured clothing – a very simple measure that has been shown to increase pedestrian visibility dramatically.

Source: *29*.

4.2.4 Improving pedestrian and motorist safety awareness and behaviour

Changing the attitudes and behaviour of drivers and pedestrians is a complex, long-term undertaking that requires a variety of interventions to be implemented. Measures commonly used to raise awareness and modify behaviour are discussed in the following sections. These measures are most effective when implemented alongside other measures described in this module such as speed management and reducing pedestrian exposure to vehicular traffic.

Education, outreach and training

Safe road-user behaviour and a reduction in pedestrian fatalities depend not only on knowledge and skills but also on community support, perception of vulnerability and risk, social norms and models, engineering measures and law enforcement (*1,4*). It is therefore important for practitioners and decision-makers to remember that road safety education is an adjunct to other measures, rather than a stand-alone intervention.

Road safety educational programmes may include the following:

- Raising awareness. This can include informing drivers about care, prudence, kindness, consideration, speed, pedestrian right-of-the way and traffic rules;
- School-based education. Such programmes help children acquire knowledge and skills for pedestrian safety (*30*). While these are important life skills and all children should be taught the rules of the road, school-based traffic education will only result in reduced pedestrian collisions when combined with other interventions.
- Outreach. The school–home journey is a point of considerable exposure and risk for children. An important question to consider is when – what time of the day, which day of the week, and which month of the year – children are most at risk. Child pedestrians walking alongside or among vehicular traffic are at risk for many reasons: they often lack the ability to distinguish between safe and unsafe crossing gaps and sites, putting them at risk as they cross the road; they themselves may be distracted or are at risk from distracted drivers using their mobile phones (*31*). One strategy to improve the safety of school-going children is the use of a walking school bus (see Box 4.7).

BOX 4.7: **Walking school bus**

Originally developed in Australia, walking school buses typically have one adult leading a parade of children, while a second adult follows the group. In the middle is a line of children who are 'walking' on the 'bus'. The bus crosses a community, picking up children at their homes and arriving at a school. It takes the reverse route after school. Studies indicate that walking school buses are effective ways to maintain children's safety and also promote an active community and physical exercise (32). Beyond safer transportation to school, children gain some minutes of walking exercise per day, which is useful for their health (33).

The walking school bus concept has been implemented in many countries around the world including China, the Philippines, the Republic of South Africa, the United States and the UK. The walking school bus has a number of challenges. The first challenge is the practicality of sustaining these programmes, which rely on volunteers (34). A second challenge is that walking school buses are easier to use on the way to school, but do not seem to work well for the return trips as children leave at different times. The third challenge is that these schemes tend to concentrate in high-income neighbourhoods, and not in areas with high levels of deprivation and greater risk for children (32).

- Mass media campaigns. These can be used to inform the public about pedestrian safety legislation, risk factors, impact of collisions and solutions available. Targeted and planned mass media and social marketing campaigns informing the public about pedestrian safety laws and risk factors are necessary to improve driver and pedestrian behaviour and enhance understanding of traffic issues such as traffic signs and right-of-way for all road users (*28*). Information alone is rarely sufficient to bring about changes in road user behaviour; communications should be supported by strong legislation, including targeted law enforcement operations (see Box 4.8).

BOX 4.8: **Prioritizing pedestrian safety measures in the Western Cape Province, South Africa**

The Provincial Government of the Western Cape of South Africa is implementing a road safety initiative known as *Safely Home*. The provincial government has set itself a target of reducing road traffic fatalities by 50% between 2009 and 2014 (*35*). The majority of these fatalities affect pedestrians and cyclists – 48% in the province and as high as 68% in urban areas. The pedestrian safety component of the *Safely Home* initiative builds on previous efforts such as the pedestrian safety action plan developed in 2000, other road safety activities and non-motorized transport programmes.

The city of Cape Town has a non-motorized transport committee that meets monthly to discuss and plan issues affecting this mode of transport. The Cape Town Freeway Management System also takes measures to improve pedestrian safety on the freeways based on video surveillance. Each of the districts in the province has specific pedestrian activities such as the promotion of wearing reflective bands and scholar patrols at schools.

In 2010, the provincial government commissioned a study to establish a baseline to help assess medium- to long-term strategy effects of interventions (*35*). The study generated a comprehensive review of key safety and traffic-calming measures that could be implemented (*20*). It also identified 16 specific actions to be pursued, a number of which are relevant to pedestrian safety. For example improved data collection and processing; auditing road markings and speed limits; analysis of hazardous location data; awareness raising and improved enforcement. In 2012, the provincial government commissioned a study to identify the six most hazardous pedestrian locations in the Western Cape Province in order to make proposals to mitigate the situation at each location (*36*). The sites have been identified and specific measures recommended.

Measures being implemented under the *Safely Home* initiative are:

- Introducing speed cameras along hazardous sections of provincial roads.
- Establishing anti-drinking and driving operation rooms, known locally as shadow centres, on the outskirts of Cape Town. The centres conduct immediate breath alcohol analysis near the location and therefore offer a greater chance of intervention, in an effort to reduce the incidence of drinking and driving.

Continued…

Continued from previous page

- Publishing a monthly 'name and shame' list of individuals and their home towns, for all drinking and driving convictions, in local and provincial newspapers.
- Conducting public awareness ("Crash Witness") campaigns using footage of serious crashes on YouTube.
- Using closed-circuit television images as evidence to strengthen enforcement at railway level crossings, which are sites for pedestrian fatalities in the province.
- Encouraging the public to report reckless driving, especially by public transport operators, using social media platforms such as Facebook, Twitter and Mxit.
- Providing pedestrian overpasses at two high-incidence locations.
- Conducting random inspection of vehicles and drivers.

The initial efforts have led to a 29% reduction in road fatalities in about three years (35). While availability of data has been identified as a major limitation for the evaluation of trends in road traffic fatalities in the province, it is hoped that the existing database systems and those that have been recommended for improvement or development will be useful for evaluating this initiative as implementation progresses. The initiative shows how pedestrian safety can be prioritized within an overall road safety programme.

Traffic law enforcement

Traffic laws affecting pedestrian safety are largely aimed at controlling pedestrian and driver behaviour at intersections, crossings and other locations (*28*). Comprehensive legislation is a key element of pedestrian safety, but legislation alone is not likely to facilitate behaviour change in the absence of law enforcement and adequate penalties. Driver and pedestrian compliance with laws critical to pedestrian safety – such as legal vehicle speed limits, drinking and driving regulations, red-light signal compliance and pedestrian traffic control signals – are motivated in part by the perceived risk of detection, i.e. law enforcement, and in part by the perceived severity of the penalties (*1*).

