Keeping Children Safe in Traffic

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FOREWORD

An OECD Working Group comprised of road safety experts has produced the present study, which explores children's characteristics, mobility needs and travel patterns, as well as design factors that affect children's safety in transport. (A list of the members of the group and of the editorial board is provided in Annex B).

The study examines various strategies for keeping children safe in the road environment and discusses their safe mobility in the context of other social objectives, including road safety, infrastructure provision and design and accessibility.

The information and recommendations presented are geared to policy makers, transport planners, regulators and strategists. The overall aim is to continue the progress achieved in reducing children's road-related injuries and fatalities.

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ABSTRACT

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In many OECD countries, road-related crashes are the number one killer of children under the age of 15. Since the last OECD report on children's transport safety was published in 1983, an estimated 100 000 children have perished in road-related crashes. At current rates, one child out of every 2 100 will die before their 15th birthday in a road-related incident, and a considerably higher number will suffer severe injuries or lifelong disabilities. Many such fatalities would be avoided if all OECD member countries adopted practices known to be effective in improving children's road safety.

This report outlines the progress that has been made in OECD countries in the last 20 years. It provides the latest statistics on children's injuries, fatalities and trends in transport. It considers the relative levels of risks in OECD countries and the casualty reduction programmes and strategies that can improve children's road safety. It also identifies practices drawn from member country experience that have proven to be most effective in improving children's road safety and outlines possible further improvements based on research undertaken. The report then makes a series of policy-oriented recommendations for achieving such improvements in children's road safety.

Fields: 81 Accident statistics, 82 Accidents and the road, 83 Accidents and the human factor, 84 Personal injuries, 85 Road safety devices, 91 Vehicle design and safety, 10 Economics and administration.

Key words: OECD, policy, legislation, design (overall design), child, accident prevention, injury, fatality, accident rate, statistics, walking, bicycle, risk, education, crossing the road, publicity, driver training, behaviour, traffic restraint, highway design, planning, safety belt, seat (veh), interior (veh), vehicle.

* The OECD International Transport Documentation (ITRD) database contains more than 300 000 bibliographical references on transport research literature. About 10 000 references are added each year from the world's published literature on transport. ITRD is a powerful tool to identify global research on transport, each record containing an informative abstract.

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EXECUTIVE SUMMARY

Introduction

In many OECD countries, road-related crashes are the number one killer of children under the age of 15. Since the last OECD report on children's transport safety was published in 1983, an estimated 100 000 children have perished in road-related crashes. Of course, this level of fatalities is not acceptable.

Considerable advances have been made by most countries, particularly since 1990. Many of the recommendations from earlier OECD work have been implemented with the support of Ministers for Transport in OECD and ECMT countries. In fact, the number of children killed per annum on the roads in OECD countries was halved between 1984 and 2000. Nevertheless, at current rates, one child out of every 2 100 will die before their 15th birthday in a road-related incident, and a considerably higher number will suffer severe injuries or lifelong disabilities. Many such fatalities would be avoided if all OECD member countries adopted practices known to be effective in improving children's road safety.

This *Keeping Children Safe in Traffic* report draws on best practice and research results to show how child casualties can be reduced whilst at the same time encouraging children to develop into safe, active and independent road users. It focuses on the contribution education, training and publicity can make; measures related to the risks children face in the road environment; vehicle and bicycle standards; safety equipment and the importance of appropriate legislation. It outlines the progress that has been made in OECD countries in the last 20 years. It provides the latest statistics on children's injuries, fatalities and trends in transport. The report considers the relative levels of risks in OECD countries and the casualty reduction programmes and strategies that can improve children's road safety. It identifies practices drawn from OECD member country experience that have proven to be most effective in improving children's road safety. It also outlines possible further improvements based on research undertaken.

One of the report's conclusions is that, currently, the best-performing countries have population-based road crash fatality rates for children that are less than half the OECD average and only a quarter of the rate in the worst-performing countries. Therefore, there is considerable potential for improving child road safety in most OECD countries. After examining the most effective strategies, based on the research undertaken, the report makes a series of policy-oriented recommendations for achieving such improvements in children's road safety.

Keeping Children Safe in Traffic is particularly geared towards policy makers, transport planners, regulators and strategists as well as road safety professionals, motorist associations and researchers.

A survey of children's road traffic safety in OECD countries was commissioned by the United Kingdom's Department for Transport and undertaken in 2002 and 2003 to complement and help with the preparation of this report from the OECD's Child Traffic

Safety Expert Group. Responses to the International Survey were therefore an important input to this report. Twenty-one of the 30 member countries responded, and data was supplemented where possible by internationally available data.

Improving children's road safety

The main purpose of the *Keeping Children Safe in Traffic* report is to highlight successful programmes and strategies that could be adopted by OECD countries to improve children's safety on the roads and to identify possible further improvements.

Road safety policy

Best practice for improving child safety needs to incorporate a variety of different measures. The survey findings showed that most OECD countries have had national plans for reducing children's traffic crashes for at least ten years, but the best-performing countries have adopted a holistic approach. These countries use a wide variety of measures covering speed reduction, promotion of secondary safety measures and publicity aimed at children, their parents and drivers.

