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PREVENTING ROAD TRAFFIC INJURY: A PUBLIC HEALTH PERSPECTIVE FOR EUROPE

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Abstract

Road traffic injuries in the WHO European Region represent a major public health problem. About 127 thousand people are killed and about 2.4 million injured every year. The cost of road traffic injuries to society is an estimated 2% of a country's gross domestic product. About one third of the victims are aged 15–29 years. Nevertheless, effective preventive strategies exist and need to be applied through multisectoral approaches, and the health sector has a unique role to play. This publication has been prepared for World Health Day 2004 to raise awareness among the general public and enhance commitment among policy-makers to take immediate action towards preventing road traffic injury. The publication builds on and complements the *World report on road traffic injury prevention*, analysing in depth the burden of disease from road traffic injury in the European Region, framing the issue in the context of sustainable mobility, presenting a comprehensive systems approach to road safety based on successful experiences developed by some Member States in the Region and highlighting opportunities for the health sector to play a broader role. The publication calls for a multisectoral and evidence-based approach to preventing road traffic injuries, with public health playing an important role, emphasizes the importance of a strong political commitment at all levels of government and makes recommendations for action.

Keywords

ACCIDENTS, TRAFFIC - mortality - prevention and control
WOUNDS AND INJURIES - prevention and control
TRANSPORTATION
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SAFETY - standards
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Foreword

Road traffic injuries in the European Region are a major public health issue, claiming about 127 thousand lives per year. This is equivalent to the entire population of Grenoble, France; Perugia, Italy; or Norilsk, Russian Federation.

Next to this intolerably high number of lives lost, about 2.4 million people per year are injured in road traffic crashes. As a result, our societies bear a huge cost that is estimated to be about 2% of gross domestic product in several countries. Road traffic injuries are the leading cause of death among young people in the Region and are predicted to increase in countries with low or medium income as they become more highly motorized.

The fact that effective preventive strategies do exist makes this situation all the more unacceptable. The success of some Member States in reducing the toll of deaths and injuries on their roads clearly demonstrates that strong political commitment and comprehensive measures provide substantial benefits in health gains for the resources invested. Much can be learned from these experiences and innovative approaches and be reapplied and adapted to various situations across the Region.

Road traffic injuries pose a global threat to health and the development of societies. The dedication of World Health Day 2004 to the theme of road safety is an opportunity to be reminded of this and to become aware of the burden of disease on our communities and of the existence of successful approaches and policies to tackle the problem. World Health Day also provides an opportunity for the health sector to rethink its role and responsibilities and to become a more active player and partner of other sectors involved, such as transport, finance, the judiciary and the environment.

This publication has been developed for the purpose of building on and complementing the *World report on road traffic injury prevention* WHO and the World Bank launched for World Health Day 2004. Its aim is to provide the European public health sector, policy-makers across different sectors and levels of government, decision-makers in the private sector and other readers with an in-depth analysis of the situation in the European Region, so that the recommendations and strategies advocated in the *World report on road traffic injury prevention* can be framed in the context of this Region and adapted to its specific political, economic and social conditions. This publication also explores the synergy that can be obtained by linking road safety to other political processes underway in the Region aiming at attaining healthier and more sustainable patterns of transport, such as the implementation of the Transport, Health and Environment Pan-European Programme.

We hope that this publication can contribute to raising awareness about the importance of road traffic injuries from a public health viewpoint and about the still largely untapped opportunities to act to reduce the burden of death and injury to our societies and the distinctive role the health sector can play in this. We also hope that this publication can stimulate a broad debate at the regional and national levels on how multisectoral and evidence-based approaches can be used to improve road safety. Finally, we hope that the experiences developed by various Member States in implementing comprehensive strategies and approaches to road safety will inspire others across the Region to act towards reducing deaths and injuries.

Marc Danzon
WHO Regional Director for Europe

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CHAPTER 1 INTRODUCTION

Road traffic injuries in the 52 countries of the WHO European Region represent a major public health problem. Each year an estimated 127 thousand people are killed (about 10% of global road traffic deaths) and about 2.4 million are injured on roads in Europe. This huge health burden adds to other adverse transport-related health effects, such as those resulting from air pollution, global warming, noise, increasingly sedentary lifestyles and disruption of communities. This burden is also unevenly distributed across the Region, with low- and medium-income countries in the eastern and southern parts of the Region being more severely affected than high-income countries in the western part of the Region.

Effective preventive strategies exist and need to be applied through multisectoral approaches in which the health sector can play a distinctive and more active role along with the other involved sectors, such as transport, finance, justice and environment.

The development of a publication presenting the European public health perspective on preventing road traffic injuries has been inspired by the preparation of the *World report on road traffic injury prevention* (*1*) published by WHO and the World Bank for World Health Day 2004. As such, this publication would be best read in conjunction with the *World report on road traffic injury prevention*.

Developing a European publication that capitalizes on the vast amount of evidence brought together in the *World report on road traffic injury prevention* and complements it was considered an excellent opportunity to bring added value by:

- raising awareness among European citizens and enhancing commitments among European policy-makers at various levels of government and decision-makers in the private sector to further their efforts towards preventing road traffic injuries;
- highlighting the burden of disease from road traffic injury in the European Region;
- describing policy approaches and options that have been successful at reducing the occurrence and severity of road traffic injuries, building on the experience of a number of European Member States and making these experiences broadly available;
- describing comprehensive, multisectoral and evidence-based road safety strategies within the framework of sustainable transport and taking into account the broader European policy framework;
- highlighting the role the health sector can play in preventing and treating road traffic injuries, including by mainstreaming this issue into the health agenda; and
- making recommendations for specific actions that could be taken forward to improve road safety in the European Region, with a special focus on the role of the health sector.

This publication is primarily intended for European policy-makers and those responsible for developing and implementing road safety and sustainable mobility programmes and strategies at the national and local levels of government and in the private sector, especially those active in the fields of health, transport and land-use planning.

Reference

1. Peden M et al., eds. *World report on road traffic injury prevention*. Geneva, World Health Organization, 2004.

CHAPTER 2 ROAD SAFETY IN EUROPE IN THE CONTEXT OF SUSTAINABLE TRANSPORT

Road safety depends on how societies choose to manage transport systems, land use and urban development in relation to their overall health and safety objectives and how they are balanced with economic, social and environmental considerations.

For passenger transport, the shift from public transport, walking and cycling towards private cars and motorized two-wheelers has marked a move towards modes and means of transport that pose comparatively higher costs to society. For goods, the combination of decentralized production, modern logistics and globalization of markets has increased the number of and distances travelled by heavy vehicles, which increases the risks to other road users compared with shipping by rail, sea or inland waterways.

For both passenger and freight transport, modal shifts and growth in traffic volume are supported by the prices of road transport, which are lower than the true social cost of providing and producing them. Although injury surveillance systems cannot capture these macroeconomic determinants of injury, they do affect the injury incidence rate (*1*). For example, the relationship between the price of transport and road deaths was shown during the 1973 energy crisis when a sudden rise in oil prices in industrialized countries resulted in a substantial fall in traffic volumes and in death rates among child pedestrians (*2*,*3*). Congestion charges in London (Box 2.1) have shown the potential effect of economic instruments on the volume of traffic and the number of crashes.

BOX 2.1. CONGESTION CHARGING SCHEME IN LONDON ONE YEAR AFTER THE INTRODUCTION: EFFECTS ON CRASHES

The central London congestion charging scheme was introduced on 17 February 2003, with the primary aim of reducing traffic congestion in and around the charging zone. Although it is still too early to draw firm conclusions about the impact of the congestion charges on crashes, there is indication that the charging zone and Inner Ring Road are experiencing greater reductions in crashes than the rest of London. Preliminary results include:

- 20% increase in cycle journeys with a 7% reduction in crashes
- car traffic reduced by 30% with a 28% reduction in crashes
- 10–15% increase in moped and motorbike journeys with 4% fewer crashes
- 6% fewer pedestrians involved in crashes
- 10% decrease in van and lorry movements
- total vehicle–kilometres reduced by 12%, with a 34% reduction among cars
- increased bus journey time reliability by up to 60%
- no evidence of any overall increase in road traffic outside the zone
- subjective improvements in noise and air quality.

Source: *Congestion charging: update on scheme impacts and operations February 2004* (*7*).

Managing these trends in transport is proving difficult: although the current European Union transport objectives aim at decoupling transport growth from economic growth (*4*,*5*), transport growth continues to shift to road and aviation rather than to rail and water in both the European Union countries and accession countries (*6*).

However, these trends should not result automatically in more deaths and injuries, because investing in effective preventive strategies that address all components of the transport system can reduce the number of injuries and fatalities, as well as other transport-related health effects, as the experience of several European countries demonstrates.

OVERVIEW OF MAJOR TRANSPORT TRENDS IN EUROPE

Motorized road transport

Transport in Europe is growing consistently and steadily for both freight and passengers. For example, in the European Union, passenger and freight transport by road increased by 18% and 40% respectively between 1990 and 2000 (*8*). In 2001, the European Union had 488 cars per 1000 inhabitants, with about 3.8 trillion kilometres driven by car on a road network that extends for about 4 million kilometres.

More recently, the increasing development of Trans European Networks, the enlargement of the European Union and the increasingly market-oriented economies of the Commonwealth of Independent States countries and the countries of central and eastern Europe have been important determinants for the growth of road transport in the central and eastern part of the Region. Transport volume in the countries of central and eastern Europe and Commonwealth of Independent States countries declined sharply after 1989 following economic recession. However, in the countries of central and eastern Europe, freight volume and passenger transport have been rising again since the mid-1990s, following economic recovery; similar trends are also likely to occur in Commonwealth of Independent States countries, although data to confirm this are limited (*9*). In addition, economic policies that reduce public investment in public transport are leading to a decline in the quality of these services. This is promoting the growth of private car use, as illustrated in Box 2.2, which presents an example from Moscow.

Non-motorized road transport

Against this background, non-motorized means of transport, such as cycling and walking, account for a very marginal share of road transport: the average person in the European Union cycles about 0.5 km, walks about 1.0 km and travels 28 km by car per day. Cycling accounts for a significant modal share in very few countries, such as Denmark and the Netherlands (*11*). This is especially relevant in the urban environment. More than 50% of the total urban trips currently carried out by car in the European Union are shorter than 5 km: a distance

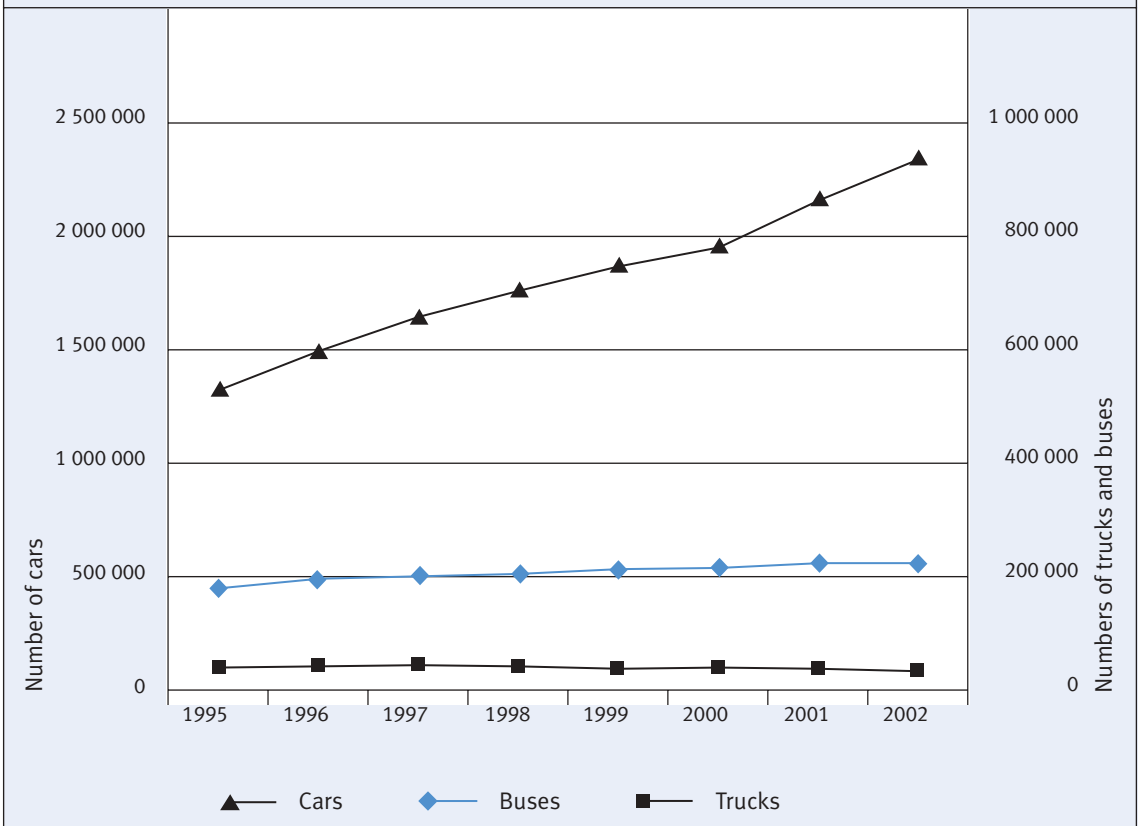
BOX 2.2. TRENDS AND CHALLENGES IN PUBLIC TRANSPORT IN MOSCOW

Moscow has about 10.5 million inhabitants according to the 2002 census. Its public transport system, one of the biggest systems in the world, is still a major component of urban transport, but it is losing ground to a very rapid increase in private cars of about 7.5% per year. The current figure is 240 cars per 1000 inhabitants (Fig. 2.1).

The decline in public transport is attributed to economic reforms in the 1990s, which transferred responsibility for urban public transport from the state to the municipalities but did not allocate sufficient funding. This resulted in the loss of quality and quantity of public transport services and in public transport companies owned by municipalities being unable to cover their operating costs. Being unprofitable, these companies are unable to renovate and maintain their fleet and assets on a regular basis. As a consequence, they lack vehicles and their fleets are considerably depreciated. The inability of public transport companies to render high-quality services makes the more affluent commuters switch to cars, which further reduces the revenue of the public carriers, thus forming a vicious circle.

Maintaining public transport as an option would require a drastic change in present policies governing the financing of public transport.

FIG. 2.1 NUMBERS OF CARS, TRUCKS AND BUSES IN MOSCOW, 1995–2002



Source: Donchenko et al. (*10*).

that could be cycled in about 15 minutes. More than 30% of the total urban trips are shorter than 3 km: a distance that could be walked in about 20 minutes (*12*).

However, real and perceived safety concerns are quoted as the most important barrier preventing many people from choosing walking and cycling as means of transport. For example, in a survey on cycling in Scotland, respondents identified such issues as "too many cars on the road"; "inconsiderate drivers" and "traffic travels too fast" as being the main barriers to cycling (*13*). Other studies show that about 90% of parents worried about traffic hazards on their child's journey to school (*14*) and that concern about traffic hazards significantly determined whether children walked to school (*15)*. These attitudes are justified by the comparatively higher risk for cyclists and pedestrians to be killed or sustain severe injury in road crashes compared with car occupants. Even in countries with comparatively better road safety performance, such as the United Kingdom and Denmark, the risk of death or injuries for cyclists is 13 and 10 times higher per vehicle–kilometre travelled, respectively (*16*).

Addressing the road safety of vulnerable road users therefore appears to be a key determinant of whether more sustainable and healthier transport modes can increase or maintain their share of total transport. For example, both the National Cycling Strategy in the United Kingdom (*17*) and the Dutch Bicycle Master Plan (*18*) aim at promoting bicycle use while simultaneously increasing the safety and appeal of cycling.

ROAD TRAFFIC INJURIES IN THE EUROPEAN REGION: KEY FIGURES AND TRENDS

According to the WHO Global Burden of Disease 2002 version 3 database (*19*), an estimated 127 378 people died in 2002 from injuries sustained in road traffic crashes in the European Region (Table A1, Annex 2). This was about 10% of the total deaths from road traffic injuries worldwide. Road traffic injuries ranked sixth in terms of disability-adjusted life–years in the Region and as the thirteenth leading cause of death (Table A2, Annex 2).

According to the transport-related database of the United Nations Economic Commission for Europe (*20*), 1.9 million road crashes resulted in nonfatal or fatal injury in the European Region in 2001, with the overall number of injuries 2.4 million (Table A3, Annex 2).[1]

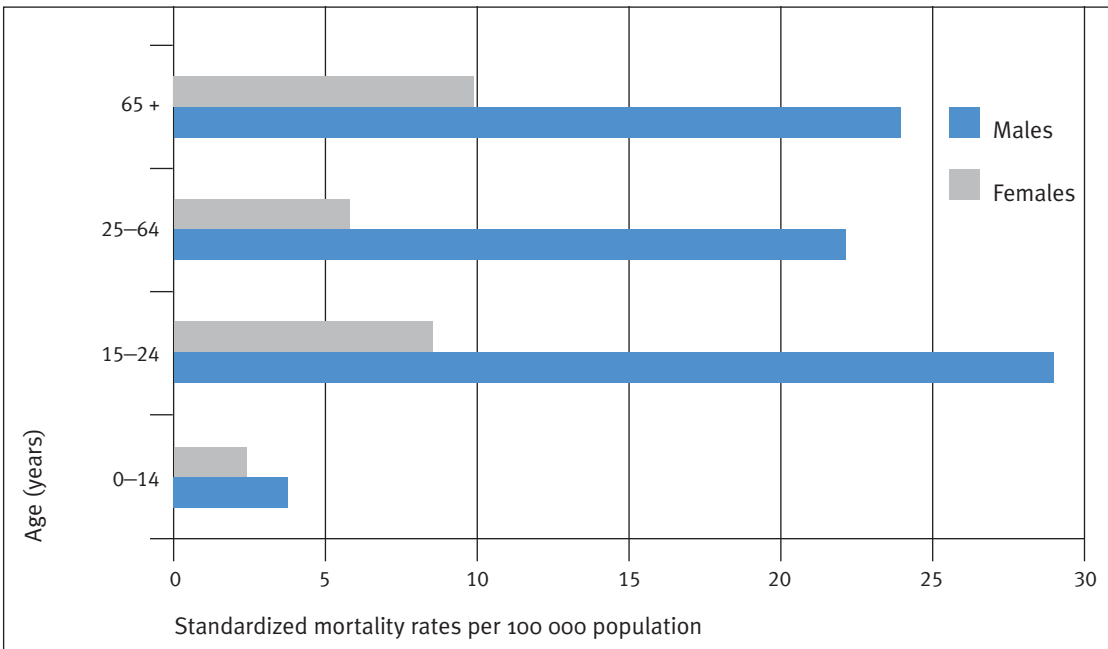
Of these crashes, nearly 67% occurred in built-up areas. This highlights the importance of implementing road safety measures in urban areas, where different road users are more likely to interact.

Three fourths of the people involved in crashes were male (Table A1, Annex 2) (*19*). This gender difference is especially pronounced among people 15–29 years old: males represent 80% of the total number of victims in that age group (Fig. 2.2) (*19*). This has been related to a combination of differences in exposure and in risk-taking attitudes. Men have greater average access to motor vehicles, including those with the highest fatality rates, such as motorbikes, than do women. Further, they are more likely to engage in risky behaviour, such as speeding and driving under the influence of alcohol, which increase both the likelihood of crashes and their severity (*21*).

Countries within the European Region differ substantially in mortality rates caused by road traffic injuries. According to the WHO European health for all database (*22*), the countries with the lowest and

[1] *These differences in estimates between WHO and the United Nations Economic Commission for Europe result from the original sources of data. WHO uses mortality and health statistics records and the United Nations Economic Commission for Europe uses transport and road police authorities' records.*

FIG. 2.2. STANDARDIZED MORTALITY RATES FROM ROAD TRAFFIC INJURIES ACCORDING TO AGE AND GENDER IN THE WHO EUROPEAN REGION, 2000



Source: *Mortality indicators by cause of death, age and sex (off-line version)*. Supplement to the WHO European health for all database (*22*).

highest rates of injuries differ by 11 times. Latvia, Lithuania, the Russian Federation and Greece (in declining order) report the highest rates in the Region (Table A4, Annex 2). Nevertheless, the very low mortality rates reported by some countries in south-eastern Europe and central Asia more likely reflect inadequate data quality than high levels of safety. The enlargement of the European Union in 2004 may increase these large differences between north and south and between west and east if the expected increases in traffic volumes are not accompanied by appropriate policies (*23*).

The European Union had an estimated 40 000 road deaths in 2001 (*11*) and about a four-fold difference between the countries with the lowest and highest death rates per 100 000 population (*22*). In the European Union, road crashes comprise 97% of all transport-related deaths and more than 93% of all transport-related crash costs and are the leading cause of death and hospital admissions for people under 50 years (*24*).

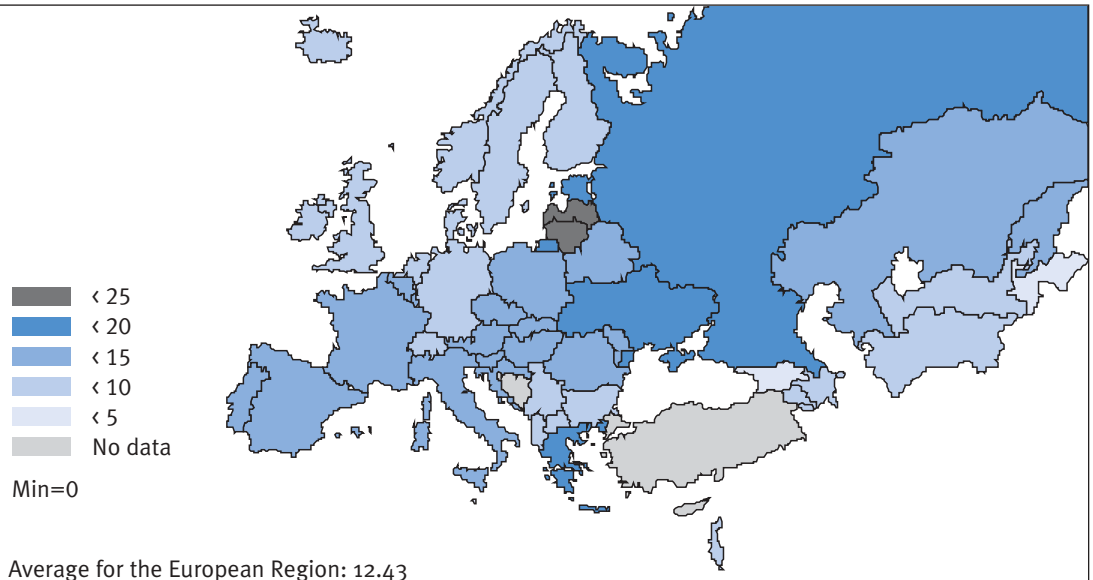
The average mortality rates of Commonwealth of Independent States countries were almost three times higher than those of the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden). These differences have not changed much since the mid- to late 1990s (*25*).