Failure of motorists to obey posted speed regulations contributes substantially to pedestrian collisions and injuries. High pedestrian use areas may be identified and associated with a lower speed limit. In addition to enforcement of speed limits by the police, there are also physical measures related to the road and the vehicle that need to be implemented, for example speed bumps, which contribute to compliance with maximum posted speed limits (see Section 4.2.2). Consistent and highly visible law enforcement operations through a mix of visible patrols and fixed cameras are therefore essential (*18*). Similarly, pedestrians should also follow regulations such stopping when the traffic light is red for vehicles to move on.

Alcohol-impaired drivers and pedestrians create injury risk for themselves and other road users. Strict legislation and complementary activities that can help reduce pedestrian road traffic injuries related to alcohol include the following (*4,18*):

- Conducting mass media campaigns on drinking and driving, including informing the public about drinking and driving regulations and penalties.
- Setting and enforcing BAC limits for the general driving population (0.05g/dl) and lower limits for young and inexperienced drivers.
- Setting and enforcing minimum drinking-age laws.
- Regulating and enforcing laws on availability of alcohol.
- Enforcing BAC limits through random breath testing and sobriety checks, and implementing penalties for offenders.
- Enforcing laws on being drunk in public places, which will cover drivers, pedestrians and other members of the public.
- Conducting briefing interventions for injured people who come into emergency rooms with alcohol-related problems, including pedestrians, drivers and other patients.
- Rehabilitating high-risk offenders, that is, those with BAC levels in excess of 0.15g/dl.

4.2.5 Improving vehicle design for pedestrian protection

Motor vehicles have become increasingly safer for occupants, due to improvements in vehicle design. Until recently, vehicle design incorporated few features to protect pedestrians, but there is an increasing effort to include design elements that reduce the likelihood of pedestrian collision and/or reduce the severity of pedestrian injury in the event that a vehicle–pedestrian crash does occur.

Collision prevention by vehicle design

The vehicle feature 'Brake Assist' improves emergency braking ability and reduces the chance of collision. Brake Assist activates when a sensor detects an emergency situation, indicated by unusually fast brake pedal actuation and/or unusually hard pressure on the brake pedal. Brake Assist, which is now fitted as standard to most new cars, can prevent some collisions with a pedestrian or at least reduce the impact speed of a collision. An evaluation conducted in France concluded that cars equipped with Brake Assist had a 10% lower involvement in pedestrian fatalities than cars without Brake Assist (*37*).

Brake Assist only activates, however, if the driver attempts to brake, which may not happen if the driver does not perceive a risk. In 45% of fatal pedestrian collisions in Adelaide, Australia, for example, drivers reported that they took no evasive action, typically because they did not see the pedestrian before impact, or realize that a collision was likely (*38*).

Autonomous Emergency Braking (AEB) is a more recent development in pedestrian-protective vehicle design. Cars with AEB have sensors, usually mounted behind the

grille and/or high behind the windscreen, that scan the road and roadside ahead of the car. If the sensors detect a risk of collision with a pedestrian (or vehicle) in front of the car, the driver is warned and/or the brakes are automatically applied. AEB has only a modest market penetration at present, but this is likely to increase rapidly with the demands of European New Car Assessment Programme (Euro NCAP) and similar programmes. As with all new technologies, it will be several years before vehicles with such systems begin to noticeably affect overall crash numbers (*39–41*).

Injury control by vehicle regulation and safety rating

The New Car Assessment Programme (NCAP) concept was developed in the late 1980s by the National Highway Traffic Safety Administration in the United States to assess and publicize levels of occupant protection provided by new cars. NCAP creates vehicle safety ratings for new vehicles based on crash test data and assessment of safety features. The programme is intended to inform consumers about vehicle safety and influence consumer behaviour in a way that encourages vehicle manufacturers to improve vehicle design. NCAPs have since been established in Europe, Australia and New Zealand, Japan, the Republic of Korea and Latin America, and also by the Insurance Institute for Highway Safety in the United States (*42*).

Since 2000, the NCAPs in Europe, Australia and Japan, and more recently in the Republic of Korea, have introduced pedestrian safety assessments based on pedestrian impact test procedures originally developed by the European Experimental Vehicles Committee Working Group in the 1980s (*42,43*) (see Box 4.9). The European and Australian NCAPs have recently incorporated the pedestrian safety score into the overall NCAP safety rating for a vehicle. These NCAP programmes have had a greater influence on vehicle design improvements for pedestrian safety than formal regulations, which are much slower to develop than the market forces that drive decision-making by vehicle manufacturers.

Some regulation of vehicle design for pedestrian protection has been introduced in Europe and Japan. More recently a Global Technical Regulation (GTR) for pedestrian protection has been issued by the United Nations World Forum for Harmonization of Vehicle Regulations (United Nations Economic Commission for Europe Working Party 29), after extensive debate over criteria to be used in mandatory vehicle regulations for pedestrian safety. The crash test criteria of the GTR are less stringent than corresponding NCAP requirements but compulsory compliance with the GTR would be likely to facilitate improvements in current vehicle design (*44*). Many vehicles currently in circulation would fail even the minimum standard that it sets. Once the minimum standard is increasingly met in new vehicles, the requirements of the GTR can be revised so that they are more closely aligned with NCAP requirements. There is also a strong case for assessment of pedestrian protection to be based on integrating the effects of collision detection and injury mitigation systems (*45*).