Where countries have specific targets for casualty reduction, many of these specifically target children. In some countries disadvantaged communities and socially deprived groups may be targeted as well.

The survey results suggested that success in improving safety for children is most likely to be achieved through combining measures to address the behaviour of all road users, to improve the road environment and to design vehicles that better protect both their occupants and those at risk outside the vehicle.

The report reviews road safety policy and practice in three key areas: education, training and publicity; the road environment; and vehicle standards and safety equipment. No one of these areas is more important than the others, and success in improving safety is likely to involve a holistic approach combining measures across all three groups.

1. Education, training and publicity

Educational measures need to be tailored to the child's stage of development, starting with practical pedestrian and then bicyclist skills, but increasingly involving higher-level skills to match children's increasing independence as pedestrians, bicyclists and ultimately young adult drivers.

All road users have a duty to keep children safe, so it is also important to target drivers through training and publicity and to make parents aware of their key role in improving the safety of their children. In particular, parents are important role models for their children and can inculcate safe behaviour through example, for instance in use of seat belts and their behaviour as pedestrians.

As children progress through school, continuing integrated road safety education in several curriculum areas has been advocated in preference to occasional talks on road safety or other less integrated approaches. Well-targeted publicity that raises risk awareness, particularly among young teenagers, can complement school-based education.

Bicycling skills are first learned off-road, but the skills needed to interact safely with traffic are most effectively developed using a supervised problem-solving approach and guided experience. Bicycle helmets dramatically reduce the severity of head injuries, and

many countries have used publicity campaigns targeting both children and parents to promote bicycle helmet wearing.

Best practices related to education, training and publicity

Many examples are provided in the report of current practices known to be effective in improving children's road safety. Examples of best practices include:

- Road safety education that is part of the national education curriculum at all levels from pre-school on, with regular high-quality inputs to develop children's skills, risk awareness, attitudes and knowledge.
- Drivers are made aware of their responsibilities to their passengers and other road users, and they understand the limitations of children's behaviour in traffic. These outcomes can be achieved by effective education, training and publicity. Legislation on driver responsibility is used in some countries.
- Publicity is used in conjunction with other measures as a powerful tool for delivering information and influencing attitudes and behaviour in all areas of road safety, from environmental improvements to changes in legislation to vehicle modifications. It is being used to engage all sectors from policy makers, professionals and businesses to communities and consumers.
- Publicity campaigns targeting drivers that encourage drivers to behave more safely by raising awareness of how children behave, alerting drivers to their legal responsibilities to protect car occupants and child pedestrians and bicyclists, and highlighting such issues as choice of speed.
- Publicity to maintain drivers' awareness of the importance of correct fitting and use of child restraints and seat belts in cars.

Areas for possible improvement

The report outlines a number of areas relating to education, training and publicity where further improvement appears possible. These include:

- The focus of responsibility for child road safety needs to be shifted more towards drivers. However well children may be educated and trained in road safety skills, they remain less able than adults to use their skills and knowledge consistently.
- Drivers must be more aware of children's abilities, and driver training needs to increase novice drivers' awareness of hazards, particularly where children are concerned.
- The status of road safety education needs to be improved through integration with other disciplines and better evaluation of measures.
- Parents need to be involved more effectively in the delivery of road safety education both informally and formally. Parents must be well informed in particular about the safety devices that can protect their children and the need to teach safe behaviour through example.

2. Children in the road environment

Helping children and other road users to adapt their behaviour in order to interact safely with traffic in the road environment is only part of what is needed to keep children safe. Traffic engineers, urban designers and planners have a duty to design systems that take account of children's mobility needs, travel behaviour and differences in perceptual and reactive capabilities in order to maximise their safety and mobility. Children cannot be expected to comprehend aspects of the built environment and react to stimuli in the same way as adults.

The survey of 21 OECD countries showed that a child-centred approach to the road environment distinguished top-performing countries from those that did less well in terms of children's road safety.

Best practices

Many examples are provided in the report of current practices known to be effective in improving children's road safety. Examples of best practices include:

- Traffic calming which reduces vehicle speeds is advocated as a key measure to improve the overall safety of road users, in particular children. Top-performing countries used area wide traffic calming to a greater extent and had a wider range of infrastructure safety measures.
- Children's safe mobility facilitated by the design of residential areas that incorporates traffic calming techniques and low speed zones such as "green districts" and "home zones" to favour walking and bicycling as the dominant modes.
- Making speed reduction a key objective in order to protect vulnerable road users.
- Setting speed limits according to the function of roads within a hierarchy. Roads with high pedestrian and bicyclist activity have designated limits no higher than 30 km/h.
- The whole community, including children, consulted and involved in traffic planning decision making, to ensure that the activities and travel needs of all are fully taken into account.
- Lower speeds on small rural roads and availability of foot and bicycle paths are important.
- Outside residential areas where low speed limits are less feasible and roads are wider with heavier traffic flows, attention is given to designing safe places to cross the road. Safety should be encouraged by use of zebra crossings and signalised intersections, pedestrian islands, and school crossing patrols where necessary. For very busy roads, segregation from motorised traffic and provision of well-lit foot bridges and tunnels may be necessary.
- In the development of new educational facilities, consideration given to safe access using all travel modes, especially bicycling, walking and use of public transport.
- Better maintenance of the road environment and in particular play spaces and safe access to such spaces - as failure to repair damage or clear away obstructions often contributes to further deterioration.