Fig. 2.3 shows the geographical variation in mortality rates from road traffic injuries in the Region.

Despite the differences between countries, mortality rates from road traffic injury have declined overall. In the early 1990s, mortality increased sharply in the eastern part of the Region. Some have related this spike to the sudden increase in motorized transport linked to numerous new and inexperienced drivers (*25*). Where estimates of the volume of road traffic are available, the declining mortality in the mid-1990s in several countries in the eastern part of the Region seems to be associated with a decline in transport activities for both goods and passengers rather than the implementation of comprehensive road safety policies (*26*).

In the western part of the Region, although road traffic-related mortality has continued to decline, progress seems to have slowed down in the past few years, including among the countries that have

FIG. 2.3. STANDARDIZED MORTALITY RATES FROM ROAD TRAFFIC INJURIES PER 100 000 POPULATION IN THE WHO EUROPEAN REGION, 2002 OR LAST YEAR AVAILABLE



Average for the European Region: 12.43

NOTE: The designations employed and the presentation of this material do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Source: *Mortality indicators by cause of death, age and sex (off-line version)*. Supplement to the WHO European health for all database (*22*).

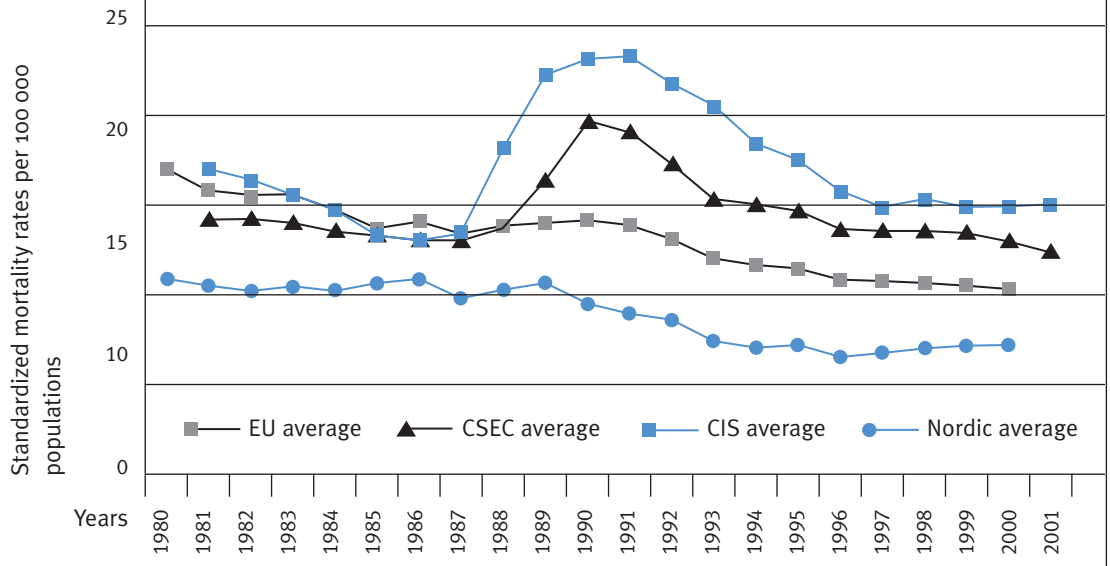
performed very well historically. The apparent difficulty in further reducing the number of deaths could indicate the need for developing and implementing new preventive strategies. Fig. 2.4 shows the overall trends in road-traffic injury mortality for various subregions.

The substantial differences between the different parts of the Region can be explained economically in part, with low- and medium-income countries having a comparatively higher burden in terms of disability-adjusted life-years (DALYs) (Table A2, Annex 2) (*19*). In addition, administrative and legislative arrangements and institutional capacity have not kept up with the relatively recent growth in private transport in many countries in southern and eastern Europe, representing an obstacle to developing more effective, better-coordinated and coherent strategies for road safety.

Children younger than 15 years represented about 5% of the total estimated deaths from road traffic injuries in 2002 (Table A1, Annex 2). However, road traffic injuries are the leading cause of death among children 5–14 years old (*19*). Children are considered to be especially vulnerable because their ability to cope with traffic evolves with age, and they remain severely limited in the first nine or ten years of their life. They are therefore highly at risk in any situation in which motorized traffic is heavy or fast, visibility is limited or the drivers focus their attention on other vehicles and tend to forget about pedestrians or cyclists (*27*). Mortality rates for road traffic injuries among children are highest (in declining order) in the Republic of Moldova, Romania, Latvia and the Russian Federation (*22*). Road traffic injuries are the leading cause of death among people aged 15–29 years. In addition, this age group accounts for one third of the total victims (*19*).

Although road traffic injuries represent a relatively less important cause of death for elderly people, they are especially vulnerable because their ability to cope with difficult traffic situations declines gradually and they become more fragile physically

FIG. 2.4. MORTALITY FROM ROAD TRAFFIC INJURIES IN THE WHO EUROPEAN REGION AND VARIOUS SUBREGIONS, 1980–2001



EU average: the 15 European Union countries. CSEC average: 15 countries in central and south-eastern Europe, including Estonia, Latvia and Lithuania. CIS average: 12 countries of the Commonwealth of Independent States. Nordic average: Denmark, Finland, Iceland, Norway and Sweden. Annex 2 shows all the countries for these groups.

Source: *Mortality indicators by cause of death, age and sex (off-line version)*. Supplement to the WHO European health for all database (*22*).

(*16,27*). For example, older pedestrians account for nearly half of all pedestrian fatalities in countries in Europe that are members of the Organisation for Economic Co-operation and Development (OECD) (*28*). Most elderly people who are aware of their own difficulty tend to avoid road traffic, thus reducing their mobility and the scope of their social life (*16,27*). Since one fourth of all residents of OECD countries are expected to be 65 years or older by 2030, new strategies need to be identified for addressing the mobility and safety needs of elderly people. These include assessing the infrastructure and how it is maintained, public transport options, new technology, vehicle design and regulation (*28*).

Additional circumstances associated with road traffic injuries further increase the burden on the social and health care systems of countries by affecting specific population groups.

- In the European Union alone, an estimated 200 000 families per year are affected by the death or life-long disability of at least one family member (*29*).
- Citizens' mobility and opportunities to lead a physically active life through cycling, walking and playing outdoors are restricted by hazardous conditions. The lack of physical activity has been identified as a major risk factor for health. For perspective, across the European Region, an estimated 500 000 to 1 million deaths per year are attributable to physical inactivity, corresponding to 5–10% of total deaths (*30*). Walking and cycling can help to maintain adequate physical activity.
- Even high-income countries have steep social class gradients in pedestrian injury rates, and the relationship between lower social class and more injuries among child pedestrians is well established (*31–34*). Children belonging to ethnic minorities have an increased risk of pedestrian injuries (*35*).
- Nearly one fifth of those injured in road traffic crashes in one study (*36*) developed an acute stress reaction, and one quarter displayed mental problems within the first year. Long-term mental

BOX 2.3. POST-TRAUMATIC STRESS DISORDER AMONG CHILDREN INVOLVED IN ROAD TRAFFIC CRASHES

A prospective study in the United Kingdom found that one third of children involved in road traffic crashes had post-traumatic stress disorder when interviewed 22 and 79 days afterwards, whereas only 3% of children from the general population studied similarly had the disorder for causes other than road traffic crashes.

The development of the disorder was related to neither the type of crash nor the nature and severity of the physical injuries; the child's perception of the crash as life-threatening was the most important determinant. The study found that the psychological needs of the children involved remained unrecognized, and none had received any professional help.

Source: Stallard et al. (*38*).

disorders consisted mainly of mood disorder (in about 10% of cases), phobic travel anxiety (20%) and post-traumatic stress disorder [2] (11%) (Box 2.3). Phobic travel disorder was frequent among drivers and passengers (*1*,*36*).

Other vulnerable road users include pedestrians, cyclists and motorcyclists. They usually suffer the most severe injuries as a result of road traffic collisions, report more continuing health problems and require more assistance than other types of road users (*39*,*40)*.

Vulnerable road users usually have a greater risk of mortality than other road users. In 1997, for example, pedestrians and cyclists comprised only 22% of the people involved in serious crashes but 33% of the people killed (*41*). Risk comparisons for the European Union show that the fatality risk for motorized two-wheelers is the highest of all modes of transport, being on average 20 times as high as that of car occupants. Cycling and walking have a fatality risk per distance travelled that is 7–9 times higher than car travel. Road transport collectively has the highest fatality risk per passenger–kilometre of all modes of passenger transport (*24*).

Among other groups at risk, road traffic crashes appear to be the leading cause of death among injured tourists in the European Union, accounting for more than 50% of all fatalities in this population group, 20% of hospital admissions and 30% of visits in emergency departments paid by tourists (*42*).

Road traffic injuries are also an important cause of occupational disease. This involves not only professional drivers but also employees commuting. For example, in the European Union, road traffic crashes at work account for about 41% of all workplace fatalities reported in 1999 (*43*).

[2] *Post-traumatic stress disorder involves symptoms such as re-experiencing the trauma through nightmares, flashbacks or uncontrollable, intrusive recollections; adopting avoidance techniques including keeping away from situations that trigger recollections of the event, blocking feelings and becoming detached and estranged from others; and excessive arousal, resulting in sleep difficulties, poor concentration and memory and being hyperalert and easily startled* (*37*).

THE ECONOMIC COST OF ROAD TRAFFIC INJURIES IN EUROPE

Several studies have estimated the cost of road traffic injuries in Europe. This is estimated to reach €180 billion per year in the countries of the European Union, twice the annual budget for all its activities, and to account for about 2% of the gross domestic product (*44,45*).

Various studies done in the 1990s produced estimates of 0.5% of gross domestic product in the United Kingdom, 0.9% in Sweden, 2.8% in Italy and an average of 1.4% in 11 high-income countries (*46*). In the countries of central and eastern Europe, the cost of crashes has been estimated to be about 1.5% of the gross domestic product, or US$ 9.9 billion (*47*). These differences are explained by differences between countries in the valuation of the costs of lives lost and of injuries and disabilities.

These large costs are explained in part by the young age of a very large proportion of the victims, which amplifies the economic damage in terms of loss of productivity and earnings. In addition, these economic estimates present ample margins of uncertainty and are based on substantial simplification and assumption. For example, estimates are greatly affected by the availability and quality of data on deaths and injuries. However, these are often poorly recorded and reported, and the police, hospitals and insurance companies may differ in how they record injuries. Economic valuations are also affected by the methods used and, at the country level, by cost adjustment factors.

Various studies carried out in several European countries have led to a progressive convergence in the estimated economic value of a life saved in the range of €1.1–1.3 million within countries with a standard of living higher than the European average. This would put the European average at about €1 million (*48*).

These studies are based on the willingness-to-pay approach, which estimates the value that individuals attach to human life by means of surveys aimed at determining the amount of money they would be prepared to pay to reduce the risk of loss of life or of injury (*48*). A very important aspect of these studies is that the values obtained are convergent from one country to another and from one mode of transport to another. This is in contrast to policy practices, since the investment in crash prevention in the public transport sector, namely rail and aviation transport, is much greater than that in the road sector, since the public authorities are liable for crashes in the public transport sector. This means that individuals would be willing to see government take charge of road safety with the same forcefulness in the road sector as in the rail and air sectors (*48*).

These values can serve as a pragmatic basis for analysing cost–benefit (assessing the economic costs of investment projects in relation to their benefits) or cost–effectiveness: the number of killed or injured road users a road safety measure can prevent in relation to its costs (*46*). Nevertheless, at the country level, these values could grossly underestimate the value of a life saved. For example, in the Netherlands this is estimated to be about €4 million.

Recent research developments are bringing new insights into the costs and benefits of providing for improved road safety and demonstrating the value of investing in safety, especially when cost–benefit analysis include the benefits of safer and more convenient travel for pedestrians and cyclists (*49)*.

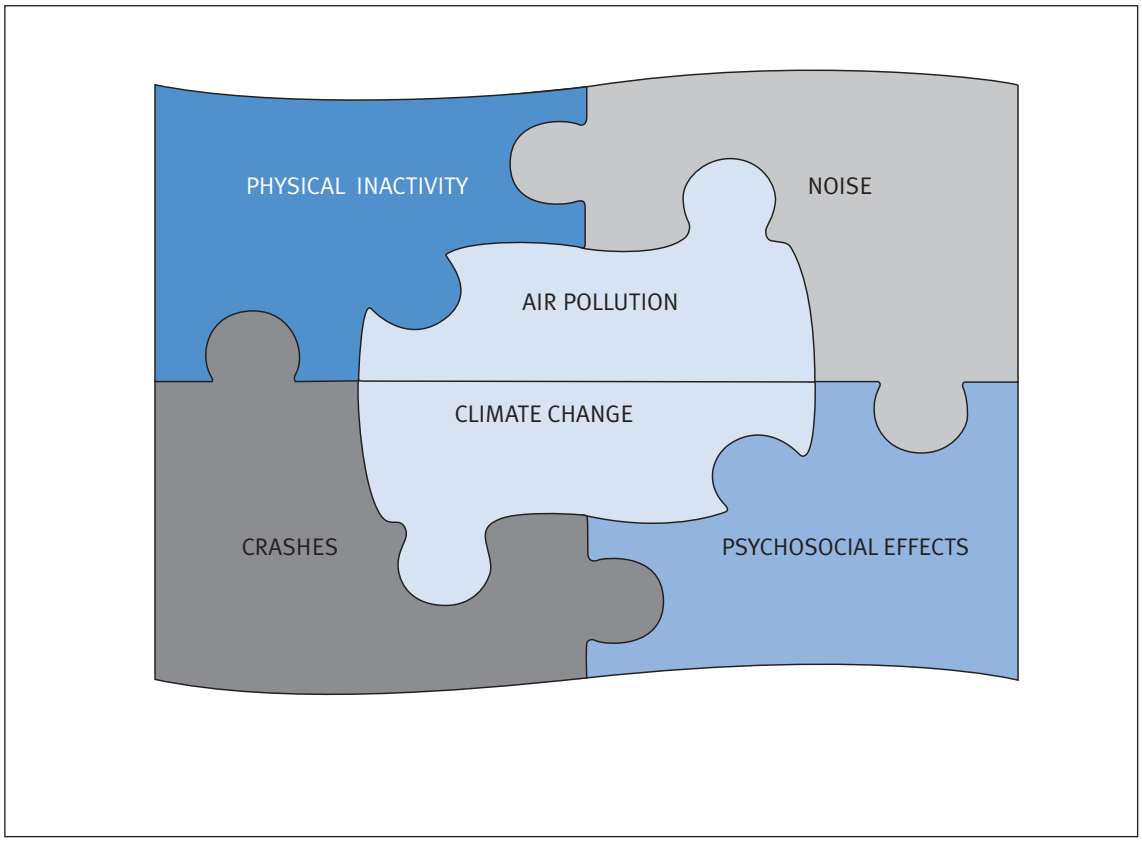
TRANSPORT-RELATED HEALTH EFFECTS: NOT ONLY INJURIES

Although road traffic injuries have been the first well-established health effect of transport, understanding that transport has other health effects is an important step in overcoming a historically fragmented approach in which policies adopted to reduce traffic crashes and injuries do not usually consider the other health effects of road transport such as traffic-related air pollution and vice versa (*50*).

As highlighted in *The world health report 2003* (*51*), transport-related air pollution has become a major public concern in most countries, and estimates of the impact of air pollution on health indicate that this concern is justified. In the European Region, the number of deaths related to air pollution from road transport is estimated to be of the same order of magnitude as deaths related to road traffic injuries (*52–54*), although air pollution disproportionately affects elderly people and road traffic injuries young people. In addition, transport-related emissions of gases that cause climate change – which are expected to increase by more than 30% in Europe by 2010 (*55*) – are expected to contribute to extreme weather events. These include floods and droughts and changes in the habitat of disease vectors such as mosquitoes, with major health effects (*56*). Current transport patterns have many other effects on health (*25*), including pervasive annoyance induced by road traffic noise; adverse effects on rates of cardiovascular disease, diabetes, obesity and some types of cancer by discouraging the use of safe cycling and walking for transport (*57*); and constraints on the development of neighbourhood support networks. These disproportionately affect urban poor people, because urban areas have higher levels of pollution and often provide fewer options for physical activity (*58*).

Taken together, these transport-related health effects add to the already dramatically high burden and cost of road traffic injuries, strengthening the case for implementing strategies to reduce such costs, which are borne significantly by the health sector through the costs of care and rehabilitation (Fig. 2.5).

FIG. 2.5. **TRANSPORT-RELATED HEALTH EFFECTS**



THE STATISTICAL DATA AND INDICATORS VARIOUS ACTORS NEED AND USE

Developing good knowledge about different aspects of road traffic crashes serves different actors and players in different ways.

For the health sector, data about road traffic deaths and injuries are especially important in:

- estimating the costs to society and to the health sector;
- setting priorities for public health;
- assessing the cost–effectiveness and evidence base of various treatment measures, such as emergency care, trauma care and rehabilitation;
- providing input to other actors, such as road safety professionals, researchers and economists; and
- attaining a reliable evidence basis to advocate and increase the awareness of policy-makers and decision-makers about the importance of the problem compared with other public concerns.

For the road sector, monitoring safety performance indicators (indicators that monitor changes in risk factors) seems especially relevant, such as those that relate to speed levels, the rate of drink-driving, the use of seat-belts and other risk factors targeted by various policies and preventive measures (*59*). Specific information is also needed for cost–benefit and cost–effectiveness analysis, for guiding research into improving vehicles and infrastructure safety and for controlling for possible confounding factors. For example, information about the travel patterns of cyclists and pedestrians is important in determining whether reduced deaths and injuries for these groups result from effective preventive measures instead of from less travel on foot or by bicycle.

The different needs of various actors are reflected in the type of indicators they use in analysis. For example, as the health sector is interested in assessing deaths and injuries from traffic crashes in comparison with other causes of death and injury, it uses rates based on the populations at risk (such as the number of deaths per 100 000 population). In contrast, the transport sector is interested in assessing safety performance in relation to other transport performance criteria and therefore uses indicators based on the amount of travel, which also indicates exposure to road traffic hazards (such as the number of deaths per passenger–kilometre or per vehicle–kilometre).

International organizations such as WHO, the European Conference of Ministers of Transport, the United Nations Economic Commission for Europe, the OECD and the European Union play an important role in promoting the identification of relevant indicators, encouraging international harmonization in definitions, collecting data and reporting to facilitate exchange of information and international comparisons, setting the international transport policy agenda and providing guidance and building capacity in countries on how to develop or improve their transport-related information systems.

For example, guidance on how to develop information systems providing better and more relevant information from a public health perspective is available through the WHO *Injury surveillance guidelines* (*60*) for developing and implementing injury surveillance systems in hospital settings and the *Guidelines for conducting community surveys on injuries and violence* (*61*), developed by the WHO with its collaborating centres. The *Injury surveillance guidelines* provide recommendations on the core minimum data set and supplementary data that should be collected on all injury patients, including road traffic casualties. Conducting surveys at the community level can be a cost-effective way of gathering relevant information without setting up expensive and complex continuous monitoring systems. This also allows ad hoc studies to be developed to assess specific situations or risk factors.

SOURCES AND QUALITY OF THE STATISTICS AND INDICATORS ON ROAD TRAFFIC DEATHS AND INJURIES IN EUROPE

In most European countries the road police, the health sector, the agency responsible for death certificates and insurance companies are the main actors responsible for collecting statistics about road traffic deaths and injuries.

States that are members of the European Union, the United Nations Economic Commission for Europe, the World Health Organization, the Organisation for Economic Co-operation and Development and the European Conference of Ministers of Transport also report their national data, according to internationally agreed questionnaires, to these international bodies, which run databases (such as the WHO health for all database (*62*), statistics on road traffic accidents from the United Nations Economic Commission for Europe (*63*), the International Road Traffic and Accident Database (IRTAD) (*64*) and the CARE (Community Road Accident Database) (*65*)) and publish reports (such as the statistical reports on road accidents of the European Conference of Ministers of Transport (*66*)) that allow some international comparisons and analyses to be made on trends across the Region.

Particularly interesting in the development of CARE is the high level of disaggregation of the data sets, as CARE comprises detailed data on individual crashes as collected by the Member States and adjusted for possible differences in definitions through correction factors. This structure allows for maximum flexibility and potential in analysing the information contained in the system and opens up a whole set of new opportunities in accident analysis (*65*).

The statistics on road safety in the European Region may be relatively good compared with other regions. Nevertheless, countries still differ substantially in the availability, quality and completeness of data on mortality and injuries related to road traffic crashes, which makes international comparisons difficult. These difficulties result in part from a lack of complete harmonization in some of the definitions used. For example, although there is international agreement to define as "killed" any person who was killed outright or who died within 30 days as a result of the crash (*67*), a few countries are still applying different definitions. At the international level, the IRTAD and CARE adjust the data to the internationally agreed definition. Data on injuries differ even more, as there is ample room for discretion in interpreting the definition of "slightly" versus "seriously" injured.

Data on mortality are comparatively more reliable and complete than data on nonfatal injuries. The reasons include differences in methods and the quality of data collected, differences in definitions

BOX 2.4. WHAT IS THE REAL NUMBER OF ROAD CRASH INJURIES IN THE NETHERLANDS?

Although underreporting of crashes by the police is a well-known phenomenon, little research is available on this. Comparing data from different data sources can provide a complete overview of this in the Netherlands. Comparing police data and data on external causes of death showed that even the police reporting of road deaths is not complete. During the years 1996 to 2001, the underreporting averaged 7%. The estimate of the real numbers of inpatients is based on comparing the police data and data from the national health care registration. The underreporting of casualties is about 40%; for vulnerable road users, especially cyclists, underreporting is even higher. Comparing police data with data from the Injury Surveillance System shows that the police data report 16% fewer injured people than those treated at accident and emergency departments. Underreporting can be taken into account quantitatively in road safety policies in the Netherlands.

Source: personal communication, Fred Wegman, Dutch Institute for Road Safety Research (SWOV), 2004.

used by bodies involved in monitoring crash outcomes and difficulty in reconciling data from different sources (*39*).

Related to this is the important problem of underestimating the real burden of road traffic injury because data are underreported. The reasons for underreporting include: the public failing to report; the police not recording cases reported to them; hospitals not reporting cases presenting to them; and certain institutions, such as the military, being exempt from reporting directly to the police (*39*). Underreporting is not exclusive to low- and medium-income countries (Box 2.4): for example, in the United Kingdom, studies comparing hospital and police records suggest that about 36% of road traffic injuries are not reported to the police (*68*). In addition, about 20% of crashes reported to the police remain unrecorded.