BOX 4.9: **Crash test procedures to assess pedestrian safety**

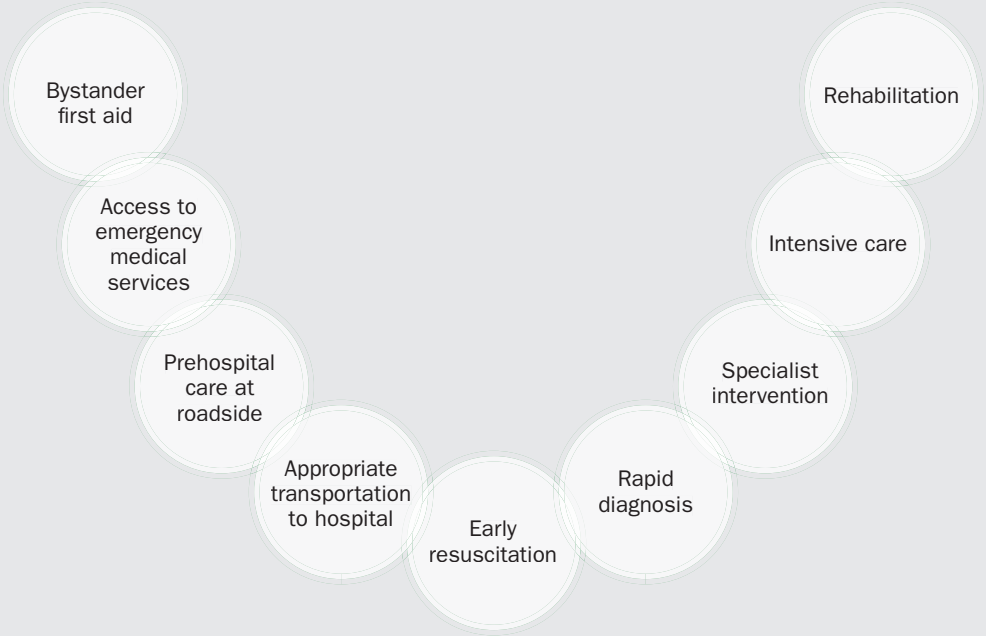
Test procedures to assess the extent to which a vehicle protects a pedestrian in the event of a collision are now well established in both regulation and consumer advisory programmes (*46*). Unlike impact tests to assess the protection of car occupants, which utilize full-scale crash test dummies, the pedestrian crash tests simulate impact between the car and the legs, hip and head of the pedestrian. This is largely because of difficulties in ensuring repeatability in full-scale collisions between a pedestrian dummy and a car, as well as concerns about the ability of a full-scale pedestrian crash test dummy to be life-like in appearance or responses (*47*). Current pedestrian impact test procedures are largely based on specifications presented by the European Experimental Vehicles Committee (EEVC) Working Group in 1987. In particular, 40 km/h was chosen as the vehicle test speed because it was thought in 1982 that it was representative of impact speeds resulting in serious injury to the pedestrian and some doubt about the ability of car designers to satisfy the test requirements at higher speeds (*48*).

4.2.6 Providing care for injured pedestrians

The primary goal in pedestrian safety should be to prevent road crashes from happening in the first place. However, pedestrians do get injured, despite the best efforts and intentions. An efficient post-crash care response can minimize the consequences of serious injury, including long-term morbidity or mortality. Pedestrians struck by motor vehicles with high energy transfer end up with high residual locomotion disability and also have significantly higher mortality rates than occupants of vehicles (*49*). Injury patterns in pedestrians are unique – in adults injuries to legs, head and pelvis are common. In children, injuries to head and neck followed by musculoskeletal injuries are commonly noted. In general, head injuries are more life-threatening while limb injuries are associated with long-term disabilities. The severity of these injuries depend upon many factors, including energy transfer (speed of the vehicle), angle of impact, the body part that first comes into contact with the vehicle and vehicle design (see Module 1). The considerations for organization and delivery of post-crash care should take into account these factors (*50*).

Post-crash care includes a sequential set of actions and care aimed to reduce the impact of injury consequences once a road traffic crash has occurred (see Figure 4.1). Patients suffering minor injuries may not need advanced medical care or hospitalization. For victims of major injuries, a chain of care is needed, consisting of action taken by bystanders at the scene of the crash, access to the pre-hospital medical care system, emergency medical services, definitive trauma care at the hospital and rehabilitation services to re-integrate the victims into work and family life. The effectiveness of such a chain and the outcomes of the injured depend upon the strength of each of its links (*51*). In a fully developed trauma system, trauma care delivery is organized through its entire spectrum, from injury prevention to pre-hospital, hospital and rehabilitative care for the injured pedestrian and other road users in an integrated way.

Figure 4.1 The chain of trauma care for injured pedestrians



Source: adapted from the Life Saving Chain (see reference 52)

Pre-hospital care

The majority of deaths from road traffic injuries occur prior to the patient reaching a hospital. Timely pre-hospital care and prompt transportation to an appropriate health facility or trauma centre are crucial to the outcome of injured pedestrians. Many high-income countries have developed complex and expensive systems for providing emergency medical care. A formal emergency medical service (EMS), easily accessed through an emergency telephone number, is in place, especially in urban areas, to offer pre-hospital care by professionally trained staff. The injured patient is transported by ambulance equipped with monitoring devices, a wide range of medicine and wireless communication, that is staffed by a physician or non-physician paramedics to render advanced pre-hospital trauma care. The goal of such a service is to quickly identify and treat life-threatening injuries until the patient arrives at a definitive care centre. Triage and direct transfer to a trauma centre has been shown to reduce mortality rates among severely injured patients, including pedestrians (*53*). In many communities, bystanders and other first responders such as police, rescue workers and firemen are trained in first aid to help such victims before the medical help arrives at the scene.

It should be noted that a majority of the world's population does not have access to such an advanced level of pre-hospital care. In many countries, few victims receive

treatment at the scene of the crash and fewer still can get transported to the hospital in an ambulance. As a result, many victims may needlessly die at the scene or during the first few hours following an injury. There are several ways to strengthen the pre-hospital care system in resource-constrained settings by building on existing systems and harnessing community resources. Many countries have trained commercial drivers, community workers and other groups to offer the post-crash care to injured pedestrians with varying degree of success. The strategy to create emergency rescue systems should aim at ensuring availability and use of equipment, supplies and organizational structures to create an effective and adaptable pre-hospital care system for injured people (*54*).

Hospital-based trauma care

An injured person will benefit most if he is promptly brought to an appropriate hospital for definitive care of injuries. Through a process of triage, the pre-hospital care providers can direct the patients to an appropriate hospital that is equipped to deal with the injuries sustained. Pedestrians often sustain 'polytrauma' or multiple injuries and consequently will have better outcomes if treated at trauma centres with full capabilities to deal with such patients. Many high-income countries have designated hospitals or trauma centres with adequate physical resources and trained health care staff to treat injured patients. Such an approach has shown to improve the outcomes of the injured in several high-income countries (*55*). The *Advance Trauma Life Support (ATLS) Guidelines* of the American College of Surgeons have standardized approaches to severely injured patients and implementing such

guidelines in treating the injured has shown to improve patient survival (*56*). Training health care staff involved in care of the injured in such protocols is important, and is a mandatory requirement in many countries. Major trauma resuscitation should be a team effort where each trained team member has a designated role in management of the patient. Such trauma teams have been shown to lead to significant reductions in resuscitation times (*57*). Improvements in hospital-based care do not necessarily require expensive technology or equipment. Trauma care can also be achieved in an affordable and sustainable way by imparting training, better organization, planning and simple quality improvement programmes (*58*).