Possible improvements

The report outlines a number of areas where further improvement appears possible in relation to children's safe interaction with traffic in the road environment. These include:

- Designing road environments in ways that recognise children's capabilities as well as their limitations. This will benefit all road users, since what constitutes a safe road environment for children will usually be safe for the general public particularly older road users.
- The built environment constructed in a way that stimulates children's growth and safe interaction with traffic. Urban design features can be used to support and complement children's safety in the road environment.
- Safety audits performed from a child's perspective.

3. Vehicle standards and safety equipment

The third element in a holistic approach to children's road safety is the design of vehicles and safety equipment such as child restraint systems and bicycle helmets. Vehicle standards cover both "primary safety" measures that reduce the risk of a crash occurring and "secondary safety" measures that are designed to prevent or minimise injury in a crash. It is these secondary safety measures that are most likely to be specifically designed to increase child safety.

Restraint systems

The most important measure to protect child occupants of vehicles is the provision and use of suitable child safety restraint systems.

Best practices and possible improvements

- Compulsory seat belt use and high levels of seat belt use in both front and rear seats. Although compulsory seat belt use is a general requirement in OECD countries, actual wearing rates vary. Significant reductions in children's fatalities and serious injuries could be achieved if all countries had the high wearing rates in both front and rear seats of the best performers.
- Correct use of child restraints. Often, the child restraints used are inappropriate for the age of the child, badly fitted, or incorrectly used. In the United States, it has been calculated that an estimated 458 lives could have been saved in 2002 if all children under 5 years of age had used a child safety seat.
- Systems such as ISOFIX, UAS, or LATCH that provide universal fixings for child restraints adopted by car manufacturers, and integrated seating systems developed.

Vehicle design

Best practices

- Vehicle design incorporates passive safety systems such as crumple zones, airbags and safety door and window locks.
- Where airbags are fitted, care is taken with the child's seating position as front seat airbags can present a risk to children. In both Europe and North America, parents

are advised that infants and young children should not use the front passenger seat, especially if an airbag is fitted.

- The evidence suggests that combined interventions are effective in improving child passenger restraint use. The recommended interventions include comprehensive legislation and community-wide information and enforcement campaigns, built around the active participation of public safety officials and safety-oriented voluntary organisations.

Possible improvements

- Vehicle manufacturers have an important role to play in developing improvements for the safety of child occupants and other road users in the event of a crash.
- Vehicle manufacturers should work with child restraint manufacturers, parents, those responsible for vehicle standards and others to find a balance in taking responsibility for child safety.
- Simple, universal designs for children's automotive restraint systems which can accommodate a diversity of children with a wide range of height, age and weight variations should be encouraged.
- More attention should be given to improving the safety of pedestrians and bicyclists by designing vehicles that reduce impact in the event of a crash. Such measures, particularly the redesign of car fronts, have significant potential to reduce deaths and injuries to children.

Pedestrians and bicyclists

Best practices and possible improvements

- Bicyclist safety increased by the development of standards for bicycle construction and bicycle helmets. It is most important that bicycle helmets for children fit properly and are comfortable.
- Both child pedestrians and bicyclists benefit from conspicuity aids and the use of light-coloured and retro-reflective clothing. Designers and manufacturers of children's clothing and accessories are well-positioned to incorporate retro-reflective materials into product lines. Parents, as well as public health and safety officials should encourage them to do so, as one component of an ongoing campaign for protecting children in traffic. Dangle tags, armbands, strips on school bags and use of bicycle lamps are all recommended.
- Given the evidence supporting the effectiveness of bicycle helmets in preventing head and brain injuries, it is recommended that bicyclists be strongly encouraged to use bicycle helmets. Further scientific investigation is recommended to study the inter-relationships of legislation, enforcement and outreach programmes in achieving greater bicycling safety through helmet use.

School buses

Best practices

- School buses fitted with seat belts where practicable and where seat belts are provided, the use of seat belts required on buses transporting children.
- In some OECD countries, notably in North America, children travel to school in specially designed buses. The North American school buses use a passive safety system rather than seat belts. School buses also have safety features such as enhanced structural integrity and strict fuel system integrity that increase their crash-worthiness. The windows are designed to reduce the risk of ejection.
- Attention is paid to the safety of children as pedestrians when boarding or disembarking from buses. Various measures such as recognition zones around bus stops, detection and warning systems, and improved mirrors for buses can contribute to safety.
- Proper training for school bus drivers.