Within countries, the numbers of reported fatalities and injuries differ between road police records and those of public health institutions, such as first aid stations and hospitals. Finally, data collected by insurance companies are often published in the form of representative surveys, to protect information considered commercially sensitive.

Several international research projects supported by the European Union are contributing to improving various aspects of crash-related information systems. For example, STAIRS (Standardisation of Accident and Injury Registration Systems) aimed at developing a harmonized procedure for collecting in-depth data on road crashes and developing methods that would provide the core data and basic framework for crash injury studies (*69*). ECOEHIS (environment and health indicators for European Union countries) aims at proposing, validating and testing for feasibility a set of core environment and health indicators for European countries, including indicators for road crashes (*70)*.

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CHAPTER 3 NEW THINKING ON ROAD SAFETY IN EUROPE

Nationally and internationally, it is now broadly accepted that tackling road safety problems is fundamentally a problem of preventing serious and fatal injury in road crashes. Preventing crashes resulting in property damage and minor injuries is less important from a public health perspective, although these add significantly to the overall economic costs of crashes.

CHALLENGING TRADITIONAL APPROACHES

Traditionally, road users have been held responsible for the safety of the road transport system. Consequently, preventive strategies have been directed mainly at improving users' behaviour and their coping skills, mostly through education, information and enforcement.

In addition, various components of the road transport system have evolved more or less separately, including legislation and regulations. This results in a piecemeal approach to road safety in which different measures have targeted users, vehicles and infrastructure without coherent and systemic approaches (*1*).

New ideas have challenged these approaches, and more comprehensive systems approaches have been developed as various European countries have used the ideas as building blocks from which to choose when rethinking their road safety strategies.

1. A systems approach addresses all the elements related to road safety.

Road crashes result from a complex combination of elements, that, in addition to the behaviour of road users, include factors beyond their control, such as poor design or failure in the performance of vehicles or road infrastructures. This leads to the development of a systems approach (*2*) in which all components of the system (users, vehicles and infrastructures) are seen as interrelated. This allows problems to be identified, strategies formulated, targets set and performance monitored (*3*).

2. "First, do no harm" (Hippocrates) – the underlying social values of road safety should be made explicit.

The degree to which road safety strategies have been implemented in various societies depends not only on their level of economic and technical development and capacity but also on the underlying social values.

If societies refuse to accept people being killed or seriously injured in road traffic crashes, they will then be ready to build a system that minimizes human mistakes and errors in judgement and accounts for those that occur and to allocate the appropriate resources to developing it. Thus, safety can be made an overarching objective and priority of the performance of road transport systems, similar to other modes of transport.

This is radically different from the traditional socioeconomic approach, which trades off health and safety against economic objectives and reduced travel time. Under the socioeconomic approach, health and safety are merely two variables in the equation to provide society with good mobility and not a governing parameter of mobility.

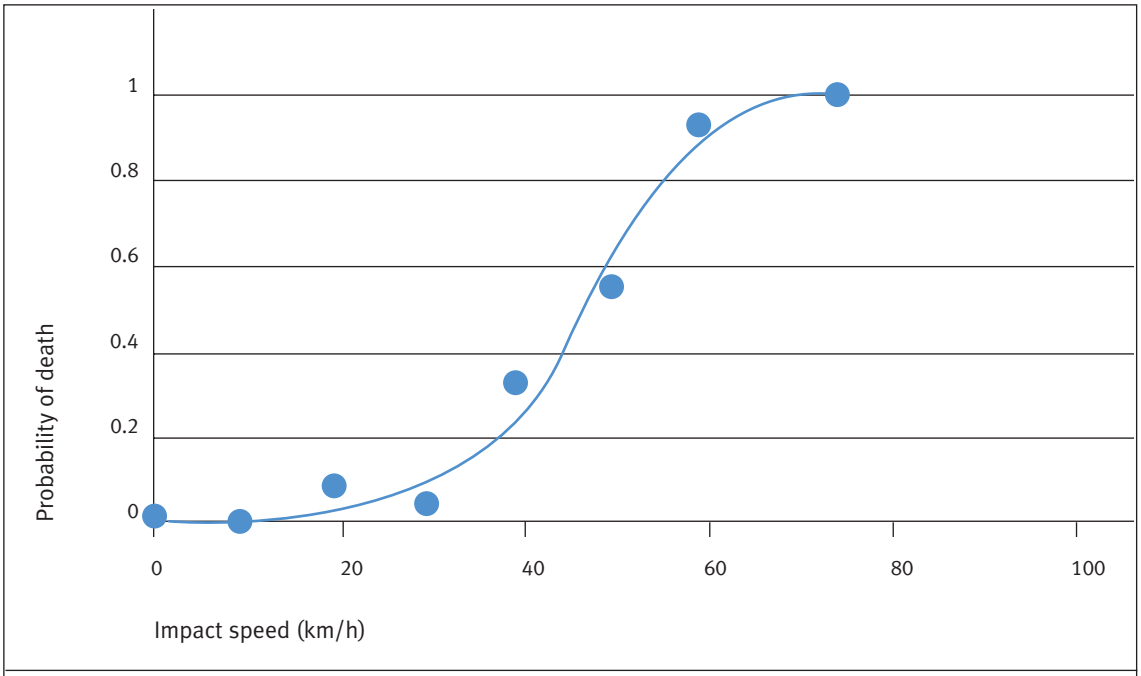
In Europe, the European Parliament made a bold political statement "that no single death on the European roads can be justified and that therefore the long-term objective must be that no European citizens should be killed or seriously injured in the road transport system" (*4*).

Similarly, the Conference of Ministers for Transport and Road Safety held in Verona on 23–24 October 2003 declared that "the huge amount of human victims on the roads is too high a price and that, the situation being such, the eradication of this scourge is a top priority on their political agenda" (*5*).

3. "Man is the measure of all things" (Protagoras) – human tolerance of mechanical forces should be at the core of road safety.

Another building block of the new thinking about road safety has been applying the laws of physics and human physiology to analysing and preventing crashes.

FIG. 3.1. PROBABILITY OF A PEDESTRIAN DYING AS A FUNCTION OF THE IMPACT SPEED OF A CAR



Source: Pasanen (*7*) with the permission of the publisher.

According to this approach, the limiting factor of a safe road transport system is the human tolerance of mechanical force. When the tolerance of the human body is exceeded, a crash event results in injury or death. The components of the road transport system – including road infrastructure, vehicles and systems of restraint – must therefore be designed such that they are linked to each other and can accommodate possible mistakes. The amount of energy in the system must be kept below critical limits by restricting speed (*3*).

This approach views the risk of injuries and deaths as a dose–response function in which injury is a result of interacting mechanical forces. This is exemplified in Fig. 3.1, which shows the relationship between the impact speed of a car and the risk of death for pedestrians. Excessive and inappropriate speed is a major cause of about one third of all fatal and serious crashes (*6*).

4. Road transport systems should be programmed to take human mistakes into account.

Research undertaken over many years confirms that, however well educated and trained, people are prone to make intentional or unintentional errors at the controls of a vehicle.

Thus, crashes cannot be totally avoided. As a consequence, human error must be programmed, and this must be applied to the road sector.

Making safety a built-in component of road transport systems is consistent with what is accepted by default in other modes of transport, such as aviation and rail systems, and in most sectors of the economy, where the possible occurrence of failures of operators and users is taken into account and appropriate mechanisms are introduced to prevent failures from occurring or causing unacceptable damage.

5. Road safety is a shared responsibility.

Accepting that human errors may occur and have to be planned for implies shifting responsibility from the users of the road transport system to its designers and managers. In this approach, the road user is responsible for complying with traffic regulations, whereas the system designers and providers, which include vehicle manufacturers, government and legislative bodies, are responsible for delivering a system that accommodates potential mistakes.

Political commitment and leadership are prerequisites for preventing road traffic injury. Nevertheless, the responsibility for road safety extends beyond the users and the designers and providers of road transport systems to include the mass media, professionals from the transport, health, environment, justice and education sectors, civil society, nongovernmental organizations, special interest groups, other actors from the private sector and individual citizens (*3*).

6. Developing a reference model for a safe road transport system allows defining safety criteria and taking steps to attain safety.

Once the criteria for safe road transport systems are set, targets need to be defined and steps taken to attain them.

Strategies should then be developed and measures implemented to bridge the difference between the safe reference model and the baseline (the present situation). This would be similar to how other sectors deal with safety. For example, the environmental and health sectors use standards or guidelines providing thresholds and safe reference values as a well-established practice, as is the case with guidelines for air, water or food quality or housing standards or occupational exposures to various hazards.

In this context, data that describe the present situation are used to measure the distance between the baseline and the model and to monitor the achievement of performance targets. This differs from the traditional approach in which historical data reflecting piecemeal interventions are used as the starting-point for shaping the future of the system.

A GENERAL INTERPRETATION OF THE NEW THINKING ABOUT ROAD SAFETY

Applying the new thinking requires a very radical reorientation of the underlying principles of road transport and road safety because the new approach does not give mobility needs priority over the inherent safety of the system and changes the balance of responsibility for safety.

This is also the first time when a critical load limit, biomechanical tolerance, has been applied to the safety of the system. Such load limits have been used for environmental reasons but never for injuries. This is a true shift from using isolated measures and an unclear structure of responsibility.

The new thinking stimulates innovation and investment in the road transport system and gives a new perspective as to how societies can handle various actors in a complex world.

INTERPRETING AND IMPLEMENTING THE NEW THINKING: THE EXPERIENCE OF SOME EUROPEAN COUNTRIES

Various countries have used these ideas as building blocks to develop their own road safety strategies, placing more or less emphasis on different elements as a function of their specific conditions, social values, cultural and scientific orientation and technical and institutional arrangements.

Several European countries that have taken the bold step of putting the new ideas into practice have achieved important results that place them among the most successful countries in achieving road safety on a worldwide basis.

Examples from Sweden, the Netherlands and the United Kingdom are presented to illustrate how certain elements of the new thinking may be given priority during implementation rather than others. Koornstra et al. (*8*) recently reviewed the experience of these countries in a collaborative research project.

Vision Zero (Sweden)

In 1997, Sweden's Riksdag (parliament) adopted Vision Zero, a bold new road safety policy based on four principles:

- **ethics:** human life and health are paramount; they take priority over mobility and other objectives of the road transport system;
- **responsibility:** providers, enforcers and users of the road transport system all share responsibility for road safety;
- **safety:** humans make errors; road transport systems should minimize the opportunity for error and the harm done when errors occur; and
- **mechanisms for change:** providers and enforcers of the road transport system must do their utmost to guarantee the safety of all citizens; they must work together, and each must be ready to change to achieve safety.

Sustainable safety (the Netherlands)

The vision on sustainable safety was developed in 1992 and further elaborated during the 1990s. In 1998, implementation of sustainable safety was linked to actual road safety targets of reducing deaths by at least 50% and injuries by 40% by 2010 compared with the 1986 baseline figures. The

Netherlands has set three objectives for its road transport system.

- Infrastructure will be designed to take into account human limitations.
- Motor vehicles will be designed and equipped to make the task of driving easier and to provide good protection in crashes.
- Road users will be provided with adequate information and education and will be deterred from dangerous behaviour.

The key to achieving a sustainably safe road transport system is applying three safety principles systematically and consistently:

- achieving functional use of the road network by preventing the unintended use of roads;
- ensuring homogeneous use by preventing large discrepancies in vehicle speed, mass and direction; and
- promoting predictable use, thus preventing uncertainties among road users by enhancing the predictability of the roads' course and the behaviour of other road users.

Tomorrow's roads: safer for everyone (United Kingdom)

In March 2000, the Government of the United Kingdom set out its strategy for improving road safety over the next decade in *Tomorrow's roads: safer for everyone* (*9*). The strategy includes targets to reduce the number of road deaths and serious injuries by 40% and deaths and serious injuries among children by 50% by 2010 compared with the average for 1994–1998. The strategy and targets will be reviewed every three years to take account of new ideas and new technologies.

The strategy is being implemented through the Road Safety Advisory Panel, chaired by the Minister for Road Safety and composed of members representing some of the main stakeholder bodies, including government departments, local authorities, police authorities, nongovernmental organizations and the private sector. The Panel is also in charge of monitoring progress in implementation.

It consists of a comprehensive approach, addressing ten priority themes: safer for children, safer drivers (training and testing and drink, drugs and drowsiness), safer infrastructure, safer speeds, safer vehicles, safer motorcycling, safer pedestrians, riders and horse riders, better enforcement and promoting safer road use.

A comparative assessment of the directions taken by these three countries in the development of national road safety policies (*8*) has highlighted the similarities and differences of these approaches. All three countries use intermediate quantitative and time-bounded targets for reducing deaths and injuries and measures addressing specific risk factors (such as speeding, drink-driving, infrastructure and vulnerable road users). They also share similar characteristics in terms of organizational settings, with safety issues debated in the parliament, a strong central coordinating ministry, good vertical coordination of safety activities from central to local groups, with supporting finance and influential nongovernmental and not-for-profit organizations with a strong interest in safety. However, road safety plans in the Netherlands and Sweden are based on an explicit vision aiming at preventing deaths and serious injuries by reshaping the road transport system into an inherently safe system, whereas the road safety strategy in the United Kingdom is based on applying good practices by safety professionals with a focus on improving the safety of groups at higher risk (*8*).

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CHAPTER 4 A BROADER PERSPECTIVE ON ROAD SAFETY IN EUROPE

Several European countries have taken the approach of identifying the control of dangerous kinetic energy as the cornerstone of road safety and acknowledging the effectiveness of measures meant to make the overall road transport system safer. These efforts have evolved in parallel with the development of the concept of sustainable transport (*1*):

> A sustainable transport system is one that i) provides for safe, economically viable and socially acceptable access to people, places, goods and services; ii) meets generally accepted objectives for health and environmental quality … ; iii) protects ecosystems by avoiding exceedance of critical loads and levels for ecosystems integrity ... and iv) does not aggravate adverse global phenomena, including climate change, stratospheric ozone depletion, and the spread of persistent organic pollutants.

When road safety becomes an integral aspect of sustainable transport, the potential additional contribution of such measures as reducing emissions of noise and air pollutants and providing conditions that can promote walking and cycling that were originally designed to achieve other health or environmental protection goals becomes apparent. In addition, the range of strategies available to improve road safety becomes broader and more cost-effective, as investments deliver multiple health benefits compared with piecemeal approaches.

For example, maintaining speeds below levels that may cause death or serious injury not only saves the costs of avoided injuries but also saves costs resulting from air pollution, noise and the barrier effect created by the fear of vulnerable road users to engage in walking and cycling and the resulting health risks related to sedentary lifestyle. The European Parliament has expressed political support for this approach, stating that (*2*):

> ... road safety policy must be seen in the context of the overall policy on sustainable mobility, implying more integrated use of all transport modes and promotion of more environmentally friendly modes of transport, such as rail, inland waterways, short sea shipping and combined transport, as well as the promotion of public passenger transport, in order to reduce impacts generated by motorization.

From a policy viewpoint, making road safety a component of sustainable transport more strongly emphasizes safety approaches that manage the exposure to road traffic hazards through land-use and transport planning. In fact, as highlighted in the *World report on road traffic injury prevention* (*3*), the organization of land use affects the number of trips people make, by what modes and means they choose to travel, the length of trips and the route taken (*4*).

Different ways of using land create different sets of road transport patterns (*5*). The main aspects of land use that influence road safety are: the spatial distribution of the origins and destinations of road journeys; the urban population density and patterns of urban growth; the configuration of the road network; the size of residential areas; and alternatives to private motorized transport (*4*).

Land-use planning practices and land-use policies promoting "smart growth" – high-density, compact buildings with easily-accessible services and amenities – can reduce the risk exposure of road users. Creating clustered, mixed-use community services, for example, can cut the distances between commonly used destinations, curtailing the need to travel and reducing dependence on private motor vehicles (*6*).

From an economic perspective, factoring the full range of the expected health benefits resulting from systemic interventions in cost–benefit analysis can further increase the value of investments in road safety (*7*).

INTEGRATING ROAD SAFETY CONCERNS INTO OVERALL TRANSPORT AND LAND-USE POLICIES

Integrating road safety along with environmental and other health concerns into transport and land-use policy is a substantial change compared with the present situation, in which traffic safety aspects and environmental and other health considerations are frequently still dealt with individually using a fragmented approach (*8*).

This integration would allow authorities to:
- identify and address possible conflicts and inconsistencies at an early stage, when various decision options are still open;
- achieve more efficient use of resources;
- increase benefits when an action can contribute to addressing other issues; and
- achieve optimization when action contributes positively to one aspect and negatively to another by solving this dilemma before final decisions are taken.

Table 4.1 presents a qualitative overview of policies that result in synergy in tackling various transport-related health effects.

Integrating policies in practice is a challenging task. It requires understanding various policies and priorities, balancing different interests and goals, overcoming political, organizational, economic and financial impediments and acting across various sectors (horizontally) and various levels of government (vertically).

In addition to an overarching policy and/or legislative framework to ensure that individual policies are coherent and consistent with national goals and priorities, other enabling conditions include:
- use of integrated assessment methods involving public participation to determine the effects of transport and planning decisions on environment and health; and
- political commitment, the availability of sufficient funds and institutional and professional capacity.

From the institutional viewpoint, coping with intersectoral issues within central and local governments presupposes adequate organizational support and adapted institutional structures to facilitate the flow of information and coordinated action (*9*).

TABLE 4.1. EXAMPLES OF TRANSPORT POLICIES AND THEIR SYNERGISTIC EFFECT IN BRINGING ABOUT VARIOUS TRANSPORT-RELATED HEALTH EFFECTS

Policy	Reducing crashes	Reducing air pollution	Reducing noise	Mitigating climate change	Promoting physical activity	Promoting community cohesion
Speed management	☺	☺	☺	☺	☺	☺
Traffic calming and speed reduction in residential areas	☺	☺	☺	☺	☺	☺
Reducing transport demand (such as by telecommunication)	☺	☺	☺	☺	☺	☺
Road pricing	☺	☺	☺	☺	☺	☺
Cleaner fuels and more efficient vehicles	😐	☺	😐	☺	😐	😐
Promotion of safe cycling, walking and public transport	☺	☺	☺	☺	☺	☺
Safer cars (including fronts protecting pedestrians)	☺	😐	😐	😐	☺	☺
Implementing noise reduction barriers	😐	😐	☺	😐	😐	☺
Investment in safe infrastructure for cyclists and pedestrians	☺	☺	☺	☺	☺	☺
Urban parking management	☺	☺	☺	☺	☺	☺
Environmentally differentiated fees for motorized transport in urban areas	😐	☺	😐	☺	😐	unclear
Reducing the power of vehicles	☺	☺	😐	☺	😐	unclear

☺ positive effect ☹ negative effect 😐 not relevant unclear: unclear effect

Box 4.1 presents the positive results obtained in Baden (Austria) following the implementation of a comprehensive list of measures.

Some health and environmental aspects, such as air pollution, noise and climate change, have regulations and standards defining safety thresholds and quality criteria to be met, whereas road safety does not normally have defined reference values. The present lack of specific measures places road safety in a comparatively weaker position when negotiations take place.

BOX 4.1. IMPLEMENTING COMPREHENSIVE STRATEGIES: THE EXPERIENCE OF BADEN, AUSTRIA

Baden (population 25 000) is situated about 20 kilometres south of Vienna, Austria. Baden is known as a tourist and health resort, with road traffic problems that derive from its role as a district capital with hospitals and schools as well as congress and shopping facilities.

The Austrian Road Safety Board prepared an integrated transport and safety plan in 1988. The DUMAS (Developing Urban Management and Safety) project evaluated the implementation of a comprehensive list of measures and their effects on road safety:

- constructing an urban throughpass
- enlarging an existing pedestrian area
- improving the network of cycling facilities
- constructing roundabouts
- implementing 30 km/h zones
- setting up city bus lines
- applying area-wide traffic calming
- implementing parking management and car parks
- strictly enforcing traffic rules
- treating crash black spots.

The DUMAS analysis shows that injuries and deaths in road traffic crashes declined by about 60% between 1986 and 1999. Today, Baden is one of the safest towns in Austria.

Source: *DUMAS (Developing Urban Management and Safety) town studies report* (*10*).

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CHAPTER 5 FROM KNOWING WHAT IS EFFECTIVE TO MAKING IT WORK: A TOOLKIT FOR ROAD SAFETY

Improving road safety requires knowledge about implementation processes, measures known to be effective and how and where in other sectors of society road safety aspects can be mainstreamed and partnerships built. It also requires the ability to choose the strategies and approaches that best fit the specific conditions of different countries.

Several strategies and tools are now available from which the most appropriate ones to address a specific situation and context can be selected. Taken together, these instruments can be considered as a toolkit for road safety that is available to policy-makers to develop their own road safety strategies.

Implementation processes

Little research has been conducted about how road safety decision-making takes place, on which knowledge it is based, by which parties it is influenced and on which grounds choices are made (*1*). Science has emphasized more developing systems that help to describe what should be done than the systems and tools that explain how to get this done.

Although several strategies and measures have been demonstrated to be effective, it is being questioned why these are not being implemented more broadly and why road safety performance across the WHO European Region is so uneven.

The answer has several components. First, implementation processes are often too rigid, isolated from other transport policies, entrusted to poorly funded bodies, with unclear and possibly overlapping responsibilities that are mainly directed towards regulation. Second, little attention is paid to analysing the mistakes and lessons learned through the implementation processes and to adapting these lessons to different contexts. Third, market dynamics and society's objectives are not handled effectively.

The diverging interests and roles of various stakeholders need to be reconciled under the broader framework of the overall transport policy so that road safety is no longer an appendage to the road transport system but becomes one of its performance criteria, to be improved along with other objectives related to health and environmental protection that are now broadly accepted by the transport sector. If this approach is taken a step further and, in line with the new thinking, road safety becomes a governing parameter of mobility and not only one of its variables, trade-offs that could result in preventable deaths and severe injuries will not be acceptable.

One step to begin reconciling the roles of the various actors is to redefine the relationship between transport authorities and citizens so that it is based on the supplier–customer business model. In this, the needs of "customers" (transport authorities and citizens) set the performance and quality criteria of the transport products and services purchased and provided.

Using rational approaches to implement road safety programmes

Conceptual models have been developed to illustrate the planning procedure for developing and implementing road safety programmes (*2*).