Rehabilitation

Many of those who survive injuries are left with physical disabilities that limit their mobility and function (see Box 4.10). Many of these consequences are avoidable and can be minimized by early, multi-disciplinary rehabilitation services. Rehabilitation services are an essential element of trauma care and should be made available to those who need them. There is an increasing trend to offer all the above services to the injured in an integrated manner, through an inclusive trauma system, which is a comprehensive injury response network that includes all facilities with capabilities to care for the injured. For example, the United States has a vision of a future trauma system that is intended to enhance community health through an organized system of injury prevention, acute care and rehabilitation that is fully integrated with the public health system in a community. It is anticipated that trauma systems will possess the ability to identify risk factors and related interventions to prevent injuries in a community, and will maximize the integrated delivery of optimal resources for patients who ultimately need acute trauma care. It is hoped that trauma systems will address the daily demand of trauma care and form the basis for disaster preparedness. The resources required for each component of a trauma system will be clearly identified, deployed and studied to ensure that all injured patients gain access to the appropriate level of care in a timely, coordinated and cost-effective manner (*59*).

Countries should also be prepared to deal with those who are injured by reducing their consequences and enhancing their quality of life. The way in which injured pedestrians are dealt with following a road traffic crash determines their chances and the quality of survival. The three components of care outlined above – pre-hospital, hospital and rehabilitation – are interrelated and form a chain of care.

BOX 4.10: **Pedestrians with disabilities**

People with disabilities make up 15% of the world population (*60*) but it is unclear what proportion of these are the consequence of pedestrian collisions. What is known is that, in general, injury rates are higher among disabled children and adults (61–64). For example:

- A United States study found that children with disabilities were more than five times as likely to have been hit by a motor vehicle as a pedestrian or cyclist than children without disabilities (*64*).
- A New Zealand study found that children with abnormal vision were four times as likely as other children to have a pedestrian injury, and that children with abnormal hearing were twice as likely to have a pedestrian injury (*65*).

In addition, people with disabilities, like other road users, may experience anxiety and stress when travelling on roads without adequate crossings or when using personal assistive devices (*66, 67*).

The risk for pedestrians with disabilities is elevated because of the following reasons (*64*):

- People with mobility impairments may cross roads more slowly and may be more at risk for falls if sidewalks or road surfaces are uneven.
- Wheelchair users will be disadvantaged if kerb cuts are lacking or if accessible routes are lacking, and may find it harder to dodge traffic.
- People who have sight or hearing loss may not be able to anticipate and avoid other road users.
- People with intellectual disabilities may be unable to make good judgements about safety – knowing when it is safe to cross the road – or may behave in unpredictable ways.

Environmental changes are likely to reduce vulnerability of people with disabilities to road traffic injury (*64*). For example, tactile paving can alert visually impaired people to the edges of steps and pavements, and indicate safe crossing places. Emerging research has shown some ways to better provide road safety facilities for pedestrians with disabilities. Participative research in Papua New Guinea, for example, explored the views of local road decision-makers and people with disabilities about road planning in rural and urban areas, with the aim of promoting inclusion of people with disabilities in road planning. This action research has led to a greater awareness and partnership (*68*). Research in the UK has investigated road safety experiences of deaf people – including drivers and pedestrians – and recommended measures to improve their safety and the police response to their needs (69, 70). However, more research is needed on the risk of injury to people with disabilities and appropriate prevention strategies.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The *World report on disability* highlighted the importance of accessibility. The basic features of access should include (*61*):

- provision of kerb cuts or ramps;
- safe crossings across the street, with signalling that can be detected by people with sight or hearing loss, and crossing periods that enable people with mobility impairments to cross;
- accessible entries to buildings;
- an accessible path of travel to all spaces; and
- access to public amenities, such as toilets.

4.3 Summary

The content of this module can be summarized as follows:

- Effective interventions to improve pedestrian safety are available. Implementation should utilize a comprehensive approach that focuses on engineering, enforcement and education measures. Taking a single approach will usually be less effective. A combination of measures is needed in order to comprehensively address the range of risks to pedestrians in different settings.
- Interventions that have been found effective are reducing vehicle speeds, separating pedestrians from other traffic, increasing the visibility of pedestrians, changing pedestrian and motorist behaviour through public education and law enforcement, improving vehicle design and improving care for the injured.
- Pedestrians should be seen as a group with diverse needs and capabilities. The needs of special pedestrian groups such as children, the elderly and disabled people need to be prioritized when designing and implementing measures.
- The case studies provided highlight several key elements for success:
  - ▹ the importance of political leadership at multiple administrative levels;
  - ▹ the involvement and contribution of multiple stakeholders;
  - ▹ the need to plan and allocate resources;
  - ▹ the necessity of setting targets;
  - ▹ the role of sustaining efforts over a long period of time;
  - ▹ the importance of implementing effective interventions; and
  - ▹ the need for evaluation (see Module 5).

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5

Evaluating pedestrian safety programmes

Evaluating pedestrian safety programmes

Module 4 provided a comprehensive overview and examples of the key interventions that can be implemented to improve pedestrian safety, emphasizing the need to integrate engineering, enforcement and educational approaches. This module goes on to discuss how to evaluate their impact as well as advocate for pedestrian safety.

The module is divided into two sections:

5.1 Evaluating pedestrian safety interventions: This section provides key principles for evaluating pedestrian safety interventions. It discusses the importance of planning in advance of evaluation and provides examples of indicators that may be used for process, output and outcome evaluation of pedestrian safety interventions.

5.2 Advocating for pedestrian safety: This section presents key principles and examples of pedestrian safety advocacy. It emphasizes the need for a strategic approach that includes a sustained effort over a period of time, prioritizing focal areas, building coalitions, promoting evidence-based solutions and reviewing progress.

5.1 Evaluating pedestrian safety interventions

Evaluation is a critical component of pedestrian safety interventions. A thorough evaluation, properly implemented, measures the effectiveness of the programme and assesses whether the desired outcomes are being achieved. It can enable the identification of success as well as constraints, and provide insights on how to adjust programmes so that targets are achieved. The results of evaluation are key inputs for decision-makers involved in pedestrian safety programmes. They also provide the content for dissemination and improvement of ideas and initiatives, and contribute to international learning.