Possible improvements

- In view of competing resources and programmes concerning travel to school, it is recommended that school jurisdictions develop and implement risk management policies related to the journey to and from school. Issues of importance to the policy include the use of public transit or dedicated buses, the fitting of seat belts, protective measures for child pedestrians outside the bus, protecting children walking and/or bicycling to school, and public awareness messages and campaigns.
- Protecting children as they use private vehicles, bicycles and buses in traffic is a responsibility shared by all levels of government and many non-governmental organisations, as well as families. Strategic partnerships should be established and nurtured to create innovative and multidisciplinary approaches to keeping children safe in traffic.

Legislation

The international survey considered the role that legislation can play in improving children's road safety. A country's range of legislation can give some indication of the political will to address the burden of injury to children. The key areas considered were child safety restraints and seat belts, bicycle helmet use, child bicyclist behaviour, driver responsibility in a crash involving children and compulsory road safety education.

Seat belt legislation is almost universal, but high wearing rates of seat belts and restraints by children were a characteristic of countries surveyed which were high performers in terms of child safety. This is achieved by active promotion of seat belt wearing involving education and publicity as well as enforcement of legislation.

Only eight countries had bicycle helmet wearing legislation. Experience indicates that legislation is effective in raising bicycle helmet wearing rates. However, increases in wearing rates can be achieved even without legislation through appropriate promotional activities. Some countries also have legislation relating to the age at which children can bicycle on the road and their competence.

Less than a third of the countries had legislation that assumes driver responsibility in a crash involving a child pedestrian; the presence of such legislation distinguished these countries from countries that performed less well in terms of pedestrian safety. Such legislation places the burden of proof on the driver, and the presence of such a law may have modified driver behaviour in residential areas and created a more child-centred approach to safety.

Many OECD countries reported compulsory road safety education, but its presence did not distinguish top performers from countries that performed less well. More important seemed to be the approach adopted, and top-performing countries shared a number of initiatives, such as teaching pedestrian skills at the roadside and providing materials and advice for parents.

Key findings

Key findings of this report include:

- Road safety policy should include specific strategies for improving child safety including specific targets for casualty reduction and monitoring and reviewing the evidence base.
- Road safety education and training is a lifelong learning process that neither begins nor ends in schools. All road users have a duty to keep children safe, and parents have a vital role to play through teaching and example in the early years.
- Driver training is an integral part of the safety education system, and while children need to know how to behave safely on the roads, drivers need to take more care and responsibility and to recognise that children will not behave in the same way as adults.
- Road safety education in schools should use approaches based on sound educational practice with an emphasis on problem-solving and practical skills training. It needs to be an ongoing programme in schools not a one-off activity.
- Publicity needs to address all road users and age groups using a targeted approach for individual audiences to raise awareness of how children will behave in traffic. Publicity should also be aimed at improving driver behaviour, especially in respect of inappropriate speed.
- Traffic engineers and planners have a duty to take children's needs and abilities into account in designing the built environment.
- More priority needs to be given to vulnerable modes through the use of traffic calming and facilities for walking and bicycling.
- All children should be provided with child restraints in vehicles that are suitable for their age and size, and properly fitted and used.
- Vehicle design should incorporate safety features such as crumple zones, airbags and safety locks for doors and windows that take account of the needs of children. Parents need good advice on the correct use of child restraints and the safest seating positions particularly where airbags are fitted.

- Vehicle designers and legislators on vehicle standards should give more attention to protecting pedestrians and bicyclists as well as vehicle occupants from injury and death.

Conclusions and recommendations

This executive summary has set out conclusions on best practices drawn from experience in OECD member countries that can make a significant contribution to reductions in children's transport-related injuries and fatalities. It has also highlighted possible improvements in the key policy and operational areas affecting children's road safety. These key aspects of the executive summary are based on the more detailed conclusions and recommendations for road safety policy set out in full in Chapter 5 of the report.

INTRODUCTION

In many OECD countries, road-related crashes are the number one killer of persons up to 14 years of age. Tragically, roughly one child out of every 2 100 will die as a result of such a crash before the age of 15, and a considerably higher number will suffer from severe injuries or lifelong disability. Since 1983, when the last OECD report on transport safety and children was published, an estimated 100 000 children have perished in road-related crashes (OECD, IRTAD database, 1983-2002).

At the turn of the new century, an estimated 160 million children up to 14 years of age lived in OECD countries (excluding Greece, Luxembourg, Mexico and Turkey). In 2000, more than 5 000 died in road traffic accidents.

These staggering statistics highlight the dangers and challenges children face daily in our highly motorised world. As our planet's most precious "natural" resource, they warrant special nurturing and protection. As members of society, we all bear responsibility for keeping children safe in traffic.

On a global basis, the promotion of children's health, safety and well-being is embraced by the United Nations "Convention on the Rights of the Child".[*] OECD countries are increasingly incorporating children's road safety issues into a broad framework of ambitious safety strategies and targets for all road users.

Progress has been made in keeping children safer in traffic. The number of children who were road casualties was halved between 1984 and 2000. This 50% reduction is superior to the 20% reduction in fatalities for the population of OECD countries as a whole over the same period. This difference may be attributable to a combination of factors, notably an improvement in children's safe mobility and a reduction of their exposure to risk. The objective is to provide children with maximum mobility and minimum risk.