The first step is to formulate a strong political statement that describes the future transport system. For example, a vision could be formulated that rejects the acceptability of death and serious injury. The second step is to analyse the problems to set quantitative targets to be achieved within a certain time period. This is followed by an assessment of possible socioeconomic measures to achieve the targets, using cost–benefit and cost–effectiveness analysis to help to set priorities among various types of action. Then a road safety programme is formulated, and its implementation needs to be

monitored and evaluated to provide feedback and allow for adjustments (*2*).

The following basic requirements have been identified for an implementation process to be effective (*1*):

- obtaining political commitment (Box 5.1);
- ensuring that there is a road safety leadership role (a road safety champion);
- making stakeholders that implement policy items accountable for the tasks allotted to them;
- organizing coordination between the key stakeholders;
- establishing a well founded relationship between objectives and targets, plans, organization and financing;
- making the best possible knowledge and information available through an information system;
- monitoring and evaluating systematically the implementation of plans and programmes;
- making trained road safety professionals available; and
- including target groups in preparing and implementing policy: politicians, administrators, policy-makers, road safety practitioners and the population and road users.

However, road safety is not the main concern of most of the actors, who are normally motivated by different and often diverging goals and objectives.

In view of this, road safety policy should be a strategic process that takes account of the interplay of actors, their main objectives, complementarity in roles and of the need to inform and consult with the public (*3*). Various tools can be used to facilitate the mainstreaming of injury prevention into the actions of these players.

- Awareness-raising may help in generating concern about a major and preventable health problem.

BOX 5.1. LEADERSHIP AND POLITICAL SUPPORT: A NEW APPROACH IN FRANCE

Since the 2002 Bastille Day speech of President Chirac, the President's personal political commitments have secured a new approach to road safety in France. This new approach was given the highest level of political impetus at a seminar in September 2002 that involved all the relevant ministers, including the Prime Minister. The new approach rejects the acceptability of traffic casualties as a by-product of road transport with action on four themes:

- better enforcement of traffic laws
- reform of the highway code
- safer vehicles
- increased action by all actors.

All relevant actors have been engaged in the process, serving the common purpose of fighting the causes of road casualties. Overall political commitment to achieving road safety has been increased at all levels. Traffic-police departments, for example, have been renamed road safety departments and greater resources placed at their disposal. The enforcement of traffic law has also been facilitated by legal changes that allow the automated control of speed. Widespread use of speed cameras has produced a massive increase in the number of speeding fines issued. It has also reduced average speeds and, more importantly, reduced crash rates. This decrease in crashes has also been aided by a crackdown on other traffic violations, especially drink–driving.

Provisional figures for 2003 show that, in one year, crash rates have declined by 17.5%, serious injuries are down by 19.4% and deaths are 20.9% lower than in 2002, although caution is needed in assessing the magnitude of effects based on very short-term results. Nevertheless, the authorities note that combating road traffic crashes is a long-term activity and that 5732 people died in road traffic crashes in France in 2003 (*4*).

- Defining how each of them can contribute to addressing the issue may help in prompting action and accountability.
- A range of tools, from regulations to "push and pull" measures, can also be used to attain such mainstreaming.

Implementation tools for road safety

The public sector can develop and use several tools and processes to effectively speed up progress towards improved road safety and to exert pressure on the various actors to take responsibility for the benefit of society as a whole (Fig. 5.1).

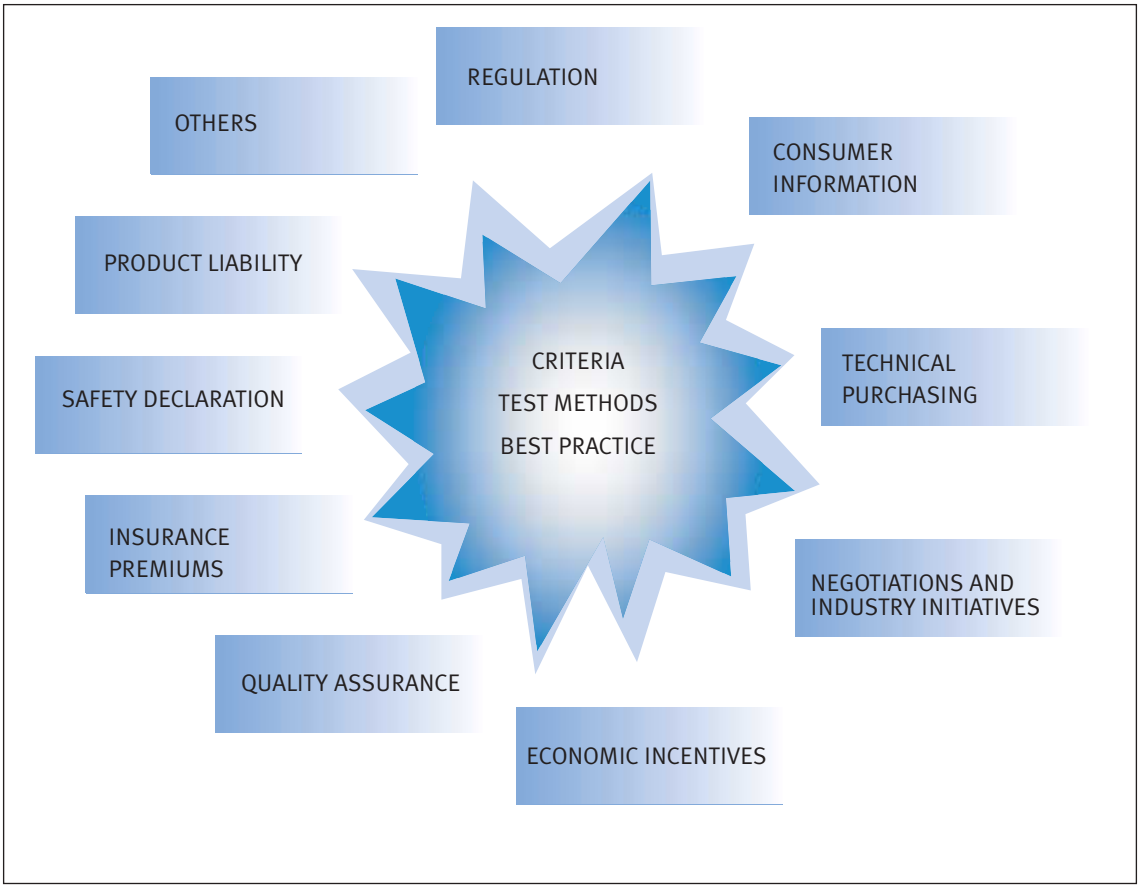
These implementation tools can be used both at the international and the national level as well as at the local level with the local government. Their use is closely interrelated and complementary to that of other tools, such as the development of regulation and enforcement. They should therefore be seen as additional rather than alternative elements of a comprehensive toolkit of possible measures that can be used to promote the empowerment and mobilization of various actors in delivering road safety.

In this context, action has already been taken towards improving existing instruments, such as: consumer information, negotiations and industry initiatives, economic incentives, quality assurance, insurance premiums, safety declarations and product liability.

The interactions between various actors are so complex that, even when the conditions described by rational approaches are in place, effective measures are not automatically implemented.

This has prompted a search for new implementation tools, such as defining product safety criteria, testing products and informing citizens about products that are comparatively better than others.

FIG. 5.1. **OVERVIEW OF TOOLS AND PROCESSES FOR ROAD SAFETY IMPROVEMENTS**



One of these tools is the European New Car Assessment Programme (EuroNCAP), which ranks different models of cars in terms of safety and makes these rankings public. This has proven to be very effective in driving the safety process beyond legal requirements. The same is now expected from the European Road Assessment Programme (EuroRAP), which ranks different roads in terms of safety and publicizes this.

These implementation tools have been developed within a context of leadership and social responsibility, well educated and informed citizens and easy access to information and are meant to influence the mechanisms that trigger the development of and the supply and demand for safe products and services. Their effectiveness relies on the assumption that leadership (both in public policy and in the private sector) is influenced by and responds to public concerns, even before these have resulted in changes in mass behaviour (Box 5.2).

Some of these tools were originally developed in the environmental sector and in the food industry, which widely use schemes that provide consumers with information about key characteristics of products, such as nutritional or environmental properties.

The critical element to ensure that mechanisms driven by these new implementation tools result in meaningful safety improvements is identifying scientifically sound criteria defining safe products and services and achieving agreement between suppliers and customers.

Another new implementation tool that has been successful in this context has been the introduction of a demand for safety in the purchase of transport services and equipment by the public sector. As the public sector accounts for a significant share of the demand for transport services and vehicles, it can influence the development and supply of safety equipment and safe transport services and support the development of a demand for increased safety.

In turn, a stronger demand for safety is expected to act as an incentive for further developments and investments.

A shared vision of the future as a tool for implementation

Developing a shared vision of the future for road safety is one of the most recent implementation tools. In the road transport system, which is an open system with a variety of stakeholders, a vision is probably more useful than in any other sector. In road safety, a vision can produce an image into the future of the qualities of the various components of the road transport system and of their reciprocal interactions.

A vision should focus on the future of the entire system and on how professionals would take responsibility for creating such a vision.

Stakeholders in the road transport system represent organizations driven by a variety of political or ideological motivations as well as by commercial interests and market forces. In other words, their actions and goals are not necessarily driven by health concerns. In this context, a vision can link the various actors in creating a moral obligation to protect life and health in the road transport system.

BOX 5.2. USE OF NEW ROAD SAFETY IMPLEMENTATION TOOLS IN SWEDEN

The Swedish National Road Administration is a government body that has acted to support the development of the demand for safer products and services by:

- adopting a travel policy that stipulates a high level of safety, limited weight and limited petrol consumption on all cars owned or rented;
- supporting the development of a system for safety ranking of heavy-duty vehicles;
- stipulating that the award of contracts is conditional on the fitting of alcohol interlock devices in all vehicles used by its contractors; and
- providing advice to local governments on how to be more oriented towards safety in their dealings and contractual arrangements with suppliers of transport services and vehicles.

BOX 5.3. INTERNATIONAL TARGETS FOR ROAD SAFETY IN EUROPE

Although national governments have the main responsibility for reducing road traffic deaths and injuries, international organizations may play an important advocacy and supportive role, including by stimulating countries to set national quantitative targets and by establishing shared goals at the international level (*9*).

The WHO health for all policy in Europe (*10*) provides international targets for reducing road traffic deaths and injuries, calling for reducing mortality and disability from road traffic accidents by at least 30% by 2020 (*10*).

The European Union has adopted the goal of reducing fatalities by 50% by 2010 (*11*). This target represents an ambition to reduce the number of deaths more quickly than continuation of past trends would imply (*7*).

The European Conference of Ministers of Transport has adopted a target of reducing road traffic fatalities by 50% by 2012, to serve as a benchmark for its 43 Member States and as a regional vision for road safety (*9*). The European Conference of Ministers of Transport is working towards establishing a mechanism to monitor annual progress towards achieving this objective in each country.

A vision also allows stakeholders to develop subsystems by themselves, still knowing that they will contribute to fulfilling the vision. It also makes identifying and understanding long-term sustainable solutions easier and allows gradual improvements to be implemented and conflicts to be worked out at an early stage.

A vision can also be a very effective way of communicating safety objectives to citizens, politicians, leaders of private enterprises and other stakeholders and of developing a common understanding of how the road transport system needs to be changed.

Setting quantitative targets: a highly effective implementation tool

Experience from several countries shows that targets can be of paramount importance in facilitating the implementation of road safety strategies and measures (Box 5.3). Target setting leads to better programmes, more effectively uses resources and improves road safety performance (*5*).

However, to be effective, targets should be quantitative, time-dependent and easily understandable, and progress towards achieving them should be able to be evaluated (*5*). Setting targets requires long-term vision, political commitment to achieving them and the identification of sustainable solutions with long-term impact.

Ambitious, long-term targets set by national governments appear to be the most effective in improving road safety performance (*5–7*).

A study that analysed the effectiveness of setting quantitative targets by national or local governments (*8*) found a statistically significant association between setting national targets and an improvement in the yearly percentage reduction in the number of road traffic deaths in the countries. Nevertheless, the complexity of factors that intervene in determining the final outcome did not allow a causal relationship to be inferred (*8*).

EVIDENCE-BASED MEASURES ADDRESSING SPECIFIC RISK FACTORS: A MAJOR COMPONENT OF THE ROAD SAFETY TOOLKIT

As highlighted in the *World report on road traffic injury prevention* (*5*), preventive strategies should be firmly based on adopting and adapting best practices to local conditions based on evidence of their effectiveness.

In the context of the new thinking about road safety, these measures should be seen as a fundamental component of the toolkit that allows comprehensive preventive strategies to be implemented that address all the components of the road transport system.

Research about the effectiveness of various measures has allowed a broad and comprehensive range of successful strategies to be identified that address all the risk factors, including:

- human error within the road transport system;
- the magnitude and nature of the kinetic energy of the impact to which people in this system are exposed as a result of errors;
- how individuals tolerate this impact; and
- the quality and availability of emergency services and acute trauma care.

The development in the early 1970s of the Haddon matrix (Table. 5.1) has contributed significantly to identifying risk factors and developing countermeasures within a systematic framework. This defines a dynamic system that identifies the three phases of the time sequence of a crash event – pre-crash, crash and post-crash – as well as the epidemiological triad of human, machine and environmental factors that can interact during each phase of a crash. Each of the resulting nine cells of the Haddon matrix allows opportunities for intervention to reduce road crash injury (*5,12*).

Although the Haddon matrix was developed in the context of the transport sector, it has become popular in the health sector. It fits very well with the public health approach to prevention, in which primary prevention corresponds to the possibility of preventing the crash from occurring (pre-crash phase), secondary prevention corresponds to the possibility of mitigating the effects of the crash during the collision (crash phase) and tertiary prevention (followed by rehabilitation) corresponds to the possibility of saving lives by providing emergency care and life support to the victims (post-crash phase).

Nevertheless, an important limitation of the Haddon matrix is that it is not well suited for the measures that manage exposure to road traffic hazards through land use, urban design and transport policy.

These measures include requiring safety impact assessment before planning decisions are made; promoting efficient patterns of land use; providing shorter, safer routes for vulnerable road users; discouraging unnecessary trips; and encouraging the use of safer modes of travel.

Other effective preventive measures include:

- **minimizing exposure to high-risk road traffic scenarios**, including by restricting access to parts of the road network; giving priority to higher-occupancy vehicles; restricting the power-to-weight ratios of motorized two-wheelers; and regulating motor vehicle use by young riders and drivers;

- **planning and design roads for safety**, including by adopting safety-conscious design of roads; designing road function to meet the needs and vulnerabilities of pedestrians and cyclists as well as of motor vehicle drivers, riders and passengers; and performing safety audits and implementing remedial action at high-risk crash sites;

- **providing visible, crashworthy, smart vehicles**, including by improving the visibility of vehicles and vulnerable road users; improving the crashworthiness of motor vehicles; protecting pedestrians and cyclists with improved vehicle fronts; protecting motor vehicle occupants; improving vehicle-to-vehicle compatibility; improving bicycle design; and designing smart vehicles;

- **setting road safety rules and securing compliance**, including by setting and enforcing speed limits and blood alcohol concentration (BAC) limits and publicizing enforcement; reducing the risk of impairment from medicinal and recreational drugs; addressing the problem of driver fatigue; reducing the risk of junction crashes; requiring seat-belts and child restraints for vehicle occupants and helmets on two-wheelers; banning drivers from using hand-held mobile telephones; and educating and informing the public; and

- **delivering care after crashes**, including by improving care before reaching a hospital; promoting response by bystanders; ensuring access to emergency services; and providing care

TABLE 5.1: THE HADDON MATRIX

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

Source: Peden et al. (*5*) based on Haddon (*12*).

through emergency services, hospitals and rehabilitation structures.

Chapters 3 and 4 of the *World report on road traffic injury prevention* (*5*) discuss risk factors in road traffic crashes and effective interventions in depth; the following section briefly reviews selected key risk factors.

Speed

Because speed at the time of collision is the key determinant of the kinetic energy the human body sustains in a crash, it is the single most important factor in determining the outcome of a collision and the single most important factor to keep under control.

Speed affects the risk of a crash occurring: the greater the speed, the less time there is to prevent a collision. In addition, the greater the speed, the more severe the consequences once a crash has occurred (*5*).

- An average increase in speed of 1 km/h is associated with a 3% higher risk of a crash involving an injury (*13,14*).
- In severe crashes, the increased risk is even greater. In such cases, an average increase in speed of 1 km/h leads to a 5% higher risk of serious or fatal injury (*13,14*).
- Travelling 5 km/h faster above a road speed of 60 km/h results in an increase in the relative risk of

TABLE 5.2. EXAMPLES OF EFFECTS OF SPEED LIMIT CHANGES

Date	Country	Type of road	Speed limit change	Effect of change on speed	Effect of change on fatalities
1985	Switzerland	Motorway	130 km/h to 120 km/h	5 km/h decrease in mean speeds	12% reduction
1985	Switzerland	Rural roads	100 km/h to 80 km/h	10 km/h decrease in mean speeds	6% reduction
1985	Denmark	Roads in built-up areas	60 km/h to 50 km/h	3–4 km/h decrease in mean speeds	24% reduction
1987	USA	Interstate highways	55 miles/h (88.5 km/h) to 65 miles/h (104.6 km/h)	2–4 miles/h (3.2–6.4 km/h) increase in mean speeds	19–34% increase
1989	Sweden	Motorways	110 km/h to 90 km/h	14.4 km/h decrease in median speeds	21% reduction

Source: *Reducing injuries from excess and inappropriate speed* (*19*) with the permission of the publisher.

being involved in a casualty crash that is comparable with having a BAC of 0.05 g/dl (*15*).

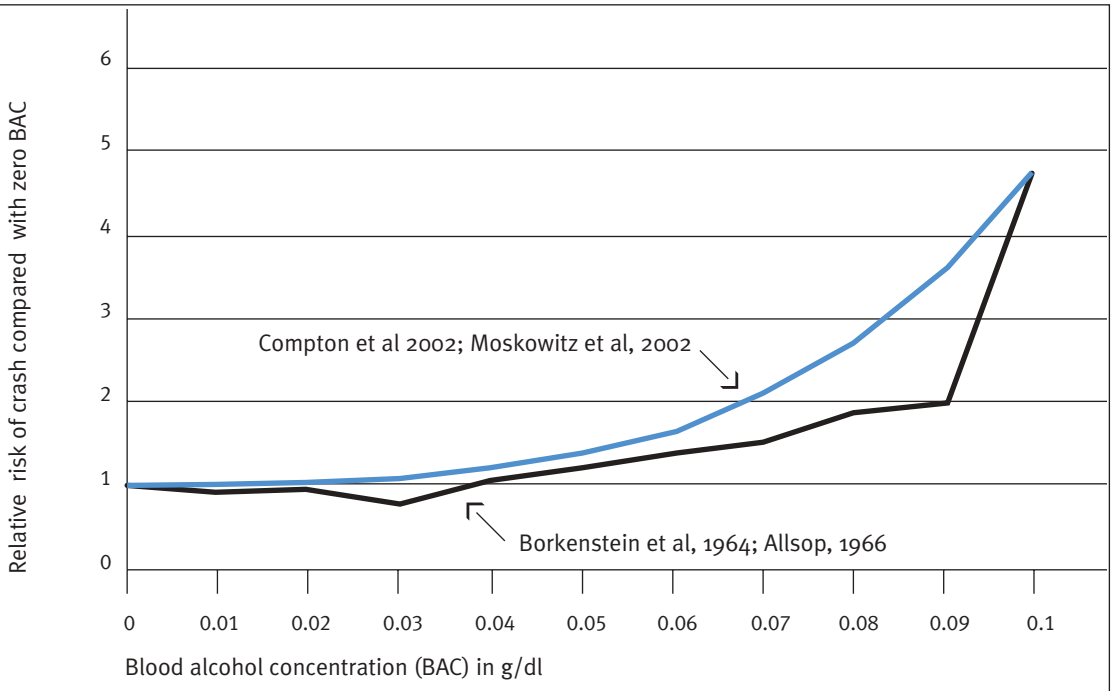
- For car occupants in a crash with an impact speed of 80 km/h, the likelihood of death is 20 times what it would have been at an impact speed of 32 km/h (*16*).
- Pedestrians have a 90% chance of surviving car crashes at 30 km/h or less but less than a 50% chance of surviving an impact at 45 km/h or above (*17*).
- The probability of a pedestrian being killed rises by a factor of 8 as the impact speed of the car increases from 30 to 50 km/h (*18*).

Excessive and inappropriate speed is a major cause of about one third of the fatal and serious crashes in the European Union (*9*). In the European Union, reducing the average speed by 3 km/h would save an estimated 5000 to 6000 lives each year and would avoid 120 000 to 140 000 crashes, saving €20 billion (*9*). Table 5.2 summarizes the effects of changes in speed limits.

Speed control is at the core of the most recent thinking about road safety. Professionals widely agree that speed should not exceed 50 km/h in urban areas and 30 km/h in residential areas and other areas with great potential for conflict between vulnerable road users and motorized vehicles. Measures reducing speed not only save lives but can be highly cost-effective. In a town in the United Kingdom, area-wide speed and traffic management were shown to be highly effective, especially in residential areas, where benefits exceeded costs by a factor of 9.7 (*20*).

Despite its importance as a risk factor, no consensus has been achieved on the harmonization of speed limits at the international level, and countries differ substantially in the speed limits on different types of roads. Table A5 in Annex 2 shows the maximum speed limits in European countries.

FIG. 5.2. RELATIONSHIP BETWEEN BLOOD ALCOHOL CONCENTRATION (BAC) AND RELATIVE RISK OF CRASH



Sources: Compton et al. (*21*), Borkenstein et al. (*24*), Allsop (*25*) and Moskowitz et al. (*26*).

Alcohol

The main effects of alcohol on the risk of crashes have been summarized as follows (*5*).

- Drivers and motorcyclists with a BAC greater than zero are at higher risk of a crash than those whose BAC is zero.
- For the general driving population, as the BAC increases from zero, the risk of being involved in a crash starts to rise significantly at 0.04 g/dl (Fig. 5.2) (*21*).
- Men 18–24 years old driving with a BAC of 0.05 g/dl have nearly twice the risk of a crash as male drivers aged 25 years or older with the same BAC (*22*).
- A study on drivers killed in road crashes estimated that teenage drivers had more than five times the risk of a crash than drivers 30 years and older at all BAC. Drivers 20–29 years old were estimated to have three times the risk than drivers aged 30 years and above at all BAC (*23*).
- Teenage drivers with a BAC of 0.03 g/dl carrying two or more passengers were 34 times more at risk of a crash than drivers 30 years or older with a BAC of zero driving with one passenger (*23*).
- A BAC limit of 0.10 g/dl will result in three times the risk of a crash compared with the most common limit in high-income countries of 0.05 g/dl. A BAC limit of 0.08 g/dl still poses twice the risk of a limit of 0.05 g/dl.
- Alcohol consumption by drivers puts pedestrians and riders of motorized two-wheelers at risk (Box 5.4).