There may be some variation in the specific ways different agencies plan, choose evaluation methods and disseminate results, but the basic principles to bear in mind on evaluation of pedestrian safety programmes remain the same (*1*):

Plan the evaluation. Ensure that monitoring and evaluation are included in any pedestrian safety plan (see Module 3), strategy or intervention at the national or local level. It is better to plan for evaluation from the beginning rather than doing so once implementation has begun. Determining the aims of evaluation, type of evaluation and indicators to adopt during the planning phase of a programme will improve the ultimate quality of the evaluation.

Identify existing monitoring and evaluation activities in your setting, and the agencies that are responsible for these activities. This exercise helps with identification of relevant existing data and can develop partnerships with the existing agencies in monitoring and evaluation. Collect baseline data using surveys and existing databases if they exist.

Identify suitable indicators to monitor processes, outputs and outcomes. Table 5.1 presents a list of three main categories of indicators for monitoring and evaluating pedestrian safety programmes. You are encouraged to also look back at Module 3 that presented a number of indicators on which data can be collected to monitor and evaluate progress in pedestrian safety programmes.

Table 5.1 Indicators for evaluating pedestrian safety programmes

Type of indicator	Purpose	Examples
Process	To assess progress in the process of change, in order to show how the programme or activity has been implemented or executed	• Setting up a working group • Conducting a situational assessment • Preparing a pedestrian safety plan • Prioritizing pedestrian safety in national and local policies and programmes • Implementing a plan of action
Output	To measure outputs or products that are attributable to the programme processes	• Publishing and disseminating a pedestrian safety plan • Officially launching a pedestrian safety plan • Endorsement of a pedestrian safety plan by national or local government • Allocating human and financial resources to a pedestrian safety plan • Securing space for sidewalks
Outcome	To measure the ultimate outcomes of implementing various activities	• Increase in knowledge and awareness about risk factors for pedestrian injury • Change in behaviour: speed, drinking and driving, street crossing and yielding at pedestrian priority points • Reduction in pedestrian fatalities and injuries

Conduct the evaluation consistently, as planned. Once the appropriate evaluation design and methods have been specified – with respect to the unit of analysis, population, sample, and methods of data collection and analysis – conduct the evaluation according to those methods. Data for evaluation can be collected by examining existing databases as well as conducting surveys, observations, testing of BAC in drivers and pedestrians, road safety audits and perception assessments (see Box 5.1). Many of the methods used for the situational assessment (see Module 3) are also applicable to evaluations.

Use evaluation results to improve the programme, and inform the public and other stakeholders about successes or failures (see Box 5.2). The results of the evaluation need to be disseminated, discussed and used by programme staff, government, public and sponsors of pedestrian safety initiatives. These different groups need to consider what the programme can do better and what it can avoid in order to improve pedestrian safety in the setting of focus.

BOX 5.1: **Pedestrian overpass on a major highway in Kampala, Uganda**

Over 40% of people killed in road traffic crashes in Uganda in 2010 were pedestrians (*2*). Though walking is a dominant mode of transport in most African countries, road infrastructure facilities for pedestrians are generally inadequate or underdeveloped in both urban and rural areas (*3,4*).

In an effort to address the safety of pedestrians, an overpass costing approximately US$ 100 000 was constructed at Nakawa Trading Centre, approximately six kilometres from Kampala city centre (*5*). This busy trading centre with many small retail shops, industries, a sports stadium, offices, low-cost residential estates and schools is on the Kampala–Jinja highway. The overpass was built in August 1998, when there was a heightened sense of the importance of road safety because the Road Safety Act had just been enacted and several crashes at the location provoked public outrage.

An evaluation of the overpass conducted in 2002 revealed the following results (*5*):

- Just over one third of pedestrians used the overpass. Users were mostly female (49%) and children (79%). The low usage of the overpass reflected some of the design flaws, as well as the position of the overpass, which raised security concerns among users. Respondents were concerned that the overpass was untidy, poorly lit and that children loitered on it. Most pedestrians found the overpass to be inconvenient and difficult to access. Consequently, many pedestrians could be seen crossing the road through motorized traffic. No changes appeared to have been made to the overpass by July 2012.
- While the number of pedestrians killed dropped from eight to two after it was constructed, the number of pedestrians seriously injured increased from 14 before construction to 17 afterwards.

The mixed outcomes associated with this isolated intervention indicate the need for a comprehensive approach to pedestrian safety. Other measures such as reducing and enforcing vehicle speeds, providing raised crossings, providing sidewalks and raising awareness about these measures would have complemented the overpass.

Box 5.2: **Sustained implementation and evaluation of pedestrian safety measures in New York City**

New York City is known for improvement in pedestrian safety in particular, and road safety in general (6). A major factor in the declining pedestrian fatality rate in New York City is continued implementation of safety measures and evaluation of their performance. The annual pedestrian fatality rate declined steadily from 5.8 deaths per 100 000 population in the 1950s to 2.0 per 100 000 population in the decade 2000–2009 (7).

The recent pedestrian safety efforts in the city demonstrate the importance of a comprehensive approach to pedestrian safety. In 2008, aiming to sustain or accelerate the decline in pedestrian fatality, the Department of Transportation of New York City set a target of reducing annual road traffic fatalities by 50% from 2007 levels by 2030, that is, from 274 to 137. Data revealed that pedestrian fatalities made up 52% of all road traffic fatalities in New York City in the period 2005–2009. Pedestrian safety was therefore identified as a key area for improvement.

To develop an effective pedestrian safety strategy, more than 7000 severe and fatal pedestrian injury crashes in New York City were analyzed, to identify the causes, risk factors and spatial distribution of these crashes. The analysis revealed the following (7):

- Pedestrians were ten times more likely to die than motor vehicle occupants in the event of a crash.
- Driver inattention was cited in nearly 36% of crashes resulting in pedestrians being killed or seriously injured.
- 27% of crashes that killed or seriously injured pedestrians involved driver failure to yield, while turning at an intersection.
- Unsafe speed and limited sight distance were cited as risk factors in 21% of fatal and serious pedestrian crashes.
- 8% of all fatal pedestrian crashes involved a driver who had been drinking. However this may be an underestimate since data suggest that drivers leave the scene in about 21% of the fatal and serious injury crashes.
- 80% of crashes that killed or seriously injured pedestrians involved male drivers.
- Most residents of New York City did not know that the standard speed limit for city streets is 30 km/h.
- 47% of pedestrian fatalities occurred on major two-way streets in Manhattan, a borough that contains the region's two largest business districts.
- 74% of pedestrian crashes occurred at intersections, with 47% of pedestrian fatalities and severe injuries occurring at signalized intersections and 57% of the crashes taking place while the pedestrian was crossing with the signal.