Reducing the number of children killed in road-related incidences requires a comprehensive approach featuring enhanced standards for safety equipment in vehicles and for children: improved road design; development and implementation of school training programmes; faster emergency response time; improved medical care and modal shifts. Legislative and enforcement actions provide an important framework for keeping children safe in traffic. Tertiary safety including emergency response time and improved medical care are outside the sphere of this report.

[*] *www.unicef.org/crc/crc.htm* and *www.unhchr.ch/html/menu3/b/25.htm*

This report aims to encourage a continuation of the progress achieved in children's road safety over the past two decades by drawing attention to successful programmes and strategies that can be tailored and adopted by OECD countries. The International Survey of Children's Road Traffic Safety conducted for this report resulted in responses from 21 OECD countries. The data collected provide information on how countries are performing in terms of road safety for children and form the basis for the array of case studies, measures and best practices to promote children's transport safety which are described in this report (see Annex A). They also underpin the conclusion and recommendations set out in Chapter 5.

For the purposes of this report, a child is defined as a person aged 0-14. Although this definition differs from that of the United Nations' Convention on the Rights of the Child, which encompasses ages 0-17, it was used to coincide with existing data in OECD national road traffic accident databases and widely agreed definitions of children in developed countries.

The report begins with an assessment of the scale and current understanding of the nature of child road safety (Chapter 1). Chapters 2, 3, and 4 explore new approaches, designs and strategies to increase children's safe mobility in the road environment. Chapter 2 describes the role that safety and education play in promoting children's safe behaviour on the road; Chapter 3 discusses how the built environment affects their safety, and Chapter 4 outlines safety equipment for a variety of travel modes.

The issues addressed in the various chapters should be considered as part of an integrated approach to improving road safety. Chapter 5 offers research and policy recommendations for safeguarding current and future generations in the road environment of OECD countries.

Chapter 1

CHILDREN'S TRAVEL: HOW RISKY IS IT?

Abstract. Chapter 1 provides an overview of children's transport safety using different transport modes, some of the risk factors associated with them, and changing mobility trends. In most OECD countries, traffic crashes are the number one killer of children below age 15, and on average, 3.5 children per 100 000 population die in traffic crashes each year. This chapter also explores the considerable progress that has been achieved in road safety over the past two decades. While noting the number of child transport-related fatalities has been halved from 1984 to 2000, the chapter outlines the need for further work that remains to be done.

Children's mobility needs and travel patterns

Children need to be able to travel safely on their journeys to and from school, as well as to enjoy freedom of movement to play and explore their surroundings. Traffic safety is thus a key issue. Personal safety concerns and changing economic and social patterns also affect children's travel behaviour. Given parents' perceptions of children's circulation in traffic being inherently hazardous, parents increasingly drive them to school and other destinations in private vehicles. Trips by car now account for at least half of all distances travelled by 10-14 year olds in many OECD countries (Table 4, Christie *et al.*, 2004). The significant shift to car travel is believed to account for the fact that more children are killed today as car passengers than in any other transport context.

Every choice involves trade-offs, and transport is no exception. Restricting children's movement may reflect parents' well-intentioned efforts to keep them out of harm's way, but may unintentionally have detrimental effects on their health. Researchers have recently linked decreases in the level of children's physical activity, walking and bicycling, to increases in lack of stamina, childhood diabetes and obesity (Branch, 2001; Greenberg *et al.*, 2000; Aarnikko *et al.*, 2002).

Keeping children healthy, safe and mobile requires a delicate balance between encouraging and allowing them to move about freely and safeguarding them in the road environment. While parents and adults must be particularly mindful of children's personal security and safety in traffic, society also bears part of the responsibility. This issue is discussed in the following chapters of the report.

Impact on society, costs and health

Road crashes have an enormous social and economic impact on society. The World Bank estimates that the cost of road crashes represents approximately 1-3% of a country's annual gross national product (GNP), and in OECD countries, on average, a road crash victim dies every four minutes (OECD, 2002).

In 1998, road-related fatalities were the tenth leading cause of death worldwide. According to World Health Organization (WHO) estimates, by 2020, road traffic disability-adjusted life years lost will move from ninth to third highest cause of the global burden of disease (*www.who.int/violence_injury_prevention/media/en/156.pdf*, p. 5).

Most governments prioritise their expenditures on road safety by using cost-benefit analysis to inform decision makers. Cost-benefit analyses place value on the benefits of reducing risk. Traditionally, these analyses have been the standard tool for determining transport funding allocations for safety infrastructure and engineering projects, education and training, and research. These economic methodologies are not without controversy; however, due to variations in units of measure, concepts such as quality-of-life-years must be carefully considered, for children in particular.