In the European Union, an estimated 5–40% of road traffic deaths could be prevented if no driver had a BAC exceeding 0.05 g/dl (*27*).

Similarly to speed, no consensus has been found on harmonization of BAC limits at the international

BOX 5.4. INTERNATIONAL POLICY TOOLS CONTRIBUTING TO REDUCE DRINK-DRIVING: THE DECLARATION ON YOUNG PEOPLE AND ALCOHOL AND THE EUROPEAN ALCOHOL ACTION PLAN 2000–2005

The WHO Regional Committee for Europe endorsed the Declaration on Young People and Alcohol in September 2001 (*28*). To complement the broader societal response, as outlined in the European Alcohol Action Plan 2000–2005 (*29*), specific targets, policy measures and support activities for young people need to be developed.

The Declaration includes various approaches to providing protection from exposure to alcohol promotion and sponsorship and to implementing control policies on age and pricing. Among other things, it calls for enforcement of drink-driving regulations and penalties.

The European Alcohol Action Plan 2000–2005 (*29*) aims to reduce the harm caused by alcohol and sets desired outcomes for drink-driving:

> "By the year 2005, all countries of the European Region should seek a substantial reduction in the number of alcohol-related accidents, fatalities and injuries resulting from driving after consuming alcohol."

Recommended actions to achieve these outcomes include:

- ensuring high levels of enforcement of current drink-driving legislation;
- promoting high-visibility breath testing on a random basis;
- reviewing current BAC limits and considering enacting legislation to adopt BAC limits of 0.05 g/dl or lower and of close to zero for novice drivers and professional drivers of transport vehicles;
- encouraging the provision of alternative transport to their own vehicles for drivers who have consumed alcohol; and
- considering mandatory driver education and treatment programmes for habitual drink-driving offenders.

level, and countries differ. Table A5 in Annex 2 shows the BAC limits in European countries.

Although implementation requires setting appropriate speed and BAC limits, success highly depends on how successfully and firmly limits and regulations are enforced and on which specific strategies are adopted to ensure compliance. Rigorously applying all current cost-effective strategies for enforcing traffic laws in European Union countries might prevent an estimated 50% of deaths and serious injuries in these countries (*30*). Boxes 5.5 and 5.6 present examples of such strategies for preventing road traffic crashes.

Table 5.3 is a toolbox providing an overview of a variety of measures addressing various risk factors that have been demonstrated to be effective. Where possible, examples have been selected from European studies with the intent of assessing quantitatively the estimated effect of implementing these measures. The *World report on road traffic injury prevention* (5) provides more detailed information.

Because the studies summarized here were conducted under very different conditions and only address selected risk factors, the table does not add up to 100% reduction, and adding the measured or estimated levels of effectiveness for different measures would be incorrect.

BOX 5.5. THE EFFECTIVENESS OF ENFORCEMENT: HIGHLIGHTS OF THE ENHANCED SAFETY COMING FROM APPROPRIATE POLICY ENFORCEMENT (ESCAPE) STUDY

This study aimed at identifying important issues of traffic law enforcement in the European Union, examining traditional and innovative enforcement approaches and tools and assessing their potential to improve compliance for increased safety on roads. The study examined the impact of enforcement on crashes.

Combined reanalysis of the scores from separate evaluation studies of changes in enforcement levels suggests that increased enforcement may have reduced injury crashes by an average of 6–17%. The results varied widely according to the method of enforcement, the type of roads, the baseline compliance level, the target behaviour, the size of the project and many other factors.

Many of the studies indicate a dose–response relationship (association) between police enforcement and safety. Increasing enforcement further reduces the number of crashes, but the marginal effect of increasing enforcement gradually becomes smaller.

Source: adapted from Mäkinen et al . (*31*).

BOX 5.6. PRELIMINARY RESULTS ON REDUCTIONS IN CRASHES AND CASUALTIES IN ITALY FOLLOWING THE INTRODUCTION OF A DRIVING LICENCE SYSTEM BASED ON POINTS

In June 2003, Italy introduced a driving licence system based on points that can be deducted in traffic violations, with the licence being suspended or revoked in cases of repeated and/or serious violations.

The effectiveness of this measure was preliminarily assessed by comparing changes in the number of crashes and casualties during the months following the initiative and the same period a year before, and this assessment was accompanied by a mass-media campaign to raise awareness and strengthened enforcement by the road police. The number of crashes, deaths and injuries declined about 20%, which saved an estimated €650 million from July to December 2003. Data used in the analysis solely included road police records for highways and regional and county roads.

	July–December 2002	July–December 2003	Change (n)	Change (%)
Total crashes recorded on highways and regional and county roads	102 328	83 247	–19 081	–18.6%
Deaths	2 438	1 991	–447	–18.3%
Injuries	74 741	57 738	–17 003	–22.7%

Source: adapted from Taggi et al. (*32*).

TABLE 5.3. A TOOLBOX OF SELECTED EFFECTIVE PREVENTIVE MEASURES

Risk factor	Measure
Inexperience among novices and young drivers	Graduated driver licensing (New Zealand)
Vulnerability of cyclists	Segregated bicycle tracks or lanes alongside urban roads (Denmark)
Unsafe road environment	Area-wide road safety management (several European countries) – specific example of Baden (Austria): 75% of the road network restricted to 30 km/h or less and an integrated system of public transport with pedestrians and cycle routes
Head-on or side collisions, crossing over	Flexible cable barriers on dual-carriageway roads, with no pedestrians or bicycles (Denmark, Sweden, Switzerland and the United Kingdom)
Striking rigid roadside objects	Crash cushions (United Kingdom)
Poor visibility of vehicles and vulnerable road users	Daytime running lights for cars (various European countries)
	Daytime running lights for motorcycles (various European countries)
	Use of bicycle lights (Netherlands)
Crashworthiness of vehicles	Improving the crashworthiness of vehicles (United Kingdom)
	Introduction of laws requiring safer car fronts to reduce injuries to pedestrians and cyclists (European Union)
Vulnerability of vehicle occupants	Use of seat-belts for car drivers and car occupants in the front seat (various countries)
	Combination of seat-belts plus air bags (various countries)
	Child restraints (various countries)
Lack of compliance with existing road safety rules	Using speed cameras to detect offenders (various countries)
	Enforcement of BAC limits by intensive random breath testing (three states in Australia)
	Enacting laws making driving with a BAC above 0.08 g/dl illegal (United States, 1980–1997)
	Enactment of zero tolerance laws (United States, 1980–1997)
	Enactment of administrative laws on licence revocation (United States, 1980–1997)
	Installing cameras that photograph vehicles going through traffic lights when signals are red (Oxnard, California, United States)
Driver fatigue	Not driving: while feeling sleepy; after sleeping for less than five hours in the previous 24 hours; or between 02:00 and 05:00 (New Zealand)
Head injuries among riders of two-wheelers	Mandatory helmet wearing for moped riders and motorcyclists (various countries – meta-analysis)
	Mandatory wearing of cycle helmets for cyclists (various countries – meta-analysis)

Source: summarized from Peden et al. (5).

Examples of estimated ranges of potential effectiveness from various studies
8% reduction in crashes involving serious injuries among young novice drivers (*33*)
35% reduction of deaths among cyclists (*34*)
60% decline in road casualties (*35*)
Reduction of fatal and serious injuries by 45–50% (*36*)
Reduction of fatal and serious injuries resulting from impact by 67% or more (*37*)
Incidence of daytime crashes reduced by 10–15% (*38*)
Crash rates of motorcycles reduced by 10% (*39*)
Could avoid 30% of bicycle crashes (*40*)
Reduction in the number of fatal or serious injuries of 15.4% (*41*)
Expected reduction of 2000 deaths per year in the European Union (*9*)
40–50% reduction in all injuries 40–65% reduction in fatal collisions 43–65% reduction in moderate and severe injuries (*42,43*)
Estimated reduction of driver and front passenger death by 68% (*43*)
Rearward facing: 76% reduction in all injuries and 92% reduction in severe injuries Forward facing: 34% reduction in all injuries and 60% reduction in severe injuries (*44*)
Various studies and countries have found different ranges of effectiveness. Examples from Europe indicate: • 50% reduction in all crashes based on various European countries (*45*) • 35% reduction in road traffic deaths and serious injuries and 56% reduction in pedestrians killed or seriously injured at a camera site in the United Kingdom (*46*)
Reduction in rates of alcohol-related road traffic deaths by 36–42% (*47*)
Significant reduction of mortality during period of enactment (*48*)
Significant reduction of mortality during the period of enactment (*48*)
Significant reduction of mortality during period of enactment (*48*)
29% reduction in crashes with injury 68% reduction in front-into-side crashes with injuries at treated sites (*49*)
Reduced the incidence of road crashes by up to 19% (*50*)
Reductions in the number of people injured of about 20–30% (*37*)
Reductions in the number of head injuries among cyclists by about 25% (*37*)

The European Road Safety Action Programme: supporting the implementation of effective measures

The European Road Safety Action Programme (*9*) aims to achieve the objective of halving the number of road crash victims in the European Union by 2010 and encourages European Union countries to strive to perform at least as well as the best performing ones.

The Programme focuses on European Union action on the following priority items:

- improving the behaviour of road users through enforcement, information campaigns and provisions related to driving licences;
- improving vehicle safety through technical inspections and better passive and active safety, including by orienting consumer choices through consumer information programmes such as EuroNCAP;
- improving road infrastructure, including through road assessment programmes, such as EuroRAP, which provides motorists across Europe with information based on objective criteria about the level of safety on the main roads they use;
- identifying and disseminating best practices by drafting technical guides;
- improving the collection and analysis of data on crashes and physical injuries;
- promoting research and development to find solutions for the future; and
- establishing a European Road Safety Observatory within the European Commission.

The Programme also encourages everyone in authority, with decision-making powers or acting in an economic, social or representative function to subscribe to a European Road Safety Charter with a commitment to undertake to implement specific actions.

MAINSTREAMING ROAD SAFETY ACROSS DIFFERENT SECTORS

Several processes at the international level are providing countries with reference policy frameworks that provide opportunities for mainstreaming road safety across various sectors.

They encompass existing legal or other measures to reduce transport risks, including the measures addressing road safety, and placing them into a broader framework (Chapter 4). These instruments also promote greater participation of the health sector in transport-related decisions that ultimately affect health.

The Charter on Transport, Environment and Health and the Transport, Health and Environment Pan-European Programme

The Charter on Transport, Environment and Health (*51*) is a non-legally binding instrument aimed at placing health and environmental considerations firmly on the agenda of transport policy-makers. It was adopted at the WHO Third Ministerial Conference on Environment and Health in London in 1999. Its negotiation brought together representatives of ministries of transport, environment and health along with intergovernmental and nongovernmental organizations.

The Charter is being implemented through the Transport, Health and Environment Pan-European Programme, adopted in 2002 (*52*) and jointly implemented under the auspices of the WHO Regional Office for Europe and of the United Nations Economic Commission for Europe.

The Transport, Health and Environment Pan-European Programme streamlines efforts in the European Region towards transport sustainable for health and the environment and provides a framework in which the United Nations Economic Commission for Europe, the WHO Regional Office for Europe and Member State representatives work in close cooperation with relevant international and nongovernmental organizations towards implementing a work plan that concentrates on a few priorities. The ones especially relevant to road safety are integrating the transport, health and environment sectors, disseminating information and good practices, giving attention to the specific needs

of the Commonwealth of Independent States countries and south-eastern European countries and addressing the health and environmental effects of transport in the urban environment.

The Children's Environment and Health Action Plan for Europe

The Children's Environment and Health Action Plan for Europe is being negotiated by Member States of the WHO European Region and will be adopted at the Fourth Ministerial Conference on Environment and Health in Budapest, Hungary on 23–25 June 2004.

The Children's Environment and Health Action Plan for Europe is an international instrument that tackles the most important environmental risk factors for the health of European children and provides concrete tools to address them. The Plan covers the whole European Region, providing a framework within which Member States can develop their national plans and policies by adapting it to their needs.

Based on evidence, the Plan sets out action aimed at various sectors to decrease environmental exposures and to give priority to preventing childhood diseases. In particular, the Plan identifies reducing the burden of injuries among children as one of the four priority regional goals on which ministries commit to focus, including by implementing the recommendations of the *World report on road traffic injury prevention* (*5*) and this report; developing, implementing and enforcing child-specific regulations to protect them from injuries; supporting child-friendly urban planning; and advocating safe access to green spaces and safer mobility within the community.

The Protocol on Strategic Environmental Assessment

The Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context (*53*) was adopted in 2003 and is currently open for signature and ratification. The Protocol requires that strategic policy decisions being considered in all sectors be assessed for their potential effects on the environment and health.

The effects of planned transport and land-use strategies, for example, on injuries and other health effects will need to be described, health authorities consulted, stakeholders heard and mitigation measures described and discussed as part of the planning process.

The clear requirement to assess the health effects that may result from planned developments and to involve health authorities in the strategic environmental assessment should facilitate the consideration of health aspects as part of planning in other sectors. This can be an important step to achieve intersectoral policy-making, which is often articulated as a goal but has been difficult to translate into practice. In addition, as road safety and other health concerns are mainstreamed into development processes at a stage when different options are still available, any changes to initial proposals are more likely to be considered and implemented.

Because of its legally binding nature, the Protocol should encourage the institutionalization of health impact assessment of sector policies, which will not depend solely on the discretion of motivated individuals (*54*).

ADAPTING NEW THINKING ABOUT ROAD SAFETY TO COUNTRIES WITH ECONOMIES IN TRANSITION

Because the new approach to road safety is based on the laws of physics and on human physiology and psychology, dangerous levels of energy and the possibilities for making errors are equivalent regardless of the economic, political and social conditions, making this approach universally applicable in principle. What differs is how countries choose to control and manage these dangerous levels of kinetic energy through road safety strategies and policies. These differences have to be taken into account in appraising and comparing road safety in different countries. The lessons learned from experiences in Europe and worldwide can be adapted and transferred to countries with economies in transition. The toolkit of measures and approaches described in the previous section may provide a good reference for countries to select the approaches that best respond to their needs and to use them as building blocks in developing new policies for road safety.

The specific solutions – whether new or rehabilitated infrastructure, new institutional structures or new regulations – must be carefully adapted to the national and local political, economic and technical conditions in each country.

Informal public transport has developed in many Commonwealth of Independent States countries and south-eastern European countries (Box 5.7). This makes controlling and ensuring good safety standards among informal operators of public transport very challenging and requires the development of new solutions. Similarly, unfavourable economic conditions make it difficult to introduce instruments that would allow for more funds for safety to be collected through market mechanisms, such as vehicle taxation, insurance premiums and other economic instruments. As the institutional settings for road safety were established at a time when private transport was extremely limited, they are not always adequate to deal effectively with the challenge posed by the steep growth in private motorization.

In countries with economies in transition, road safety problems can be improved by applying a tiered approach:

- selecting measures from the toolkit that can be implemented speedily as front-line treatment to improve road safety rapidly, focusing on strengthening the enforcement of well known and cost-effective measures, such as reducing speeds,

BOX 5.7. THE "SEC" SAFETY BELT: IMPROVING TRANSPORT SAFETY IN SOUTHERN, EASTERN AND CENTRAL EUROPE (*55*)

With the enlargement of the European Union in 2004, the imbalance between northern and southern Europe is likely to be reinforced. An increased transport volume will bear additional risks for the countries that are already relatively unsafe. Without appropriate policies, the current situation in the new countries is likely to worsen and might lead to a permanent situation in which the north-south divide is complemented by a west–east divide.

However, appropriate policy-making can restore the balance to such an unbalanced transport safety topography. Experts from across Europe agree that safety in these countries is not impossible but requires cultivating that which has fallen dry.

This is the background to a proposed project of the European Transport Safety Council. The overall aim is to contribute to durable improvement of transport safety in the countries of southern, eastern and central Europe. Hence, this project seeks to translate a European safety vision into practical measures to improve the safety of transport users within these countries. The project will raise awareness for the introduction of measures within six priority areas: user behaviour; vehicle technology; road infrastructure; road technology; information and databases; and evaluation of national road safety policies.

wearing seat-belts, wearing helmets, using other safety restraints, preventing drink-driving and respecting speed limits and vulnerable road users;
- building understanding of and consensus for the new approach that accounts for human imperfection, orienting investments towards gradually making the road transport system more tolerant of mistakes, shifting the responsibility for safety towards the designers and providers of the road transport system and building safety into road transport systems; and
- promoting the notion that road safety is an integral component of sustainable transport and therefore actively seeking synergy with policies that also tackle other transport-related health effects.

These approaches should be applied through establishing new partnerships that span across businesses, civil society and various sectors of the government, including transport, infrastructure, health, justice, education, environment and finance. The international community should support them by building capacity, exchanging information, supporting research and allocating funds.

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CHAPTER 6 THE HEALTH SECTOR AND ROAD SAFETY IN EUROPE: EMBRACING A BROADER ROLE

Of the many actors that share responsibility for road safety, the health sector has traditionally played a leading role in injury surveillance and in the post-crash phase of road traffic crashes to avoid preventable death and disability, to limit the severity and suffering caused by the injury and to ensure optimal functioning of the crash survivors and reintegration into the community (*1*). The health sector also plays a leading role in advancing research on and implementation of evidence-based practices for trauma care and rehabilitation.

This requires allocating substantial public health resources to road traffic casualties, leaving fewer resources available to deal with other public health priorities. For perspective, recent estimates of the cost of road traffic crashes in the European Union indicate that health care costs are in the range of €7000 per fatality and €12 000 per serious injury (*2*). At the level of the European Region, this would translate into costs that could reach the order of tens of billions of euros.

Not only improving road safety would allow resources to be saved by reducing hospital admissions, the severity of injuries, rehabilitation needs and demand on emergency services. Improving safety for cyclists and pedestrians would also help to create conditions that can facilitate the choice of healthier lifestyles, thereby contributing to reducing risks for many noncommunicable diseases.

The health sector has a huge interest in being fully engaged and embracing an ever-increasing role in preventing road traffic crashes, including by exploring new areas of involvement that have emerged recently. Nevertheless, the health sector has historically regarded road safety as not being part of its core business, leaving the main responsibility to the transport sector (*3,4*).

The *World report on road traffic injury prevention* (*1*) proposes that the health sector take on a new and broader role in preventing road traffic injury globally. In Europe, it is also time for the health sector to take a more proactive role and to bring road traffic injuries back into its core business. The following section articulates the diverse roles the health sector can assume in various aspects of promoting road safety.

ADVOCATING HEALTH

The WHO Constitution says that the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition.

In this context, advocating for safe road transport systems that reject the occurrence of preventable deaths and serious injuries is an important way for the health sector to fulfil its mission of protecting the fundamental human right to health. The health sector calling for road safety to become a built-in and key performance parameter of road transport systems can become a very powerful advocacy argument, especially because many health professionals can integrate knowledge of effective measures with the ability to speak forcefully and convincingly to different audiences.

Professionals involved in trauma care and rehabilitation can use the emotional impact and moral authority deriving from witnessing the human tragedy behind road traffic injuries to advocate for effective measures to be implemented and energize various stakeholders, including nongovernmental organizations (Box 6.1).

Professionals involved in preventive medicine and environmental health, together with public health administrators and civil servants, can be instrumental in placing road safety on the agenda of other sectors. They can do this by promoting greater awareness about the relationships between road safety and other transport-related health effects, facilitating the identification of new and synergistic strategies and implementing win–win policies with other relevant sectors, such as those of transport, urban planning and the environment (*6*).

BOX 6.1. HEALTH PROFESSIONALS AS PASSIONATE AND EVIDENCE-BASED ADVOCATES FOR ROAD SAFETY: AN EXAMPLE FROM NEW ZEALAND

In 1987, a group of intensive care specialists in New Zealand decided to become involved in preventing road traffic injury by promoting five initiatives:

- using the term crash rather than accident
- installing motorway median barriers
- ensuring appropriate child restraints in vehicles
- sampling of BAC for legal purposes
- advocating a Ministry of Trauma Prevention.

The core of this advocacy activity was changing the discourse on road traffic injuries by rejecting the concept of "accidents", speaking of the tragedy of real people rather than of "road deaths", proposing effective and immediate action rather than "more reports" and focusing on opportunities for prevention instead of causation. A communication campaign became a successful lobbying action based on clever use of the mass media, which included raising awareness by ruthlessly and immediately exploiting every crash and every death, personalizing the victims and being well informed and innovative in communication.

This resulted in the term crash being widely publicized in all mass media, being adopted by the Coroner in reporting road deaths and being received favourably by the Minister for Health. Median barrier installation became an issue for the electronic and print media, politicians and the public. A petition from Auckland with 16 000 signatures was presented to Parliament in July 1988. Because of the increasing pressure on the Ministry of Transport, the Prime Minister announced a new policy in which "all new motorways will have median barriers as part of design and all old motorways will be retrofitted". These installations were completed in Auckland by 1992.

Source: Streat (*5*).

PROVIDING EVIDENCE-BASED INFORMATION

The health sector plays a leading role in monitoring and reporting on road traffic deaths and injuries as well as various risk factors. The health sector then makes this information available to inform research aiming at redesigning road transport systems around the vulnerability of the human body and at identifying cost-effective strategies for treating and rehabilitating people who are injured.

In particular, the health sector has a unique role in:

- developing the evidence base for effective practices in preventive interventions, emergency practices, trauma care and rehabilitation;
- developing injury information systems based on hospital data and supporting the reconciliation of injury data from different sources;
- developing good practices and guidelines on essential trauma care and emergency services;
- identifying appropriate indicators to monitor various risk factors;
- estimating the social costs of road traffic injuries (including health care costs, costs to families and the loss of income and productivity) and using these in advocacy and in identifying cost-effective measures; and
- defining and articulating key factors and mechanisms for effective policy implementation, such as identifying the enabling factors for various stakeholders to take action to prevent injury and understanding policy-making and decision-making in the context of injury prevention.

These information-related aspects should not be separate. They should be developed as the key components of an integrated information system that helps in linking risks to effects, preventive measures and results. Such a system could be linked and add value to other relevant information systems, including those developed in environmental health indicators and in policy integration, such as the Transport and Environment Reporting Mechanism (TERM) developed by the European Commission and the European Environment Agency (*7*).

The health sector generates evidence-based information, which makes it an important partner for the road transport sector in defining the risks for injuries and in translating these into the risk to public health. Although the health and transport sectors already cooperate in many areas in research on factors that influence driving (such as mental health, illicit drugs, medicines and physical fitness for driving) and in developing systems for quality assurance, benchmarking and knowledge transfer, organizing this cooperation better would make progress even more rapid and use resources more efficiently.