- 79% of the crashes that killed or seriously injured pedestrians involved private vehicles as opposed to taxis, trucks and buses.
- Senior pedestrians (over 65 years old) accounted for 38% of all pedestrian fatalities and 28% of severe injuries.
- Manhattan had four times as many pedestrians killed or severely injured per mile of street compared to the other four boroughs.
- 43% of pedestrians killed in Manhattan lived in another borough or outside of New York City.
- 40% of pedestrian crashes occurred in the late afternoon and/or early evening.
- Late night pedestrian crashes were nearly twice as deadly as other time periods.

The New York City Department of Transportation formulated a pedestrian safety action plan involving other key agencies such as New York City Police Department, New York City Department of Health and Mental Hygiene, and New York State Department of Motor Vehicles. The action plan focuses on a combination of highly targeted engineering, enforcement and education/public information measures. Implementation began immediately, starting with strengthening already existing actions. Many measures set out in the plan that have been implemented already include:

- redesign of 30 kilometres of high-crash corridors annually;
- installation of pedestrian countdown signals at 1500 intersections;
- implementing 75 additional 30km/h hour school speed zones;
- implementing Neighbourhood Slow Zones in several neighbourhoods citywide, where the speed limit will be reduced to 30 km/h; and
- conducting public information campaigns and enforcement targeting speeding along major corridors and intersections where drivers commonly fail to yield.

In addition to pedestrian safety measures, there are a number of other measures being implemented in order to reduce road traffic injuries and fatalities in general (6).

An evaluation of 13 recent safety measures implemented in New York City included pedestrian interventions such as all pedestrian phase, high-visibility crossings, increasing pedestrian crossing time, split-phase timing, pedestrian fencing, road diet (reduction in the number of travel lanes, with added turning lanes), speed hump and speed limit reduction (6). Split-phase timing, signal installations, high-visibility crossings, all pedestrian phase and increasing pedestrian crossing time were found to reduce pedestrian and total crashes by 25–51%. Measures with lesser effect were posted speed limit reduction signs, and middle block pedestrian fencing (6).

AFTER:

New York City Department of Transportation

5.2 Advocating for pedestrian safety

Even a locally tailored evidence-based plan of action is not a guarantee of lasting results once implemented. The natural order of many institutions is to resist change. When change is required to bring about greater equity and justice, considerable pressure may be needed to effect that change, especially when the issue or group in question traditionally has been overlooked. Advocacy or pressure groups can be key to creating conditions that foster policy and programme change (see Box 5.3). Advocacy seeks to raise awareness of an issue for the purpose of influencing the policies, programmes and resources devoted to it (*8*).

BOX 5.3: **Living Streets**

In 1929, a group of people became concerned about the rising tide of automobile use and the associated rise in deaths of people walking in the UK. They decided to take action and form the Pedestrians Association, which became Living Streets in 2001. This group has been the national voice for pedestrians in the UK throughout its history. In the early years, their campaigning led to the introduction of the driving test, zebra crossings, and 50 km/h speed limits. Today, they influence decision-makers nationally and locally, run projects to encourage people to walk, and work to create safe, attractive and enjoyable streets, where people want to walk. They have local groups throughout the country, and they get more than 1.6 million children involved in their 'Walk to School' campaign each year.

Advocacy for pedestrian safety takes many forms including (*9*):

- urging public officials to change policies, plans, and projects to be more accommodating to pedestrian safety and travel;
- promoting the importance of safe walking and creating broader demand for safe, walkable communities (see Box 5.4);
- providing expertise for the benefit of communities;
- urging community leaders or public officials to narrow streets, install walk signals and widen sidewalks;
- sponsoring neighbourhood walks to introduce the public to the benefits and joys of walking;
- testifying at hearings; and
- demonstrating in the streets to raise awareness of unsafe pedestrian walking routes.

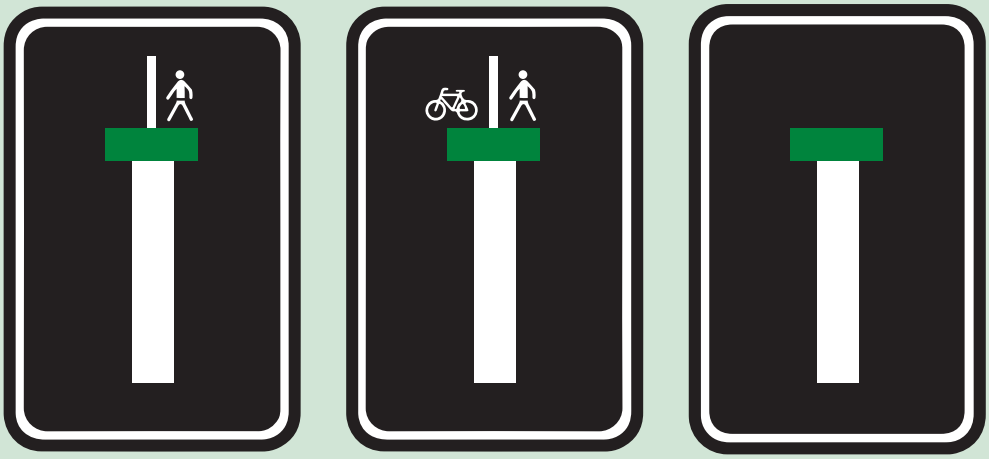
BOX 5.4: **'Living End Roads'**

The International Federation of Pedestrians (IFP) was founded in 1963 as the umbrella organization for national pedestrian advocacy groups. In 2005 IFP was reorganized with the support of the Swiss Pedestrian Association and a private foundation, and it is now a growing network of pedestrian associations from around the world, as well as other institutions and people interested in walking. The goal of IFP is to promote and defend the right to full access and mobility for people walking. To translate these goals into policies, IFP works towards preventing road traffic crashes and injuries.

IFP represents the interests of the pedestrian at the international level, working with agencies of the United Nations and the European Union, and cooperates with a wide range of nongovernment organizations. A long-term commitment by IFP in the past decades has been to represent the concerns of walking road users on technical committees of the United Nations Economic Commission for Europe. In recent years, the IFP has begun to undertake pilot projects such as the Living End Road project, which seeks to persuade jurisdictions to update their signage about 'dead end' roads where pedestrians or cyclists may go through.