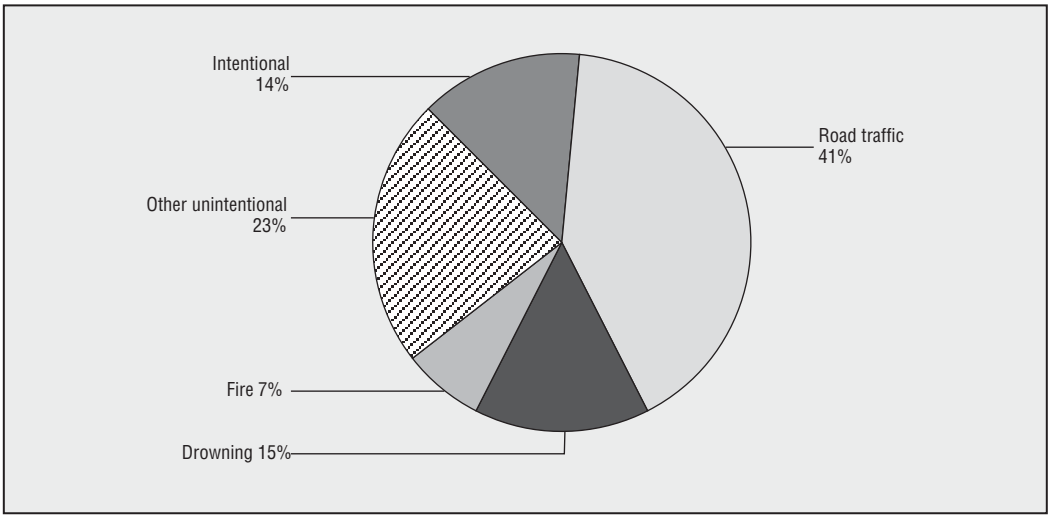
In recent years, a few OECD countries have adopted a concept known as "Vision Zero". This approach, which originated in Sweden, takes an ethical approach to safety and mobility (Tingvall and Haworth, 1999; *www.vv.se/traf_sak/nollvis/tsnollvis3.htm*). Vision Zero aims to design traffic systems that take better account of the needs and vulnerabilities of road users. Its goal is to eliminate transport-related fatalities or injuries leading to long-term health problems.

Whatever approach is used to determine appropriate governmental action, it is crucial to focus on reducing children's road-related fatalities and injuries. Road crashes account for a greater share of children's injury-related deaths in OECD countries than drowning or fire (Figure 1). Because road crashes account for around 40% of all fatalities due to accidents or acts of violence in OECD countries, this report advocates putting transport safety at the top of every policy maker's agenda.

The number of fatal traffic crashes in OECD countries involving children varies, as a comparison of figures from the United Kingdom and Korea shows. In the United Kingdom, traffic-related incidents represent fewer than a third (29%) of all children's accidental deaths, while in Korea, they exceed 50% - these figures are the averages of accident statistics for 1991-95 (UNICEF, 2001).

Since the 1970s, deaths attributable to road crashes have declined less than other types of accidents. Undoubtedly, the rise in motorised traffic in many countries and the resulting increased exposure to risk have contributed to the rise in road-related incidents as a share of all child fatalities.

Figure 1. Causes of children's injury-related fatalities in OECD countries, 1991-95



Note: Children in OECD countries aged 1-14 in 1991-95; excluding Turkey.

Source: UNICEF, Innocenti Report, 2001, New York.

Data sources and characteristics of road crashes involving children

This report uses the OECD-linked IRTAD (International Road Traffic and Accident Database) as the main data source for road crashes in OECD countries. Owing to differences in countries' definitions of injury and collection of injury data, IRTAD only offers data on road traffic fatalities. This discussion focuses on children aged 0-14 to match the IRTAD data set.

The IRTAD database includes statistics on all OECD countries except Mexico but only countries that provided data by age group are included in this analysis. In countries with low population figures and correspondingly few fatal accidents, the figures are subject to strong random annual fluctuations, which may be reflected in population-related accident rates, making comparability with other countries unreliable. Therefore, country-specific fatality figures are given as average values for the years 1996-2000. The terms "fatality rate" and "risk" are important concepts for comparing children's transport safety among OECD countries. In this report, risk is defined as the rate and probability that an event will occur, enabling comparison of different fatality rates. "Fatality rate" relates to the number of children killed and can refer to either the population or a measure of exposure (*e.g.* person-kilometres).

For example, if children aged 0-14 have a higher "risk" of dying as car passengers than as pedestrians, the number of deaths per 100 000 population (or person-kilometres) for car passengers is higher than the number of deaths per 100 000 population (or person-kilometres) for pedestrians.