BEHAVING AS A RESPONSIBLE USER OF TRANSPORT SERVICES

The health sector plays a very important role as a consumer of road transport services. The health sector generates substantial road traffic both through its employees and users and by purchasing transport services. Safety can become an integral part of the responsible corporate behaviour of the health sector.

As a responsible employer and user and purchaser of transport services, the health sector should ensure that all employee duty travel is carried out safely. Public transport, cycling and walking should be promoted when possible. When motor vehicles are required, the vehicles should be safe, operated under safe conditions, travelling within the existing speed limits, using the best safety equipment and operated without consuming alcohol and recreational drugs. By purchasing transport services that are safe, the health sector can be an influential actor in creating demand for safe transport products and services and in stimulating partners within and outside the health sector to act accordingly.

The health sector can also play an active role in minimizing exposure to the risk of crashes for its employees and customers by ensuring that health care premises are conveniently accessible by safer modes and means of transport, in particular public transport, cycling and walking (*8*).

In addition, the health sector should use its knowledge about effective measures to support and encourage the public, organizations and enterprises to make responsible choices by giving preference to the purchasing and supplying of safer transport products and services and adopting safer corporate transport policies for their employees. For example, a corporation commissioned a research institute in the United Kingdom to systematically review the evidence about the effectiveness of additional education for licensed drivers in preventing road traffic crashes. The results of the review provided no evidence that this additional education is effective in preventing road traffic injuries or crashes and were used to revise the corporate travel policy (*9*).

TABLE 6.1. ESTIMATED ANNUAL GLOBAL RESEARCH AND DEVELOPMENT FUNDING FOR SELECTED DISEASE AND INJURY GROUPS AND RANKING OF THE TOTAL NUMBER OF DALYs LOST IN 1990 AND 2020 (PROJECTION)

Disease or injury	Millions of US dollars	1990 ranking in DALYs	2020 ranking in DALYs
HIV/AIDS	919–985	2	10
Malaria	60	8	–
Diarrhoeal diseases	32	4	9
Road traffic crashes	24–33	9	3
Tuberculosis	19–33	–	7

Source: Investing in health research and development: report of the Ad Hoc Committee on Health Research Relating to Future Intervention Options (*10*).

LEADING RESEARCH AND INNOVATION

The current research efforts and resources in the health sector for road traffic injury prevention fail to match the magnitude of the problem compared with other public health challenges (Table 6.1).

This requires much stronger action from the health sector to develop and maintain strong support for investing in independent research for various aspects of road safety.

Areas in which additional research appears to be needed include improving practices for trauma care and emergency support, in particular for the treatments whose effectiveness has not been clearly demonstrated, such as fluid resuscitation (which is intended to minimize the effects of haemorrhagic shock and to stabilize the haemodynamic response to trauma and hypovolaemia (*11*)), head injury management and the use of ambulances and helicopters to transfer injured people to health facilities.

Although research is in progress on chronic impairment from ageing, mental illness and disease as well acute impairment from drugs, alcohol and medicines (*12*), more efforts are needed to elucidate the effects of medicinal and recreational drugs as well as their possible interactions in increasing the risk of crashes.

The health sector also needs to strengthen its participation in research projects aiming at developing integrated models to simulate the effects of various transport policy scenarios on road safety and other transport-related health effects and in supporting the development of cost–benefit analysis of transport-related policies, plans and projects that include safety and other health benefits for all road users in the assessment.

ENSURING THAT DRIVERS ARE FIT TO DRIVE AND DELIVERING POST-CRASH CARE[1]

Opportunities to prevent deaths and to mitigate the effects of injuries start with the role of the health sector in ensuring that drivers are fit to drive. This continues all along the chain of post-crash care, from the possible interventions by bystanders at the scene of the crash to emergency rescue, access to the emergency care system and trauma care and rehabilitation. Each step may influence the next one.

Ensuring that drivers are physically and mentally fit

In several European countries, the granting and renewal of driving licences is contingent on satisfactorily passing health examinations that aim at assessing the physical and mental health conditions of would-be drivers and at monitoring this periodically. For example, European Union directive 91/439/EEC stipulates minimum criteria for granting driving licences, in particular requiring that health examinations assess the absence of potential risk conditions deriving from lack of adequate visual acuity and hearing capacity, locomotor disability, cardiovascular diseases that may cause a sudden impairment of cerebral functioning, diabetes mellitus, nervous system diseases, mental disorders, alcohol abuse, use of drugs and medicinal products and serious renal insufficiency (*14*).

Improving care before reaching a hospital

A review of studies in Europe (*15*) concluded that about 50% of road traffic deaths occur within a few minutes at the scene of the crash or on the way to a hospital, 15% at the hospital within four hours of the crash and 35% after four hours. A study comparing road traffic deaths across a range of countries (*16*) found that the vast majority of deaths in low- and middle-income countries occur before reaching the hospital. The same study also found that the probability of dying before reaching the hospital increases as the socioeconomic status of the victim decreases.

[1] *This section is largely adapted from the* World report on road traffic injury prevention. Summary (*13*).

The people arriving first at the scene of a crash can play important roles in preventing more serious consequences by: calling emergency services; putting out fires; securing the scene to prevent further collisions or harm to other bystanders and rescuers; and applying first aid. Bystanders trained in first aid could prevent, for example, many deaths that result from airway obstruction or external haemorrhage (*17*).

Access to emergency services

In most high-income countries, the large volume of road traffic and of mobile phones usually permit the early alerting of emergency services about a crash. There is usually a well-publicized emergency number to call, but the number varies from country to country. In the European Union, a common phone number for emergencies has been introduced, and most telephone operators allow calls to be made free of charge from public telephones and mobile phones in emergencies. In addition, many motorways have emergency call points distributed along them, further facilitating the involvement of rescuers.

However, few emergency services are available at the scene of road crashes in many low-income countries and especially in the eastern part of the European Region, especially if crashes occur in remote areas and far from urban areas.

Care by emergency services

Police and firefighters often arrive at a crash scene before emergency medical personnel. Police officers and firefighters should be equipped and trained to rescue people from a variety of emergency situations (such as fire, immersion in water and entrapment in a twisted vehicle) and to provide basic first aid (*15*).

Another concern is that emergency vehicles are highly prone to becoming involved in crashes, since they tend to travel at high speeds and weave in and out of traffic. Road safety laws, including ones requiring appropriate restraints for vehicle occupants, should also apply to them.

Further, in congested urban areas, emergency vehicles may be trapped in traffic congestion both on their way to the crash scene and on their way to the health care facility, wasting life-saving minutes. In addition, provisions to expedite emergency vehicles, through both traffic rules and infrastructure (such as by reserving a lane in highways and main roads for emergency vehicles) should be established and strictly enforced.

Improving hospital care

In high-income countries, a chain of well-trained practitioners typically provides trauma treatment in hospitals. In addition, the progressive introduction of triage in emergency departments is providing a tool to set priorities among patients, preventing long and dangerous delays between arrival at a hospital and the start of emergency surgery and treatment.

In general, knowledge and practice of trauma treatment has significantly improved over the past 30 years, although stronger evidence would be needed for such practices as fluid resuscitation, which is intended to minimize the effects of haemorrhagic shock and to stabilize the haemodynamic response to trauma and hypovolaemia (*11*), and head injury management (*18,19*). The Advanced Trauma Life Support course of the American College of Surgeons is widely acknowledged to be the optimal standard for training in high-income countries (*15,20*). The College and similar national and international organizations also provide guidelines and recommendations on staffing, equipment, supplies and organization.

In low- and middle-income countries, emergency departments of the public health care system are often poorly equipped and staffed. Costs of accessing better facilities, where they exist, can be prohibitively high for most people, as public health schemes may not provide for this and private insurance may either not exist or be accessible only to the most affluent part of the population, representing an additional source of inequality in access to health.

Very little has been documented about effective programmes to address these issues, but there is some evidence of success (*21*). Meanwhile, WHO and the International Society of Surgery are collaborating on the Essential Trauma Care Project, which aims to improve the planning and organization of trauma care worldwide (*22*).

Improving rehabilitation

In high-income countries, a variety of specialists provide rehabilitation: physical therapists, occupational therapists, prosthetists (prosthetics specialists), neuropsychologists, psychological

counsellors and speech therapists. Services and equipment are often provided in homes. These services are known to make important contributions to reducing disability, although the best practices have yet to be defined (*15*). Not surprisingly, such services are in short supply in low- and middle-income countries. They need to expand the capacity of their health care systems, in general, and to decide which rehabilitation services are to be given high priority.

MAINSTREAMING ROAD SAFETY ACROSS DIFFERENT SECTORS

In overall transport and land-use policy

The health sector can play an important role in mainstreaming road safety as part of developing integrated transport policies and strategies that take account of all relevant health effects while aiming to achieve environmental objectives and other performance goals (*6*).

A practical way of facilitating this integration is by applying tools for health impact assessment and strategic and environmental impact assessment that describe the estimated effects of planned transport and land-use strategies, for example, on injuries and other health effects. This means consulting health authorities, hearing stakeholders and identifying and discussing mitigation measures as part of the planning process, with the ultimate goal of maximizing overall health benefits and minimizing health inequality (*23*).

Linked to this is the development of analytical tools that allow modelling and integrating under a coherent framework the various health effects related to transport policies. An example of such a research project is HEARTS (Health Effects and Risks of Transport Systems) (*24*), which attempts to bring together models of the exposure and health effects associated with air pollution, noise and injuries generated by different transport policy scenarios.

In the public health agenda

Opportunities for mainstreaming road safety into the public health agenda are provided by establishing synergy with other processes in which the health sector plays a leading role, in partnership with others. Examples of this are the development of national and local environment and health action plans, the implementation of the European Alcohol Action Plan 2000–2005 (*25*), the development of national children's environment and health action plans, initiatives targeting specific population groups such as children or elderly people or settings, such as health-promoting schools, health-promoting hospitals and workplaces and healthy cities.

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CHAPTER 7 CONCLUSIONS, RESEARCH NEEDS AND RECOMMENDATIONS

CONCLUSIONS

Road traffic injuries in the European Region represent a major social, economic and public health problem. About 127 thousand people are killed and 2.4 million injured per year. Road traffic injuries are the leading cause of death among people 5–14 years and 15–29 years of age. In the latter age group, men account for almost 80% of the victims. The cost of road traffic injuries to society is estimated to be about 2% of a country's gross domestic product. The share for health systems, which pay for the health care portion of this cost, amounts to tens of billions of euros annually in the European Region. This leaves fewer resources to deal with other public health priorities. Countries differ widely in terms of mortality, morbidity and risks. Moreover, progress in reducing deaths and serious injuries has slowed in the past few years. Nevertheless, road traffic deaths and injuries are preventable, and there is substantial evidence of effective measures that can be implemented across Europe.

Other negative outcomes of transport activities besides road traffic injuries that require more integrated approaches include the health effects of air pollution, noise and lack of physical activity; climate change; and the economic and political vulnerability of societies through increasing dependence on fossil fuel.

This requires attaining much stronger political commitment, including a stronger role for the health sector, developing new preventive strategies, forging new partnerships, using evidence-based interventions better and improving the implementation mechanisms that promote road safety.

A new thinking has evolved about road safety based on accepting that road crashes cannot be avoided (because of human error) and that crashes result from complex combinations of elements that include human behaviour, vehicles and infrastructure and need to be addressed by sharing the responsibility for safety between the users and providers of the road transport system. The two pillars of the new thinking are: refusing to accept deaths and severe injury as possible outcomes of crashes and placing human tolerance to mechanical forces at the core of road safety, redesigning the system as a function of human vulnerability and accommodating human error and in turn making road safety a built-in component of road transport systems. More and more European countries are successfully implementing this new thinking, which is universally applicable in principle.

Road safety should be an integral aspect of sustainable transport and of policies related to fiscal and economic matters, spatial planning and road infrastructure investment. This makes apparent the potential additional contribution of measures that were originally designed to achieve other goals, and the range of strategies available to improve road safety becomes broader and more cost-effective. Integrating road safety under a broader policy framework so that road safety becomes one of the performance criteria of the transport system allows road safety to be improved along with other objectives related to health and environmental protection.

Although knowledge about effective preventive measures exists, progress in road safety is hampered by ineffective implementation processes. Numerous models and approaches have been developed that define the basic requirements for delivering road safety. These include: exercising leadership and political commitment; ensuring the accountability of stakeholders and coordinating their actions; establishing a relationship between goals, plans, organization and financing; using and disseminating best practices; monitoring and evaluating

systematically the implementation of road safety programmes; building capacity for road safety; and including stakeholders and target groups in developing and implementing road safety.

However, to effect change the public sector must assign high priority to improving road safety based on political decisions. Real improvement requires explicit political commitment.

The complex interplay between the various actors is a major stumbling block that hampers progress and implementation. Greater attention should be paid to identifying the mechanisms that allow different and diverging interests to be reconciled under the common objective of delivering road safety and saving lives and to the tools that can be used to overcome this block. Examples of these include EuroNCAP, EuroRAP and public purchasing of safe transport products and services.

Developing shared visions of the desired level of safety of the road transport system has been identified as a way of linking various actors in creating a moral obligation to protect life and health in the road transport system. The use of quantitative, time-dependent targets the achievement of which can be evaluated may be of paramount importance in facilitating the implementation of road safety strategies and action plans.

Existing tools that have been improved in the context of greater social responsibility may prove helpful in exerting pressure on the various actors to take responsibility for the benefit of society as a whole. These include: consumer information about the safety performance of various vehicles, negotiations and industry initiatives, economic incentives, quality assurance, insurance premiums, safety declarations and product liability.

Further, mainstreaming road safety across different sectors, such as by integrating it along with other objectives under transport and land-use policies, is emerging as a still largely untapped opportunity for developing synergy and new partnerships. Several processes at the international level are now providing policy frameworks that enable stronger and more coherent action towards reducing road traffic deaths and injuries.

Taken together, these tools and instruments can be considered as the elements that constitute a comprehensive road safety toolkit from which governments can choose the building blocks that are most suitable to their specific conditions and strategies.

International organizations such as WHO, the United Nations Economic Commission for Europe, the European Conference of Ministers of Transport, the OECD, the European Union, the World Bank, the European Bank for Reconstruction and Development, the European Investment Bank and international development agencies active in the European Region play a major role in advocacy, building capacity, disseminating information and mainstreaming road safety into their own policies. In addition to supporting the implementation of measures proven to be effective and the development and enforcement of regulations, international organizations should also concentrate on facilitating and encouraging the broader use of the new tools and processes for delivering road safety, including by removing any legal and political barriers.

Nongovernmental organizations active in road safety can be very effective in placing road safety higher on the political agenda.

The health sector has an essential role in fulfilling the vision and goals for traffic safety. In addition to injury surveillance and delivering post-crash support, the health sector needs to make road safety part of its core business by embracing a broader, more proactive role and exploring new areas of involvement that have emerged more recently. The health sector should advocate for safety, provide evidence-based knowledge and information, define and monitor success and failure, behave as a responsible user and purchaser of transport services for its customers and employees, lead research and innovation, champion the mainstreaming of road safety across different sectors and become the driving force for a safer road transport system.

RESEARCH NEEDS

The *World report on road traffic injury prevention* (*1*) identifies several areas in which additional research is required on a global basis. The specific conditions of the European Region require expanding research into additional areas, such as:

- improving knowledge about implementation processes and the development of measures and tools that can improve the implementation of safety strategies and encourage the public, organizations and enterprises to act responsibly by giving preference to safer products and services;
- improving the quality and availability of injury-related indicators that provide useful information about the health effects of crashes and correlate data collected through health care facilities with those collected by other relevant bodies, such as the road police;
- improving the assessment of the severity of injuries and the capacity to estimate their long-term effects, especially disability;
- improving the evidence base for practices in crash notification, trauma care (such as fluid resuscitation and head injury management) and rehabilitation, rescue measures (such as the use of helicopters and ambulances) and for interventions related to such risk factors as alcohol, fatigue, medicines and recreational drugs;
- elucidating the effects of medicinal and recreational drugs as well as their possible interactions in increasing the risk of crashes, including when used in combination with alcohol;
- better understanding the roles of ageing, disease and fatigue as risk factors for crashes;
- clarifying the cost–effectiveness of practices in health examinations for granting and renewing driving licences;
- developing risk analysis and simulation models that are based on the human tolerance of mechanical forces and are integrated with the other components of the road transport system, allowing the effects of human behaviour leading to a crash to be predicted for all possible kinds of crash situations resulting from different combinations of vehicles and infrastructure;
- optimizing the balance between changes in speed, acceleration and the capacity of a vehicle to absorb the energy of a crash through deformation and possible intrusion;
- improving knowledge of injury mechanisms and tolerance and defining the tolerance attributes of the type of person around which the system is going to be dimensioned;
- further developing models simulating the exposure and effects of crashes involving pedestrians and cyclists and integrating these with models simulating the exposure to and effects of other transport-related effects, such as those related to air pollutants and noise;
- identifying and improving methods of assessing the effectiveness of safety approaches that manage the exposure to road traffic hazards through land-use and transport planning and by managing the demand for transport, such as by using economic instruments;
- further developing methods for cost–benefit analysis that integrate all the benefits of safer and more convenient travel for pedestrians and cyclists and changes to other transport-related health effects;
- further improving methods, tools and models for integrated impact assessment (such as health impact assessment, environmental impact assessment, strategic environmental assessment and road safety impact assessment) to ensure that safety aspects are considered along with other health and environmental objectives in the appraisal and public discussion of transport-related policies, plans and projects; and
- further exploring the possible role of videophones as risk factors for crashes as well as the cost–effectiveness of telematics and electronic signals in preventing crashes.

RECOMMENDATIONS

Governments should give high priority to preventing road traffic deaths and injuries in their policy statements and mobilize resources and political commitment to carry this out. The *World report on road traffic injury prevention* (*1*) identifies six main recommendations for improving road safety at the global level.

1. Identify a lead agency in government to guide the national road traffic safety effort.

2. Assess the problem, policies and institutional settings relating to road traffic injury and the capacity for road traffic injury prevention in each country.

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 safety crashes, minimize injuries and their consequences and evaluate the impact of these actions.

6. Support the development of national capacity and international cooperation.

Building on the *World report on road traffic injury prevention*, this section presents additional recommendations aimed at facilitating the implementation of the global recommendations in the European Region.

Recommendation 1. Strengthen and expand the role of the health sector as a champion of road safety.

The health sector should consider developing stronger leadership in road safety to be an essential part of its core business. This is a way of fulfilling its mission of protecting the human right to health and is an opportunity to mainstream road safety into other sectoral policies and into the public health agenda. In addition to maintaining its leading role in injury surveillance and in the post-crash phase of road traffic crashes, the health sector should:

- **become the leading champion for road safety**, including by advocating safe road transport systems that reject preventable deaths and serious injuries; supporting the implementation of effective preventive measures; and supporting the efforts of the transport sector to keep speeds within safe levels;

- **provide evidence-based information**, including by developing injury information systems based on hospital data and facilitating the link and consistency between different data sources; identifying appropriate indicators to monitor various risk factors; estimating the social costs of road traffic injuries; defining and articulating key factors and mechanisms for effective policy implementation; integrating the various components of its information systems to link risk factors, effects, preventive measures and their results; and adding value to the information systems used by other sectors;

- **become active in promoting the demand for greater safety**, by behaving as a responsible employer and user and purchaser of transport services, as well as a responsible provider of health services, including by ensuring that all duty travel and purchased transport services are carried out safely, including safe vehicles and safe conditions when car transport is required; stimulating partners in all sectors to act accordingly; and providing patients with the possibility of travelling to health facilities safely and by healthier modes and means of transport, such as public transport and safe cycling and walking;

- **lead research and innovation**, including by improving the evidence base for practices in trauma care and rehabilitation and developing guidelines for their implementation; elucidating risk factors still not fully understood, especially the effects of ageing, fatigue, and the use of

medicines and recreational drugs and their possible interactions; and developing a stronger basis for effective health tests and criteria for physical and mental health conditions that adequately reflect driver fitness; and

- **mainstream road safety into the policies of other sectors and into the public health agenda**, by further developing and promoting the use of integrated assessment and modelling tools; establishing links with other relevant public health processes; and promoting the development of road safety targets to be met to achieve acceptable levels of safety.

Recommendation 2. Improve implementation mechanisms and tools.

Ineffective implementation processes and lack of political commitment have a much greater effect on road safety than lack of knowledge about effective preventive strategies. Critically analysing policies, institutional settings, implementation mechanisms and the capacity for road safety is required to identify the measures and changes needed to remove inconsistencies between competing policies, duplication and overlap in the responsibilities assigned to different bodies. Governments have a special role to play in:

- making strong commitments for road safety and developing long-term strategic visions of safe road transport systems that can mobilize support from various actors;
- building public and political support for road safety to become a critical parameter of road transport systems;
- providing the means to develop and implement mechanisms to allow different interests to be reconciled under the common objective of delivering road safety and saving lives and the tools that can be used to achieve this;
- promoting strong institutional and political integration across different policies, especially those affecting transport and land-use management;
- establishing mechanisms for collaboration with other relevant sectors (health, environment, justice and education), including by promoting the use of tools for implementation;
- identifying and pursuing synergy with other goals related to sustainable development and public health; and
- establishing explicit links between national strategies for road safety and other relevant policies and processes.

Recommendation 3. Consider speed as the single most important determinant for safety in road transport systems.

Of the risk factors and mechanisms related to road traffic crashes speed at the moment of collision is clearly the single most important determinant of the severity of a crash. In addition, human beings are prone to make mistakes. Several evidence-based measures have become available to help in preventing crashes, in controlling kinetic energy at the moment of the impact and in mitigating the severity of effects after the crash. Governments should:

- ensure that, in case of crash, speeds remain below levels that can cause death or severe injury under differing conditions of traffic;
- work towards turning road safety into a built-in element of road transport in which vehicles, infrastructures and users are interrelated;
- provide appropriate resources for this purpose; and
- give priority to measures that address population groups at especially high risk, such as children, young people and vulnerable road users.

Recommendation 4. Strengthen the role of international organizations in preventing road traffic injury.

Strengthening the role of the health sector, improving implementation mechanisms and re-engineering the road transport system to build in safety require the development of technical and institutional capacity to deal with the necessary changes to regulations, administrative and institutional arrangements and acquisition of new professional skills. International organizations can play a very important role in supporting governments in implementing measures proven to be effective and in providing technical assistance for developing enforcing road safety regulations. They can also assist in developing and improving professional training, including by supporting the establishment of networks among professionals across relevant sectors (transport, health, environment, justice and education) at the national and international level and multilateral and bilateral collaboration for capacity-building.