The Living End Roads project builds on a frequent discrepancy in road signage: streets marked with a dead-end sign are often dead ends only for cars, while they may be the preferred and safer route for cyclists and pedestrians. IFP provides local pedestrian associations with a set of tools to help the municipalities make simple changes to the signs – where legally permitted – so that pedestrians and cyclists receive the appropriate information. While the direct output typically is a straightforward improvement in road signage, the real value of the Living End Road project is that it may encourage local traffic engineers to think 'outside the box' by taking the needs of pedestrians and cyclists more readily into account. Within the process, the pedestrian associations can position themselves as a partner of the municipality and part of the solution.

Source: *8*



Living end road (pedestrians)

Living end road (pedestrians and cyclists)

Dead end for all

How groups advocate depends partly upon the personal styles and skills of their leaders, as well as their political connections. Whatever the skills and strengths of the core group, the following six principles apply to most pedestrian safety advocacy efforts (*8,10*):

1. Make a long-term commitment: Change is rarely achieved overnight, and even in the best-performing countries it has taken years to achieve a decrease in pedestrian traffic fatalities. Advocacy for policy change on behalf of pedestrian safety entails seemingly endless hours of effort, including service on advisory committees, tracking and evaluating projects and plans, providing comments and testimony, and advocating for changes to standard operating procedures such as street design standards and crossing marking policies. Persistence and commitment in the long term are required for success.

2. Prioritize focal areas: Take a strategic approach by identifying and focusing on a few key priorities at once. Setting priority areas requires a good assessment of the road safety and political situation in the local setting (see Module 3). Instead of engaging in a broad range of activities that may not always yield results, it is better to target advocacy efforts carefully, to make the best use of the limited time and resources, in favour of the greatest potential gains. Advocacy groups must be realistic about what their staff and partners can achieve, and take on a limited number of projects each year, especially in the first years of operation.

3. Promote evidence-based solutions: It is critical to ensure that efforts are based on the best scientific evidence. Nongovernmental organizations should engage in an ongoing dialogue with road safety experts in order to stay informed about the latest knowledge and practice from the field and use that understanding to enhance ongoing research and activities. In certain settings, the best scientific evidence may contradict the common understanding, and nongovernmental organizations can play a role in resolving this conflict.

4. Utilize existing resources: It is helpful to make use of existing materials and resources in order to avoid duplication of effort. Many organizations offer materials that can be used to support national and local road safety initiatives. These should be tailored for relevant audiences and translated into appropriate languages.

5. Build an advocacy network: It is vital to engage with partners. Few nongovernmental organizations are able to succeed without the support of partners from government, academia, the private sector, foundations or agencies such as the police, fire department and medical services. They also gain by reaching out to other nongovernmental organizations to coordinate messages, support one another's activities and generate resources. The importance of engaging with partners, promoting similar actions and speaking as a community with one voice cannot be overstated.

6. Review progress regularly: While most advocacy efforts contribute to general awareness raising, targeted advocacy can most effectively contribute to concrete and measurable change. Even when an organization lacks the capacity to monitor

its programmes in detail, it is useful to make a conscious effort to identify some measures of success before activities begin. These measures should then be used to compare progress before and after the advocacy effort to determine if that effort needs to be redirected or redesigned in some way.

Advocacy groups can facilitate implementation of the measures presented in Module 4 by:

- raising awareness about pedestrian safety;
- drawing the attention of local and national governments to the need to prioritize pedestrian safety in policies and programmes;
- mobilizing action at the local level to implement pedestrian safety measures;
- generating public demand for pedestrian safety measures; and
- championing the safety rights of children, as well as elderly and disabled pedestrians (see Boxes 4.1 and 4.11).

5.3 Summary

The content presented in this module is summarized as follows:

- Evaluation is an integral component of implementation. It is necessary to plan for evaluation with regard to aims, objectives, evaluator, indicators, methods and dissemination of results. Evaluation planning should precede implementation.
- Advocacy groups can have a significant role in creating conditions that foster the implementation of pedestrian safety measures.

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A

Appendices

Appendices

Appendix 1
A comprehensive framework for safe walking: strategic principles

The *International Charter for Walking* provides a comprehensive framework for understanding the needs of people on foot and the actions to be undertaken to provide safe, sustainable, healthy and efficient communities where people choose to walk. Built on extensive discussions with experts around the world, the charter presents eight strategic principles, each with a practical list of actions that can be undertaken in most communities (*1*). An explanation of each of the eight principles follows:

- *Increased inclusive mobility*: People have accessible streets, squares, buildings and public transport systems regardless of their age, ability, gender, income level, language, ethnic, cultural or religious background, which strengthen the freedom and autonomy of all people, and contribute to social inclusion.
- *Well designed and managed spaces and places for people*: Healthy, convenient and attractive environments tailored to the needs of people, so they can freely enjoy the amenities of public areas in comfort and safety away from intrusive noise and pollution.
- *Improved integration of networks*: A network of connected, direct and easy to follow walking routes which are safe, comfortable, attractive and well maintained, linking homes, shops, schools, parks, public transport interchanges, green spaces and other important destinations.
- *Supportive land-use and spatial planning*: Land-use and spatial planning policies that allow people to walk to the majority of everyday services and facilities, maximizing the opportunities for walking, reducing car dependency and contributing to community life.
- *Reduced road danger*: Streets to be designed and managed to prevent crashes and to be enjoyable, safe and convenient for people walking – especially children, the elderly and people with limited abilities. This includes enacting and enforcing road safety laws.
- *Less crime and fear of crime*: An urban environment designed, maintained and policed to reduce crime and the fear of crime, giving people the confidence to choose to walk.
- *More supportive authorities*: Authorities provide for, support and safeguard people's ability and choice to walk through policies and programmes to improve infrastructure and provide information and inspiration to walk.

- *A culture of walking*: People are given opportunities to celebrate and enjoy walking as part of their everyday social, cultural and political life. This includes providing up-to-date, good quality, accessible information on where they can walk, how to stay safe and the quality of the experience to expect.

Reference

1. Walk21. *International Charter for Walking: Creating healthy, efficient and sustainable communities where people choose to walk* [website] (http://www.walk21.com/charter/default.asp, accessed 9 January 2013).

Appendix 2
Traffic-calming measures

This appendix provides a brief description of various vehicle speed management measures, with a particular focus on traffic-calming interventions to enable readers to distinguish their basic characteristics (*1, 2*). For the specification of design requirements, we recommend that guidelines approved in your jurisdiction are also consulted.