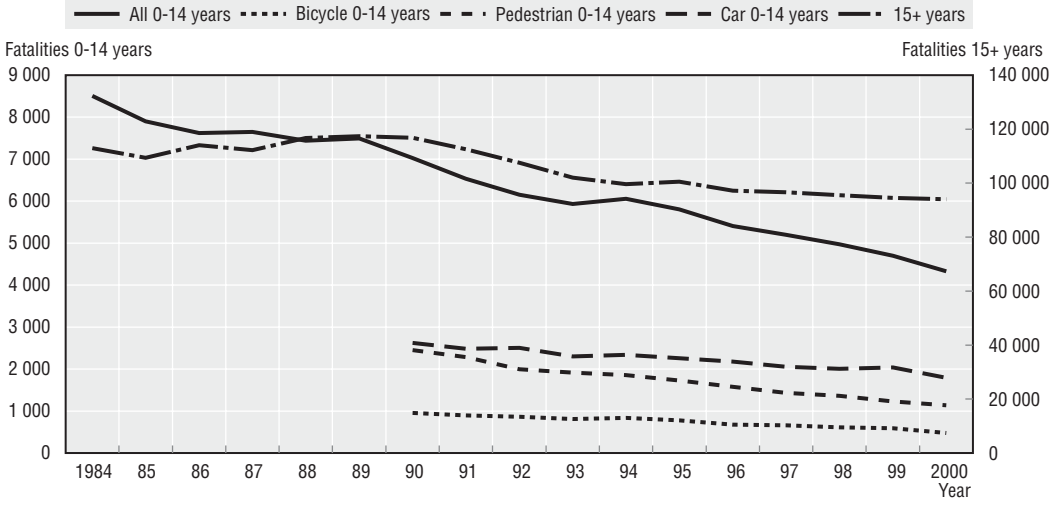
Additional data used in this report are drawn from The International Survey of Children's Transport Safety, a comprehensive survey conducted in OECD countries in 2002. Of the OECD's 30 member countries, 21 responded (a 70% response rate) (Christie *et al.*, 2004).

Fatal road traffic crashes involving children in OECD countries

Figures 2 and 3 illustrate the declining trend in children's road-related fatalities by mode of transport. It should be noted that data by transport mode have only been available in the IRTAD database since 1990. Children's safety in traffic has clearly improved more than that of adults. The number of child fatalities has diminished by 50% over the period from 1984 to 2000, but the decrease has been less than 20% for the rest of the population. It is unclear how much this differential is due to increased focus on children's safety and how much is due to changing mobility trends. In the decade between 1990 and 2000, the number of children killed as pedestrians declined by 54%, as bicyclists by 50%, and as car passengers by 32%. The differing trends in accidents involving pedestrians and car passengers are particularly striking. In 1990, figures for the two transport modes were at approximately the same level, but by 2000, there were two-thirds as many fatalities among pedestrians as among car passengers.

Figure 2. Trends in child (0-14 years) and adult (15+ years) road traffic fatalities in OECD countries

In absolute numbers



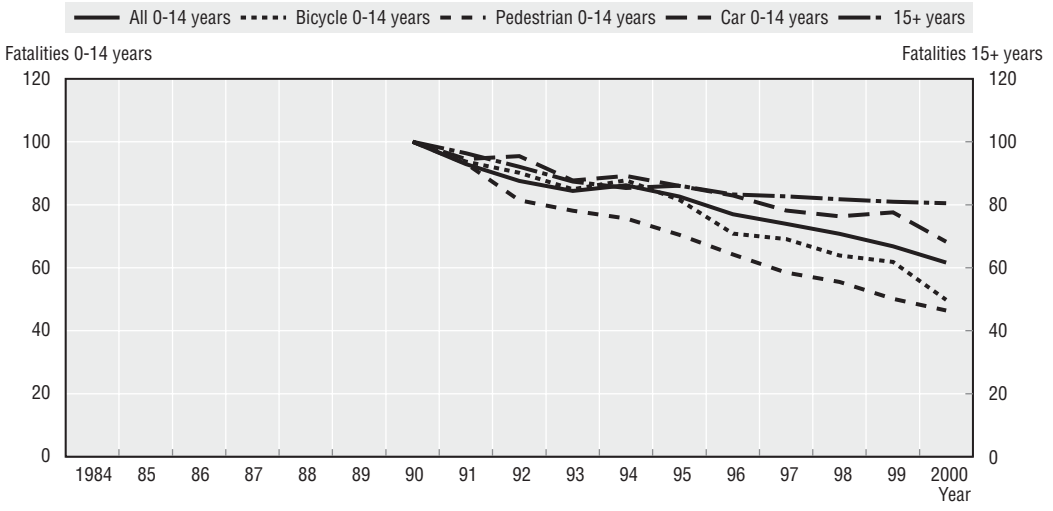
Note: This figure excludes Mexico, the Slovak Republic, Poland and Turkey.

Source: OECD, IRTAD.

It is difficult to assess the safety level offered by different transport modes owing to a lack of exposure data for children in most OECD countries. Given these limitations, the best available indicator for the level of safety in a given country is fatalities per age group. This methodological challenge is discussed in more detail in the following section (Christie *et al.*, 2004).