In particular, international organizations such as the European Union, WHO, the OECD, the European Conference of Ministers of Transport and the United Nations Economic Commission for Europe should concentrate on:

- facilitating and encouraging the use of new tools and processes, including by removing legal and political barriers for some of them;
- supporting the development of good practices in mechanisms for delivering road safety and providing assistance in disseminating, adapting and pilot-testing them across the European Region, especially emphasizing closing the gaps between countries in northern and southern Europe and between countries in western and eastern Europe; and
- promoting compatibility and coherence between different information systems and data sets, to facilitate international comparisons and exchanges of information.

International donors and international financial institutions, such as the World Bank, the European Bank for Reconstruction and Development, the European Investment Bank and donors and development agencies active in the European Region, should support:

- implementing capacity-building programmes;

- disseminating best practices and case studies;
- carrying out professional and academic exchange programmes;
- developing policy and technical studies to assess the feasibility of adapting the new approaches to road safety to countries with various economic, political and social conditions; and
- mainstreaming road safety into transport development by making funding for projects related to the development of transport infrastructure and land-use planning conditional on improving road safety.

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ANNEX 1 OVERVIEW OF HIGHLY EFFECTIVE MEASURES FOR ROAD SAFETY FROM THE RECOMMENDATIONS OF THE *WORLD REPORT ON ROAD TRAFFIC INJURY PREVENTION*

Highly effective measures for road safety include:

- incorporating as a long-term goal, safety features into land-use and transport planning – such as the provision of shorter and safer pedestrian and bicycle routes and convenient, safe and affordable public transport – and road design, including controlled crossings for pedestrians, rumble strips and street lighting;
- setting and enforcing speed limits appropriate to the function of specific roads;
- setting and enforcing laws requiring seat-belts and child restraints for all motor vehicle occupants;
- setting and enforcing laws requiring riders of bicycles and motorized two-wheelers to wear helmets;
- setting and enforcing blood alcohol concentration limits for drivers, with random breath testing at sobriety checkpoints;
- requiring daytime running lights for two-wheeled vehicles (the use of daytime running lights on four-wheeled vehicles should also be considered);
- requiring that motor vehicles be designed for crashworthiness to protect the occupants, with efforts to expand this concept to the design of the fronts of motor vehicles, so as to protect pedestrians and cyclists;
- requiring new road projects to be subject to a road safety audit, by a road safety specialist independent of the road designer;
- managing existing road infrastructure to promote safety, through the provision of safer routes for pedestrians and cyclists, traffic-calming measures, low-cost remedial measures and crash-protective roadsides;
- strengthening all links in the chain of help for road crash victims, from the crash scene to the health facility (for example, specific groups, such as commercial vehicle drivers, most likely to be first on the scene of crashes, might be provided with basic training in first aid, and health professionals might be provided with specialized training in trauma care); and
- enhancing programmes of law enforcement with public information and education campaigns (for example, on the dangers of speeding or driving while under the influence of alcohol, and the social and legal consequences of doing so).

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ANNEX 2 STATISTICAL INFORMATION

Background on statistical information

Data for the European Region are collected annually. This report relies on three main sources of information for the statistical data, tables, figures and annexes: the WHO Global Burden of Disease database, the United Nations Economic Commission for Europe and the WHO European health for all database.

WHO Global Burden of Disease database project for 2002 version 3

The WHO Global Burden of Disease database version consulted for this report uses all available and relevant information to generate the best possible population-based data on mortality and morbidity that are currently available. For countries and causes of death for which data are sparse, the Global Burden of Disease database uses all the evidence at hand and the best available methods to make inferences (*1*). These data are consistent with those reported in *The world health report 2003* (*2*) and may slightly differ from other published Global Burden of Disease database versions as well as from the data published in the *World report on road traffic injuries* (*3*), which used the Global Burden of Disease 2002 version 1 data.

WHO analyses data from country registration systems as well as from surveys, censuses, epidemiological studies and health service systems to determine patterns of causes of death for countries, regions and the world. WHO also uses these data, along with other information, to assess the global burden of disease. The first assessment of the global burden of disease was published in 1996 (*4*) and represented at that time the most comprehensive examination of global mortality and morbidity ever produced. The methods employed for estimating the global burden of disease have since been refined and improved, and in 2000 a new assessment was undertaken.

Complete or incomplete vital registration data together with sample registration systems are complemented with survey data and indirect demographic techniques to obtain the total estimated child and adult mortality. Data on causes of death have been analysed to take into account incomplete coverage of vital registration in countries and the likely differences in cause-of-death patterns that would be expected in the uncovered and often poorer subpopulations (*1*). For all other countries lacking vital registration data, cause-of-death models were used to generate an initial estimate of the maximum likelihood distribution of deaths across the broad categories of communicable and noncommunicable diseases and injuries, based on estimated total mortality rates and income. This proportionate distribution was then applied within each broad group of causes. Finally, the resulting estimates were adjusted based on other epidemiological evidence from studies on specific diseases and injuries.

Special attention has been paid to the problems of misattribution or miscoding of causes of death in cardiovascular diseases, cancer, injuries and general poorly defined categories. The category “Injury undetermined whether accidentally or purposely inflicted” (E980–E989 in the three-digit ICD-9 (International Classification of Diseases, ninth edition) codes or Y10–Y34 in ICD-10) can often include a significant share of deaths from injury. Except when more detailed local information is available, these deaths have been proportionately allocated to the other injury causes of death. Deaths coded to the four-digit ICD-9 code E928.9, “Unspecified accidents”, have been redistributed proportionally across other unintentional injury categories. There is no corresponding ICD-10 code for unspecified accidents, forcing coders to specify at least a broad category of injury.

United Nations Economic Commission for Europe

The United Nations Economic Commission for Europe collects data annually and compiles them based on replies submitted by Member States and from official national and international sources. Of the 55 Member States of the Commission, 52 countries are Member States in the WHO European Region. Canada and the United States of America are Member States in the WHO Region for the Americas, and data for Liechtenstein are consolidated with those for Switzerland.

Data from the United Nations Economic Commission for Europe (5) are presented in two parts. The first includes economic and social profiles of the member countries. The data used are for the most recent year available, which is 2001 in many cases. The second part has 13 chapters addressing specific issues. This report uses data from Chapter 8, which focuses on transport and tourism.

The WHO European health for all database

The WHO European health for all database (available at http://www.euro.who.int/hfadb) contains data on about 600 health indicators, including mortality, morbidity and disability from multiple causes, including transport-related injuries. These data allow trend analysis and international comparisons for several health statistics. These data also contain age-standardized mortality indicators. Age-standardized rates enable the rates to be compared in populations with different age structures. Absolute numbers and rates per 100 000 for the population of the European Region are presented by gender and for the age groups 0–4 years, 5–14 years, 15–29 years, 30–44 years, 45–59 years and 60 years or older.

Data are compiled, validated and processed uniformly to improve the international comparability of statistics. Nevertheless, since systems and practices for recording and handling health data vary between countries, so do the availability and accuracy of the data reported to WHO. International comparisons between countries and their interpretation should thus be carried out with caution.

The data for mortality-related indicators are relatively complete and comparable, although the coding of underlying causes of death may differ slightly in some countries, mainly those in the eastern part of the Region and especially the Commonwealth of Independent States countries. In addition, a few countries cannot ensure complete registration of all births and deaths. In certain cases, under-registration of deaths may be as high as 20%, which should be borne in mind when comparing countries. This problem can be further aggravated by a lack of sufficiently accurate population estimates used for denominators when calculating rates. Most of these issues affect data reported during the 1990s and are related to the occurrence of severe socioeconomic conditions that hampered data quality and to the development of armed conflicts in certain countries. The following regions are the most affected: the central Asian republics (especially Tajikistan), the Caucasus countries (especially Georgia) and selected countries in the Balkans (especially Albania and Bosnia and Herzegovina).

For some countries, therefore, indicators calculated based on officially registered national mortality data – such as life expectancy, infant mortality, maternal mortality and standardized death rates – may be less reliable or in some cases not available at all.

Mortality data in suitable detail are not available at all for Andorra, Monaco and Turkey.

Categories of analysis used in the Global Burden of Disease database

Deaths and nonfatal injuries are categorically attributed to one underlying cause using the rules and conventions of ICD-9 (*6*) and ICD-10 (*7*). The cause list used for the Global Burden of Disease 2000 project has four levels of disaggregation that include 135 specific diseases and injuries (*1*). Overall mortality is divided into three broad groups of causes:

A. group I: communicable diseases, maternal causes, conditions arising in the perinatal period and nutritional deficiencies;
B. group II: noncommunicable diseases; and
C. group III: intentional and unintentional injuries, with external cause codes; the codes for road traffic injuries are:
    - ICD-9 codes: E810–E819, E826–E829 and E929.0
    - ICD-9 basic tabulation list codes: B471–B472
    - ICD-10 codes: V01–V04, V06, V09–V80, V87, V89 and V99.

Countries are also divided by income level according to 2002 estimates of gross national income per capita according to the World Bank. Based on the gross national income per capita, economies are classified as low income (US$ 735 or less), middle income (US$ 736–9075) or high income (US$ 9076 or more) (*8*).

The measure of disability-adjusted life-years (DALYs) is used to quantify the burden of disease (*4*,*9*). This is a health-gap measure that combines information on the number of years of life lost (YLLs) from premature death with the loss of health from disability. The number of years lived with disability (YLDs) corresponds to the disability component of DALYs, measuring the equivalent healthy years of life lost as a result of disabling sequelae of diseases and injuries. This requires estimating the incidence, the average duration of disability and the severity of disability. The Global Burden of Disease 2000 project analysed the burden of injury based on the methods developed for the 1990 project. It was decided to retain all 1990 disability weights relating to injury in the Global Burden of Disease 2000 project until more refined methods for this aspect of calculating the burden of disease are developed (*10*). The Global Burden of Disease 1990 project methods define a case of injury as one severe enough to warrant health care attention or one that leads to death.

Many sources of information were used to estimate YLDs for diseases and injuries in the Global Burden of Disease 2000 project. These included national and international surveillance data and disease registries, health survey data, data on the use of hospital and health care services and international and country-specific epidemiological studies (*1*).

The proportion of incident cases resulting in long-term disabling sequelae was estimated for each category of type of injury from a review of long-term epidemiological studies of injury outcomes. To produce the rankings in Table A2, deaths and disabilities were first divided into the three broad groups of causes mentioned earlier. Next, deaths and disabilities within each of these broad groupings were divided into categories. For example, injuries were divided between unintentional and intentional injuries.

Following this level of disaggregation, deaths and disabilities were further divided into subcategories. Unintentional injuries, for example, were subdivided into road traffic injuries, poisonings, falls, fires and drowning. The same procedure was followed for the other two broad groups of deaths and disabilities. Ordering the subcategories obtained produced the rankings.

The 12 leading causes of death and DALYs are reported in Table A2 for all Member States in the WHO European Region. In regions where deaths related to road traffic injury and DALYs rank below the 12 leading causes, the actual rank order is reported.

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TABLE A1 DEATHS, DALYs, YLLs AND YLDs BY AGE, GENDER AND CAUSE OF INJURY FOR 2002 IN THE WHO EUROPEAN REGION

	Total	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
Population (thousands)	877 886.91	25 832.26	60 004.35	98 719.99	98 064.39	76 724.83	36 314.21	22 766.65	6 952.96	425 379.64

GLOBAL BURDEN OF DISEASE DATABASE 2002: **DEATHS BY AGE, GENDER AND CAUSE FOR 2002**
WHO EUROPEAN REGION

		MALES (years)								
Cause	Total	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
All causes	**9 481 569**	**106 639**	**23 626**	**180 212**	**399 319**	**862 370**	**1 024 843**	**1 316 984**	**966 221**	**4 880 215**
Injuries	**802 759**	**6 987**	**11 039**	**120 338**	**164 951**	**163 968**	**67 110**	**38 464**	**23 107**	**595 965**
A. Unintentional injuries	**546 807**	**6 637**	**9 310**	**73 879**	**102 506**	**110 314**	**46 752**	**26 405**	**18 442**	**394 245**
1. Road traffic injuries	127 378	898	3 089	29 645	25 574	19 016	8 226	5 992	2 272	94 712
2. Poisonings	114 128	552	457	11 435	27 466	33 214	11 048	2 759	502	87 433
3. Falls	80 501	364	437	3 259	6 663	9 876	6 052	6 710	10 064	43 424
4. Fires	23 432	721	384	1 950	4 176	5 268	2 435	1 255	511	16 701
5. Drownings	40 047	1 169	2 206	7 740	9 561	7 603	2 936	1 280	332	32 828
6. Other unintentional injuries	161 321	2 933	2 736	19 850	29 065	35 337	16 055	8 409	4 761	119 147
B. Intentional injuries	**255 951**	**350**	**1 728**	**46 459**	**62 445**	**53 655**	**20 358**	**12 059**	**4 665**	**201 719**
1. Self-inflicted injuries	164 150	6	1 111	27 243	37 340	36 091	15 182	10 126	4 167	131 266
2. Violence	71 822	319	449	11 643	18 760	15 231	4 243	1 624	351	52 619
3. War	19 286	24	165	7 474	6 139	2 200	928	309	146	17 386
Other intentional injuries	694	1	3	99	207	133	5	0	0	448

	Total	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
Population (thousands)	877 886.91	25 832.26	60 004.35	98 719.99	98 064.39	76 724.83	36 314.21	22 766.65	6 952.96	425 379.64

GLOBAL BURDEN OF DISEASE DATABASE 2002: **DALYs BY AGE, GENDER AND CAUSE FOR 2002**
WHO EUROPEAN REGION

		MALES (years)								
Cause	Total	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
All causes	**149 775 563**	**5 561 228**	**3 085 629**	**15 149 029**	**17 226 117**	**19 364 115**	**12 368 603**	**8 446 120**	**2 400 879**	**83 601 720**
Injuries	**21 315 667**	**481 126**	**1 121 268**	**5 654 359**	**5 063 636**	**3 045 002**	**713 757**	**238 390**	**55 115**	**16 372 653**
A. Unintentional injuries	**14 878 696**	**461 266**	**993 114**	**3 711 210**	**3 192 451**	**2 106 637**	**520 375**	**174 162**	**44 717**	**11 203 931**
1. Road traffic injuries	3 617 724	39 572	164 405	1 230 317	769 953	355 673	80 732	32 310	4 984	2 677 945
2. Poisonings	2 255 695	19 591	18 443	377 456	667 922	552 345	103 343	14 534	1 047	1 754 681
3. Falls	2 067 851	80 087	195 820	467 296	334 311	235 184	83 321	53 555	24 124	1 473 698
4. Fires	648 926	56 532	51 115	115 169	138 843	101 027	23 873	7 274	1 174	495 007
5. Drownings	945 606	41 378	82 490	259 439	235 960	125 086	27 147	6 585	702	778 787
6. Other unintentional injuries	5 342 893	224 106	480 842	1 261 533	1 045 461	737 321	201 958	59 905	12 686	4 023 813
B. Intentional injuries	**6 436 971**	**19 860**	**128 154**	**1 943 150**	**1 871 185**	**938 365**	**193 382**	**64 228**	**10 398**	**5 168 723**
1. Self-inflicted injuries	3 402 361	188	76 646	938 792	947 909	596 784	139 725	52 506	8 665	2 761 216
2. Violence	2 265 097	12 260	41 470	670 002	648 697	286 137	42 962	9 588	1 039	1 712 153
3. War	748 954	7 171	9 818	329 375	268 504	53 052	10 645	2 121	685	681 371
Other intentional injuries	20 559	241	220	4 980	6 075	2 393	50	14	9	13 983

Source: *Global Burden of Disease 2002 version 3 database*. Geneva, World Health Organization, 2002 (http://www3.who.int/whosis/menu.cfm?path=whosis,burden&language=english, accessed 1 February 2004).

	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
Population (thousands)	24 576.35	57 337.06	95 717.68	97 580.38	81 109.24	44 109.31	35 431.68	16 645.55	452 507.27

	FEMALES (years)								
Cause	**0–4**	**5–14**	**15–29**	**30–44**	**45–59**	**60–69**	**70–79**	**80+**	**Total**
All causes	**84 768**	**15 194**	**57 163**	**140 242**	**380 289**	**608 523**	**1 312 880**	**2 002 295**	**4 601 353**
Injuries	**5 333**	**5 253**	**25 455**	**33 292**	**43 649**	**25 631**	**28 535**	**39 646**	**206 794**
A. Unintentional injuries	**5 048**	**4 237**	**16 318**	**20 721**	**30 014**	**18 400**	**21 936**	**35 887**	**152 562**
1. Road traffic injuries	831	1 693	7 600	5 921	5 927	4 008	4 581	2 105	32 666
2. Poisonings	463	355	2 703	5 873	9 784	4 512	2 037	970	26 695
3. Falls	269	163	746	1 200	2 153	2 305	7 076	23 165	37 077
4. Fires	598	200	556	978	1 378	928	1 135	959	6 731
5. Drownings	683	810	1 258	1 287	1 311	769	748	354	7 219
6. Other unintentional injuries	2 205	1 017	3 455	5 463	9 461	5 879	6 359	8 334	42 174
B. Intentional injuries	**285**	**1 016**	**9 136**	**12 571**	**13 635**	**7 231**	**6 599**	**3 759**	**54 232**
1. Self-inflicted injuries	0	563	5 353	6 947	8 034	4 715	4 505	2 767	32 884
2. Violence	266	367	3 433	5 039	4 957	2 268	1 971	903	19 203
3. War	16	86	336	509	504	239	124	86	1 900
Other intentional injuries	3	0	14	76	141	9	0	2	245

	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
Population (thousands)	24 576.35	57 337.06	95 717.68	97 580.38	81 109.24	44 109.31	35 431.68	16 645.55	452 507.27

	FEMALES (years)								
Cause	**0–4**	**5–14**	**15–29**	**30–44**	**45–59**	**60–69**	**70–79**	**80+**	**Total**
All causes	**4 627 454**	**2 438 570**	**10 552 100**	**10 797 345**	**12 615 438**	**9 779 168**	**10 177 015**	**5 186 754**	**66 173 843**
Injuries	**289 168**	**504 535**	**1 426 091**	**1 183 405**	**909 539**	**320 287**	**210 544**	**99 446**	**4 943 014**
A. Unintentional injuries	**277 251**	**423 438**	**1 019 494**	**794 417**	**654 813**	**244 370**	**170 766**	**90 216**	**3 674 765**
1. Road traffic injuries	38 623	108 645	377 435	209 380	127 028	44 872	28 439	5 358	939 779
2. Poisonings	16 566	14 579	94 402	147 017	168 816	45 830	11 710	2 095	501 014
3. Falls	48 395	71 524	134 824	89 189	72 580	46 438	71 052	60 152	594 153
4. Fires	29 254	16 708	28 462	31 267	29 558	9 715	6 833	2 121	153 919
5. Drownings	24 495	30 566	44 074	32 576	22 227	7 791	4 292	798	166 819
6. Other unintentional injuries	119 918	181 417	340 297	284 988	234 604	89 724	48 441	19 692	1 319 080
B. Intentional injuries	**11 917**	**81 096**	**406 597**	**388 988**	**254 726**	**75 917**	**39 778**	**9 230**	**1 268 249**
1. Self-inflicted injuries	0	36 561	194 069	187 258	141 024	48 784	26 927	6 523	641 146
2. Violence	9 784	26 686	197 496	182 405	97 418	24 507	12 143	2 504	552 944
3. War	584	17 833	14 540	17 373	13 818	2 527	707	200	67 583
Other intentional injuries	1 549	16	493	1 951	2 466	98	0	3	6 577

TABLE A1. CONTD

	Total	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
Population (thousands)	20 559	241	220	4 980	6 075	2 393	50	14	9	13 983

GLOBAL BURDEN OF DISEASE DATABASE 2002: **YLLs BY AGE, GENDER AND CAUSE FOR 2002**
WHO EUROPEAN REGION

		MALES (years)								
Cause	Total	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
All causes	**82 227 445**	**3 568 072**	**880 427**	**5 967 719**	**9 640 644**	**13 385 042**	**9 082 358**	**6 411 906**	**1 862 731**	**50 798 900**
Injuries	**15 481 648**	**240 322**	**411 404**	**3 994 407**	**4 052 667**	**2 661 812**	**614 437**	**192 230**	**43 503**	**12 210 780**
A. Unintentional injuries	**10 182 203**	**228 453**	**346 948**	**2 456 957**	**2 509 771**	**1 787 563**	**428 985**	**131 243**	**33 973**	**7 923 892**
1. Road traffic injuries	2 861 287	31 197	115 129	991 819	636 629	309 007	74 645	29 907	4 683	2 193 016
2. Poisonings	2 221 900	19 112	17 044	374 253	665 228	542 902	102 850	14 375	1 019	1 736 784
3. Falls	762 079	12 586	16 292	107 720	161 293	157 818	54 717	32 158	17 537	560 120
4. Fires	430 785	24 726	14 307	64 595	101 507	84 714	22 479	6 368	1 018	319 712
5. Drownings	939 524	40 981	82 196	257 998	235 443	124 779	27 017	6 520	701	775 635
6. Other unintentional injuries	2 966 629	99 851	101 980	660 573	709 671	568 343	147 277	41 914	9 014	2 338 625
B. Intentional injuries	**5 299 444**	**11 869**	**64 456**	**1 537 449**	**1 542 896**	**874 249**	**185 452**	**60 987**	**9 530**	**4 286 888**
1. Self-inflicted injuries	3 232 787	188	41 436	904 797	917 762	586 005	137 416	51 067	8 448	2 647 118
2. Violence	1 556 132	10 789	16 723	383 929	462 141	251 475	39 357	8 355	731	1 173 498
3. War	494 995	859	6 169	245 474	157 919	34 608	8 631	1 566	351	455 577
Other intentional injuries	15 531	33	129	3 249	5 074	2 162	48	0	0	10 695

	Total	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
Population (thousands)	20 559	241	220	4 980	6 075	2 393	50	14	9	13 983