Chicane
A chicane consists of alternately placed kerb extensions into the street. This design creates a horizontal shift in traffic and narrows the roadway down either a single lane or two narrow lanes. Motorists are obligated to slow their speed to manoeuvre through the chicane. Good visibility for drivers and pedestrians can be maintained by either planting low shrubs or groundcover, or by using trees with high canopies. The design of a chicane must consider the needs of not just drivers but also pedestrians and cyclists. As in the serpentine street design (see page 113), chicanes must take into account driveway access and parking needs.

Choker
Chokers are kerb extensions that narrow a street by widening the sidewalks or planting strips. The street may be narrowed from two lanes to a single lane or to two narrow lanes. Motorists are obligated to slow and, in cases with just one lane, to stop to allow oncoming vehicles to pass. Chokers must be wide enough to accommodate emergency and sanitation vehicles.

Kerb extension
Kerb extensions, also known as 'bulbouts' or 'neckdowns', extend the sidewalk or kerb line out into the parking lane, thereby reducing the effective street width. These serve to shorten the pedestrian crossing distance, narrow the roadway, and improve the ability of pedestrians and motorists to see each other. Kerb extensions also prevent motorists from parking in, or too close to, crossings, or from blocking kerb ramps. Kerb extensions should only be used where there is a parking lane. Installation of kerb extensions should consider the special needs of larger vehicles (such as fire trucks and school buses) to turn including options for such vehicles to turn from the outer lane rather than the normal turning lane. Street furniture and landscaping on and near the kerb extension should be chosen carefully to ensure sight distance. Kerb extensions should also be designed to facilitate adequate water drainage.

Kerb radius reduction
A common type of vehicle–pedestrian collision occurs when a pedestrian is struck by a right-turning vehicle at an intersection in right-hand-drive areas (the opposite is true in left-hand-drive locations). Large kerb radii encourage motorists to make

right turns at higher speeds, increasing the risk to pedestrians. Reducing the kerb radius creates a tighter turn and results in motorists making right turns at lower, and therefore safer speeds. Other important benefits of reduced kerb radii are shorter crossing distances for pedestrians and improved sight distances between pedestrians and motorists. Larger kerb radii have been determined to be helpful for older drivers. They also are needed for safe turning by larger vehicles such as fire trucks, school buses, moving vans, and delivery trucks.

Mini-circle

Mini-circles are raised circular islands constructed in the centre of residential street intersections. Intended to reduce vehicle speeds by forcing motorists to manoeuvre around them, mini-circles may be appropriate at intersections where traffic volumes do not warrant a signal or stop sign. A series of intersections along a local street could be treated as part of a neighbourhood traffic improvement programme to improve pedestrian safety and also beautify the neighbourhood. Tight kerb radii should accompany mini-circles to discourage motorists from making high-speed turns. Mini-circles with cuts in 'splitter' islands make crossing easier for pedestrians, especially those in wheelchairs. Larger vehicles such as fire trucks and school buses, can be accommodated by creating a mountable kerb on the outer portion of the circle. Mini-circle landscaping should not block sight distance – groundcover, short shrubs, or trees with tall canopies may be used. Yield controls should be used.

Modern roundabout

A modern roundabout is built with a large, often circular, raised island located in the centre of the intersection of a street with one or more crossing roadways. Motorists enter the circle, travel around it, and then turn onto the desired street. All entering traffic yields to vehicles approaching from within the roundabout. A roundabout is intended to be applied where vehicular delay can be maintained at or below levels experienced by stop or signal controlled intersections. Because of this, they can sometimes be installed on two-lane roadways in lieu of a road widening to four lanes. Modern roundabouts can be relatively friendly to pedestrians if they have splitter islands on each approach to the roundabout and are designed to slow traffic prior to entering the roundabout. The splitter islands can serve as a refuge for pedestrians and make crossing safer. There is lingering concern, however, about safety for visually-impaired pedestrians at roundabouts. Accessible pedestrian signals and truncated domes placed at splitter islands can assist visually impaired pedestrians with gap selection and 'wayfinding'. In larger roundabouts, an off-road bicycle path may be used to allow bicyclists to use the pedestrian route.

Pedestrian refuge islands and raised medians

Raised pedestrian refuge islands, or medians, at crossing locations along roadways, provide another strategy to reduce pedestrian exposure to motor vehicles. Also called 'centre islands' or 'pedestrian islands', refuge islands and medians that are raised (i.e. not just painted) provide pedestrians with more secure places of refuge during street crossing. This simplifies the crossing manoeuvre for pedestrians by creating

the equivalent of two narrower one-way streets instead of one wide two-way street. Landscaping can be used on medians but should be chosen carefully to ensure adequate sight distance between motorists and pedestrians, including children, wheelchair users, and others with reduced sight distance. Design of raised medians must also consider vehicle turning movements carefully so that motorists do not travel on inappropriate routes, such as residential streets, or make unsafe u-turns. Raised median designs must also accommodate pedestrians with visual impairments through use of tactile cues at the border between the pedestrian refuge area and the motorized vehicle roadway and for pedestrians in wheelchairs through the use of kerb ramps or cut-throughs.

Raised intersections

Raised intersections are intended to slow all vehicular movements through an intersection. They are built by raising the entire intersection to the level of the sidewalk. The crossings on each approach may also be elevated, so that pedestrians cross at the same level as the sidewalk, without the need for kerb ramps. Raised crossings can be an urban design element through the use of special paving materials. Detectable warning strips mark the boundary between the sidewalk and the street for pedestrians with vision impairments.

Serpentine street

A serpentine street uses a winding pattern with built-in visual enhancements. These allow vehicles to move through slowly and prevent fast driving. Landscaping can be used to enhance visual appeal and create a park-like atmosphere. Serpentine street design needs to be coordinated with driveway access and parking needs. Serpentine streets offer many advantages, but are more costly than other equally effective traffic calming strategies.

Speed humps and speed tables

A speed hump is a rounded raised area placed across the roadway. Speed humps are generally negotiated easily on bicycles and should be built through any bicycle lanes present on the roadway so that motorists do not swerve into the bicycle lane to avoid the hump. Flat-top speed humps are also referred to as speed tables.

Woonerf

Woonerf is a Dutch word that translates as 'living street'. Typically used on residential streets, a woonerf is a space shared by pedestrians, bicyclists, and low-speed motor vehicles. It is usually constructed with a narrow width and without kerbs or sidewalks. Vehicles are slowed by placing trees, parking areas and other obstacles in the street. Along with improving pedestrian safety, a woonerf creates a public space for social and possibly commercial activities, as well as a play area for children. A woonerf identification sign is placed at each street entrance. A woonerf must be constructed to allow access by emergency vehicles, school buses, and other service vehicles.

References

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