GLOBAL BURDEN OF DISEASE DATABASE 2002: **YLDs BY AGE, GENDER AND CAUSE FOR 2002**
WHO EUROPEAN REGION

		MALES (years)								
Cause	Total	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
All causes	**67 548 118**	**1 993 156**	**2 205 202**	**9 181 310**	**7 585 473**	**5 979 073**	**3 286 245**	**2 034 214**	**538 148**	**32 802 820**
Injuries	**5 834 019**	**240 804**	**709 864**	**1 659 953**	**1 010 970**	**383 190**	**99 320**	**46 160**	**11 612**	**4 161 873**
A. Unintentional injuries	**4 696 492**	**232 813**	**646 167**	**1 254 253**	**682 680**	**319 074**	**91 389**	**42 919**	**10 744**	**3 280 039**
1. Road traffic injuries	756 437	8 375	49 276	238 498	133 324	46 667	6 086	2 402	301	484 930
2. Poisonings	33 795	478	1 399	3 203	2 694	9 443	493	159	28	17 897
3. Falls	1 305 772	67 501	179 528	359 577	173 019	77 365	28 605	21 396	6 587	913 577
4. Fires	218 142	31 806	36 808	50 574	37 336	16 313	1 395	906	156	175 295
5. Drownings	6 083	397	294	1 441	517	307	130	65	1	3 152
6. Other unintentional injuries	2 376 264	124 255	378 861	600 960	335 790	168 978	54 681	17 990	3 672	1 685 188
B. Intentional injuries	**1 137 527**	**7 991**	**63 698**	**405 700**	**328 290**	**64 116**	**7 931**	**3 241**	**868**	**881 834**
1. Self-inflicted injuries	169 574	0	35 211	33 996	30 147	10 779	2 309	1 439	218	114 097
2. Violence	708 965	1 471	24 747	286 073	186 556	34 662	3 605	1 233	308	538 655
3. War	253 959	6 312	3 649	83 901	110 586	18 444	2 015	555	333	225 794
Other intentional injuries	5 028	208	91	1 731	1 001	231	2	14	9	3 288

	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
Population (thousands)	1 549	16	493	1 951	2 466	98	0	3	6 577

	FEMALES (years)								
Cause	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
All causes	**2 850 719**	**568 529**	**1 917 989**	**3 428 629**	**6 064 243**	**5 810 221**	**7 044 098**	**3 744 117**	**31 428 546**
Injuries	**184 157**	**196 582**	**860 905**	**828 198**	**723 100**	**251 734**	**155 208**	**70 982**	**3 270 867**
A. Unintentional injuries	**174 411**	**158 548**	**553 038**	**514 438**	**495 778**	**180 743**	**118 583**	**62 770**	**2 258 311**
1. Road traffic injuries	29 002	63 364	259 218	148 798	98 615	39 027	25 336	4 910	668 271
2. Poisonings	16 079	13 267	90 657	143 816	162 734	45 083	11 455	2 025	485 116
3. Falls	9 324	6 103	25 258	29 670	34 851	22 076	36 774	37 903	201 958
4. Fires	20 592	7 463	18 730	24 246	22 847	9 056	6 164	1 974	111 072
5. Drownings	23 991	30 307	42 906	32 178	21 937	7 595	4 180	796	163 888
6. Other unintentional injuries	75 423	38 044	116 268	135 731	154 795	57 908	34 674	15 162	628 005
B. Intentional injuries	**9 746**	**38 034**	**307 866**	**313 760**	**227 322**	**70 991**	**36 625**	**8 212**	**1 012 556**
1. Self-inflicted injuries	0	21 073	181 040	173 191	133 147	46 151	25 049	6 017	585 668
2. Violence	9 087	13 728	115 090	125 844	83 639	22 371	10 882	1 993	382 634
3. War	572	3 218	11 274	12 846	8 241	2 373	694	199	39 418
Other intentional injuries	87	15	464	1 878	2 294	96	0	3	4 836

	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
Population (thousands)	1 549	16	493	1 951	2 466	98	0	3	6 577

	FEMALES (years)								
Cause	0–4	5–14	15–29	30–44	45–59	60–69	70–79	80+	Total
All causes	**1 776 735**	**1 870 041**	**8 634 111**	**7 368 716**	**6 551 195**	**3 968 947**	**3 132 917**	**1 442 637**	**34 745 297**
Injuries	**105 011**	**307 953**	**565 186**	**355 207**	**186 439**	**68 552**	**55 335**	**28 463**	**1 672 147**
A. Unintentional injuries	**102 840**	**264 890**	**466 456**	**279 979**	**159 035**	**63 627**	**52 183**	**27 445**	**1 416 454**
1. Road traffic injuries	9 620	45 281	118 217	60 582	28 413	5 845	3 102	448	271 508
2. Poisonings	487	1 312	3 745	3 201	6 082	747	255	70	15 898
3. Falls	39 071	65 421	109 566	59 519	37 728	24 363	34 278	22 249	392 195
4. Fires	8 662	9 245	9 732	7 021	6 711	660	669	147	42 847
5. Drownings	505	259	1 167	398	291	196	112	3	2 931
6. Other unintentional injuries	44 495	143 373	224 029	149 257	79 809	31 816	13 767	4 529	691 075
B. Intentional injuries	**2 171**	**43 063**	**98 731**	**75 228**	**27 404**	**4 926**	**3 152**	**1 018**	**255 693**
1. Self-inflicted injuries	0	15 488	13 029	14 067	7 876	2 633	1 878	506	55 477
2. Violence	697	12 958	82 406	56 561	13 779	2 136	1 261	511	170 310
3. War	12	14 615	3 266	4 527	5 577	154	13	1	28 165
Other intentional injuries	1 462	1	29	74	172	2	0	0	1 741

TABLE A2. THE LEADING CAUSES OF MORTALITY AND LOSS OF DALYs FOR THE WHO EUROPEAN REGION ACCORDING TO GENDER AND TO COUNTRY INCOME, 2002

TOTAL		
Rank	**Cause**	**Proportion of total deaths (%)**
1	Ischaemic heart disease	24.7
2	Cerebrovascular disease	15.1
3	Trachea, bronchus and lung cancer	3.8
4	Lower respiratory infections	2.8
5	Chronic obstructive pulmonary disease	2.7
6	Colon and rectum cancers	2.4
7	Hypertensive heart disease	1.8
8	Cirrhosis of the liver	1.8
9	Self-inflicted injuries	1.7
10	Stomach cancer	1.6
11	Breast cancer	1.6
12	Diabetes mellitus	1.5
13	**Road traffic injuries**	**1.3**
	Other causes	37.1

TOTAL		
Rank	**Cause**	**Proportion of total DALYs (%)**
1	Ischaemic heart disease	10.3
2	Cerebrovascular disease	7.2
3	Unipolar depressive disorders	6.2
4	Alcohol use disorders	3.1
5	Hearing loss, adult onset	2.6
6	**Road traffic injuries**	**2.4**
7	Chronic obstructive pulmonary disease	2.3
8	Self-inflicted injuries	2.3
9	Trachea, bronchus and lung cancer	2.1
10	Osteoarthritis	2.1
11	Alzheimer's disease and other types of dementia	2.0
12	Perinatal conditions	1.9
	Other causes	55.7

TABLE A2. CONTD

GENDER

MALES

Rank	Cause	Proportion of total deaths (%)
1	Ischaemic heart disease	23.7
2	Cerebrovascular disease	11.5
3	Trachea, bronchus and lung cancer	5.8
4	Chronic obstructive pulmonary disease	3.3
5	Self-inflicted injuries	2.7
6	Lower respiratory infections	2.7
7	Colon and rectum cancers	2.4
8	Cirrhosis of the liver	2.2
9	**Road traffic injuries**	**1.9**
10	Prostate cancer	1.9
11	Stomach cancer	1.9
12	Poisonings	1.8
	Other causes	38.2

MALES

Rank	Cause	Proportion of total DALYs (%)
1	Ischaemic heart disease	11.3
2	Cerebrovascular disease	6.2
3	Alcohol use disorders	4.6
4	Unipolar depressive disorders	4.1
5	Self-inflicted injuries	3.3
6	**Road traffic injuries**	**3.2**
7	Trachea, bronchus and lung cancer	3.0
8	Hearing loss, adult onset	2.2
9	Chronic obstructive pulmonary disease	2.2
10	Poisonings	2.1
11	Cirrhosis of the liver	2.1
12	Violence	2.0
	Other causes	53.7

FEMALES

Rank	Cause	Proportion of total deaths (%)
1	Ischaemic heart disease	25.6
2	Cerebrovascular disease	18.9
3	Breast cancer	3.2
4	Lower respiratory infections	2.9
5	Colon and rectum cancers	2.4
6	Hypertensive heart disease	2.3
7	Chronic obstructive pulmonary disease	2.1
8	Diabetes mellitus	1.8
9	Trachea, bronchus and lung cancer	1.7
10	Alzheimer's disease and other types of dementia	1.5
11	Stomach cancer	1.4
12	Cirrhosis of the liver	1.3
20	**Road traffic injuries**	**0.7**
	Other causes	34.0

FEMALES

Rank	Cause	Proportion of total DALYs (%)
1	Ischaemic heart disease	9.1
2	Unipolar depressive disorders	8.9
3	Cerebrovascular disease	8.4
4	Hearing loss, adult onset	3.1
5	Alzheimer's disease and other types of dementia	2.9
6	Osteoarthritis	2.8
7	Breast cancer	2.5
8	Chronic obstructive pulmonary disease	2.4
9	Perinatal conditions	1.8
10	Diabetes mellitus	1.8
11	Lower respiratory infections	1.6
12	Vision disorders, age-related	1.4
14	**Road traffic injuries**	**1.4**
	Other causes	51.8

TABLE A2. CONTD

COUNTRY INCOME

HIGH-INCOME COUNTRIES

Rank	Cause	Proportion of total deaths (%)
1	Ischaemic heart disease	16.8
2	Cerebrovascular disease	10.3
3	Trachea, bronchus and lung cancer	5.3
4	Lower respiratory infections	4.5
5	Chronic obstructive pulmonary disease	3.6
6	Colon and rectum cancers	3.5
7	Alzheimer's disease and other types of dementia	2.5
8	Diabetes mellitus	2.4
9	Breast cancer	2.3
10	Stomach cancer	1.8
11	Hypertensive heart disease	1.7
12	Self-inflicted injuries	1.6
14	**Road traffic injuries**	**1.2**
	Other causes	42.5

HIGH-INCOME COUNTRIES

Rank	Cause	Proportion of total DALYs (%)
1	Unipolar depressive disorders	8.0
2	Ischaemic heart disease	6.7
3	Cerebrovascular disease	5.0
4	Alcohol use disorders	4.3
5	Alzheimer's disease and other types of dementia	3.9
6	Hearing loss, adult onset	3.6
7	Chronic obstructive pulmonary disease	3.4
8	Trachea, bronchus and lung cancer	3.2
9	**Road traffic injuries**	**2.4**
10	Osteoarthritis	2.3
11	Diabetes mellitus	2.2
12	Colon and rectum cancers	2.0
	Other causes	53.0

LOW- AND MIDDLE-INCOME COUNTRIES

Rank	Cause	Proportion of total deaths (%)
1	Ischaemic heart disease	29.8
2	Cerebrovascular disease	18.2
3	Trachea, bronchus and lung cancer	2.9
4	Chronic obstructive pulmonary disease	2.1
5	Self-inflicted injuries	2.1
6	Hypertensive heart disease	1.9
7	Poisonings	1.9
8	Cirrhosis of the liver	1.9
9	Lower respiratory infections	1.7
10	Stomach cancer	1.7
11	Colon and rectum cancers	1.7
12	**Road traffic injuries**	**1.5**
	Other causes	32.6

LOW- AND MIDDLE-INCOME COUNTRIES

Rank	Cause	Proportion of total DALYs (%)
1	Ischaemic heart disease	12.7
2	Cerebrovascular disease	6.8
3	Self-inflicted injuries	3.7
4	Alcohol use disorders	3.6
5	Unipolar depressive disorders	3.5
6	**Road traffic injuries**	**3.1**
7	Poisonings	2.9
8	Violence	2.8
9	Trachea, bronchus and lung cancer	2.3
10	Perinatal conditions	2.3
11	Tuberculosis	2.3
12	HIV/AIDS	2.0
	Other causes	51.9

Source: Global Burden of Disease 2002 version 3 database. Geneva, World Health Organization, 2002 (http://www3.who.int/whosis/menu.cfm?path=whosis,burden&language=english, accessed 1 February 2004).
Note: These data are based on mortality statistics and death records.

COUNTRY GROUPING BY LEVEL OF INCOME OF THE 52 MEMBER STATES OF THE WHO EUROPEAN REGION	
High-income	**Low- and middle-income**
Andorra	Albania
Austria	Armenia
Belgium	Azerbaijan
Cyprus[a]	Belarus
Denmark	Bosnia and Herzegovina
Finland	Bulgaria
France	Croatia
Germany	Czech Republic
Greece	Estonia
Iceland	Georgia
Ireland	Hungary
Israel	Kazakhstan
Italy	Kyrgyzstan
Luxembourg	Latvia
Malta	Lithuania
Monaco	Poland
Netherlands	Republic of Moldova
Norway	Romania
Portugal	Russian Federation
San Marino	Serbia and Montenegro
Slovenia	Slovakia
Spain	Tajikistan
Sweden	The former Yugoslav Republic of Macedonia
Switzerland	Turkey
United Kingdom	Turkmenistan
	Ukraine
	Uzbekistan

[a] Joined the WHO European Region in 2003 and is not included in the Global Burden of Disease project 2002 analysis.

TABLE A3. NUMBERS OF INDIVIDUAL DEATHS AND INJURIES IN ROAD CRASHES AND NUMBERS OF ROAD TRAFFIC CRASHES RESULTING IN INJURIES AND THOSE OCCURRING IN BUILT-UP AREAS IN COUNTRIES OF THE WHO EUROPEAN REGION, 2001

COUNTRY	PEOPLE KILLED OR INJURED IN ROAD TRAFFIC CRASHES			
	Number of people killed	Number of people injured	Number of road traffic crashes with personal injury	Number of these crashes occurring in built-up areas
Albania	297	250	400	112
Andorra[a]	9	138	97	59
Armenia	237	1 258	1 021	606
Austria	958	56 265	43 073	26 036
Azerbaijan	559	2 228	1 985	1 010
Belarus	1 594	6 401	6 327	4 108
Belgium[a]	1 470	67 961	49 065	24 796
Bulgaria	1 011	7 984	6 709	4 689
Croatia	647	22 093	15 656	13 204
Cyprus	98	3 528	2 393	NA
Czech Republic	1 334	33 676	26 027	16 557
Denmark	431	8 465	6 861	4 041
Estonia	199	2 443	1 888	1 068
Finland	433	8 411	6 451	3 460
France	7 720	153 945	116 745	77 136
Georgia	558	2 376	1 940	1 629
Germany	6 977	494 315	375 345	239 883
Greece	1 895	25 881	19 710	NA
Hungary	1 239	24 149	18 505	12 853
Iceland	24	1 256	831	NA
Ireland	411	10 222	6 909	3 829
Israel	542	37 047	18 140	13 360
Italy	6 682	334 679	235 142	179 817
Kazakhstan	2 219	14 357	12 163	9 208
Kyrgyzstan	703	3 808	3 122	1 909
Latvia	517	5 852	4 766	3 269
Lithuania	706	7 103	5 972	4 357
Luxembourg	70	1 176	774	315
Malta	16	1 215	13 372	NA
Netherlands	1 085	42 810	35 313	22 641
Norway	275	11 522	8 244	1 693
Poland	5 534	68 194	53 799	38 690
Portugal	1 466	57 044	42 521	28 735
Republic of Moldova	420	3 390	2 765	2 003
Romania[a]	2 499	6 315	7 555	6 665
Russian Federation	30 916	187 790	164 403	118 234
Serbia and Montenegro	1 273	19 873	61 493	55 707
Slovakia	614	10 839	8 181	5 565
Slovenia	278	12 673	9 199	5 123

TABLE A3. CONTD

COUNTRY	PEOPLE KILLED OR INJURED IN ROAD TRAFFIC CRASHES			
	Number of people killed	Number of people injured	Number of road traffic crashes with personal injury	Number of these crashes occurring in built-up areas
Spain	5 517	149 599	100 393	54 910
Sweden	583	22 330	15 796	8 915
Switzerland	544	30 160	23 896	14 963
Tajikistan	396	1 556	1 368	NA
The former Yugoslav Republic of Macedonia	107	1 830	1 314	881
Turkey	4 386	116 203	66 243	43 910
Turkmenistan[b]	499	1 992	1 764	1 242
Ukraine	5 984	38 196	34 541	25 450
United Kingdom	3 450	309 859	229 014	167 048
Total	**105 382**	**2 430 657**	**1 869 191**	**1 249 686**

Source: United Nations Economic Commission for Europe, road traffic injuries statistical database, 2003.

[a]The latest available data are from 2000.
[b]The latest available data are from 1999.
NA: not available.
Note: These data are based on police reports.

TABLE A4. STANDARDIZED MORTALITY RATES FOR ROAD TRAFFIC INJURIES PER 100 000 POPULATION FOR ALL AGES, LAST AVAILABLE YEAR

COUNTRY	RATES PER 100 000 POPULATION	LAST AVAILABLE YEAR
Albania	2.14	2000
Andorra	NA	–
Armenia	5.33	2001
Austria	9.72	2001
Azerbaijan	5.67	2000
Belarus	14.75	2001
Belgium	13.62	1997
Bosnia and Herzegovina	NA	–
Bulgaria	10.67	2001
Croatia	13.51	2001
Czech Republic	11.72	2001
Denmark	9.22	1999
Estonia	13.49	2001
Finland	7.77	2001
France	12.99	1999
Georgia	3.99	2001
Germany	8.53	2000
Greece	19.3	1999
Hungary	12.39	2001
Iceland	9.77	1998
Ireland	9.7	2000
Israel	9.34	1998
Italy	12.14	1999
Kazakhstan	11.48	2001
Kyrgyzstan	12.3	2001
Latvia	23.48	2001
Lithuania	21.52	2001
Luxembourg	17.62	2001
Malta	4.33	2001
Monaco	NA	–
Netherlands	6.47	2000
Norway	7.72	2000
Poland	13.58	2001
Portugal	12.47	2000
Republic of Moldova	14.2	2001
Romania	13.31	2001
Russian Federation	19.71	1998
San Marino	8.45	2000
Serbia and Montenegro	6.75	2000
Slovakia	12.29	2001
Slovenia	13.75	2001
Spain	14.18	1999
Sweden	5.81	2000
Switzerland	6.64	1999
Tajikistan	3.82	1999
The former Yugoslav Republic of Macedonia	5.37	2000
Turkey	NA	–
Turkmenistan	8.47	1998
Ukraine	10.96	2000
United Kingdom	5.5	2000
Uzbekistan	9.19	2001

TABLE A4. CONTD

COUNTRY GROUP	RATES PER 100 000 POPULATION	LAST AVAILABLE YEAR
European Union average	10.33	2000
Central and south-eastern European countries	12.44	2001
Commonwealth of Independent States	15.04	2001
Nordic countries	7.21	2000
Central Asian republics	9.15	1999
European Region (52 Member States)	12.43	2000

DEFINITION OF COUNTRY GROUPINGS

European Union (before 1 May 2004)	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom
Central and south-eastern European countries	Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Serbia and Montenegro, Slovakia, Slovenia, The former Yugoslav Republic of Macedonia
Commonwealth of Independent States	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Republic of Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine, Uzbekistan
Nordic countries	Denmark, Finland, Iceland, Norway, Sweden
Central Asian republics	Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan

Source: WHO European health for all database. Copenhagen, WHO European Regional Office for Europe (http://www.euro.who.int/hfadb, accessed 1 February 2004).

NA: not available.
Note: These data are based on mortality statistics and death records.

TABLE A5. MAXIMUM SPEED LIMITS AND PERMISSIBLE BLOOD ALCOHOL CONCENTRATIONS IN THE COUNTRIES THAT ARE MEMBERS OF THE EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT FOR WHICH INFORMATION IS AVAILABLE

COUNTRY	MAXIMUM SPEED LIMITS (km/h)				PERMISSIBLE BLOOD ALCOHOL CONCENTRATIONS
	Motorways	Road with separate carriageways	Main roads	Built-up areas	
Austria	130	100	100	50	0.05 g/dl or 0.0025 g/l air exhaled
Azerbaijan	110	90	90	60	0 g/dl
Belarus	NA	110	90	60	0.04 g/dl
Belgium	120	90	90	50	0.05 g/dl or 0.0022 g/l air exhaled
Bulgaria	120	90	90	50	0.05 g/dl
Croatia	130	100	100/90	50	0.05 g/dl
Czech Republic	130	130[a]	90	50	0 g/dl
Denmark	110	80	80	50	0.05 g/dl
Estonia	NA	110	90	50	NA
Finland	120[b]	80/100[b]	80/100[b]	50	0.05 g/dl or 0.0025 g/l air exhaled
France	130	110	90	50	0.05 g/dl or 0.0025 g/l air exhaled
Germany	130	130	100	50	0.05 g/dl or 0.0025 g/l air exhaled
Greece	120	100	90	50	NA
Hungary	130	110	90	50	0 g/dl
Iceland	NA	90	90/60/70/80	30/50	0.05 g/dl or 0.0025 g/l air exhaled
Ireland	97	97	97	48	NA
Italy	130	110	90	50	0.05 g/dl
Latvia	NA	NA	90	50	0.05 g/dl
Liechtenstein	NA	NA	80	50	NA
Lithuania	110/130	100	90	60	0.04 g/dl
Luxembourg	120	90	90	50	0.08 g/dl
Malta	64	64	64	NA	NA
Netherlands	100/120	100	80	30/50/70	0.05 g/dl
Norway	90/100[c]	90	80	30/50	0.02 g/dl or 0.001 g/l air exhaled
Poland	130	110/100	90	60	0.02 g/dl
Portugal	120	100	90/100	50	0.02 g/dl
Republic of Moldova	NA	NA	90	60	NA
Romania	90	90	90	50	0 g/dl
Russian Federation	110	90	90	60	0 g/dl
Serbia and Montenegro	120	100	80	60	0.05 g/dl

TABLE A5. CONTD

COUNTRY	MAXIMUM SPEED LIMITS (km/h)				PERMISSIBLE BLOOD ALCOHOL CONCENTRATIONS
	Motorways	Road with separate carriageways	Main roads	Built-up areas	
Slovakia	130	130	90	60	0 g/dl
Slovenia	130	100	90	50	0.05 g/dl
Spain	120	100	90	50	0.05 g/dl
Sweden	90/110	90/110	70/110	30/50/70	0.02 g/dl or 0.001 g/l air exhaled
Switzerland	120	100	80	50	0.08 g/dl
Turkey	120	90	90	50	0.05 g/dl
Ukraine	NA	120	90	60	NA
United Kingdom	112	112	97	48	0.08 g/dl

Source: European Conference of Ministers of Transport, 2003 (http://www1.oecd.org/cem/topics/safety/Speed.pdf, http://www1.oecd.org/cem/topics/safety/Alcohol.pdf, accessed 1 February 2004).

NA: not available.
[a] Roads for motor vehicles.
[b] In winter: 100 km/h on motorways and 80 km on roads with separate carriageways and main roads.
[c] Being tested at 100 km/h on some motorways.

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