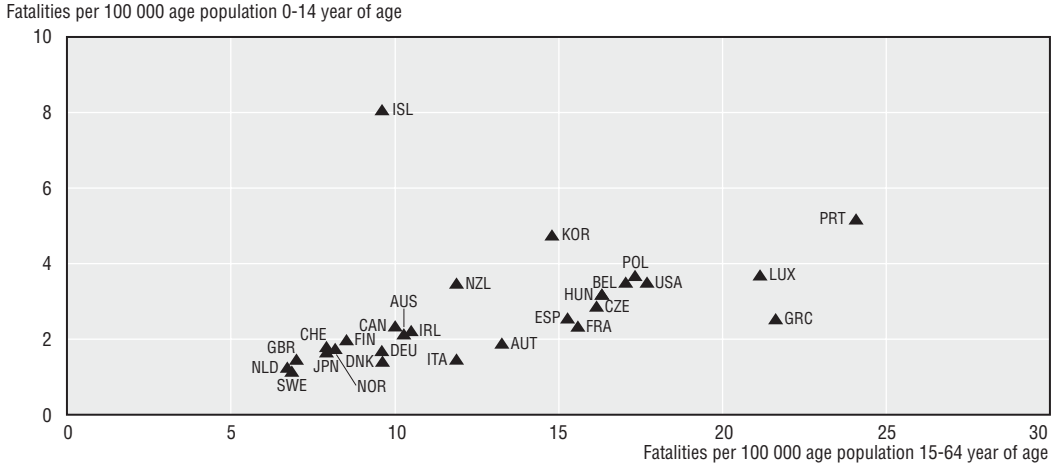
Recommendation: Better and more comprehensive exposure data would improve the analysis of traffic crashes and fatalities involving children. This constitutes the present report's first research recommendation.

Figure 3. Trends in child (0-14 years) and adult (15+ years) road traffic fatalities in OECD countries



If fatality rates for children are compared to those for the population at large, there are clear similarities. In general, countries with "good" overall transport safety performance have fewer child fatalities among road users. Figure 4 makes clear which countries do not reflect this general trend.

Figure 4. Road traffic fatality rates for children 0-14 years compared to other ages per 100 000 population in OECD countries



Note: Data from year 2002, except for Belgium (2001), Canada (2001), Italy (2000), Luxembourg (2000) and Portugal (1999).

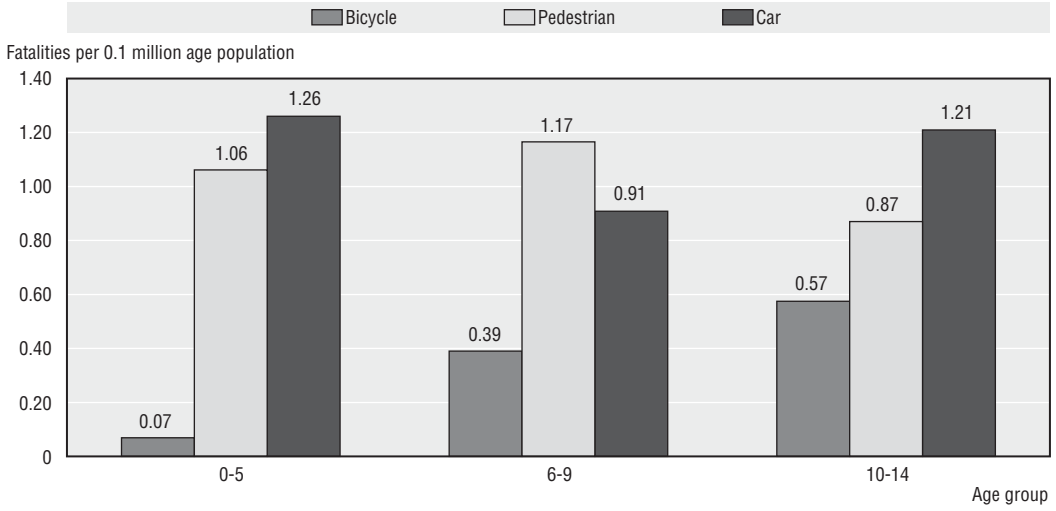
Abbreviations:
AUS: Australia. AUT: Austria. BEL: Belgium. CAN: Canada. CHE: Switzerland. CZE: Czech Republic. DEU: Germany. DNK: Denmark. ESP: Spain. FIN: Finland. FRA: France. GBR: United Kingdom. GRC: Greece. HUN: Hungary. IRL: Ireland. ISL: Iceland. ITA: Italy. JPN: Japan. KOR: Korea. LUX: Luxembourg. NLD: Netherlands. NOR: Norway. NZL: New Zealand. POL: Poland. PRT: Portugal. SWE: Sweden. USA: United States.

Source: OECD, IRTAD.

Figure 5 displays the risks of children's fatal crashes by age and travel mode. The greatest differences occur for bicyclists. While bicycling fatalities are rare for children aged 0-5 years, with .07 fatalities per 100 000 population, fatalities rise to .39 fatalities per 100 000 population for those aged 6-9 and reaches .57 fatalities per 100 000 population for children aged 10-14.

Figure 5 shows that fatality rates per 100 000 population for pedestrians and car passengers are higher than for bicyclists in all age categories. Only children aged 6-9 have higher rates for pedestrian than for car passenger fatalities. This may be attributable to the fact that children in this age group increasingly move about without adult accompaniment, yet lack the maturity to react safely as pedestrians in complex traffic situations. Since these rates are not related to exposure, they do not reflect the risk of injury related to different transport modes.

Figure 5. Fatality rates related to road crashes, by age group and mode of travel in OECD countries, 2000



Note: Only countries providing data on mode of transport and population (excluding Italy, Norway and Portugal).

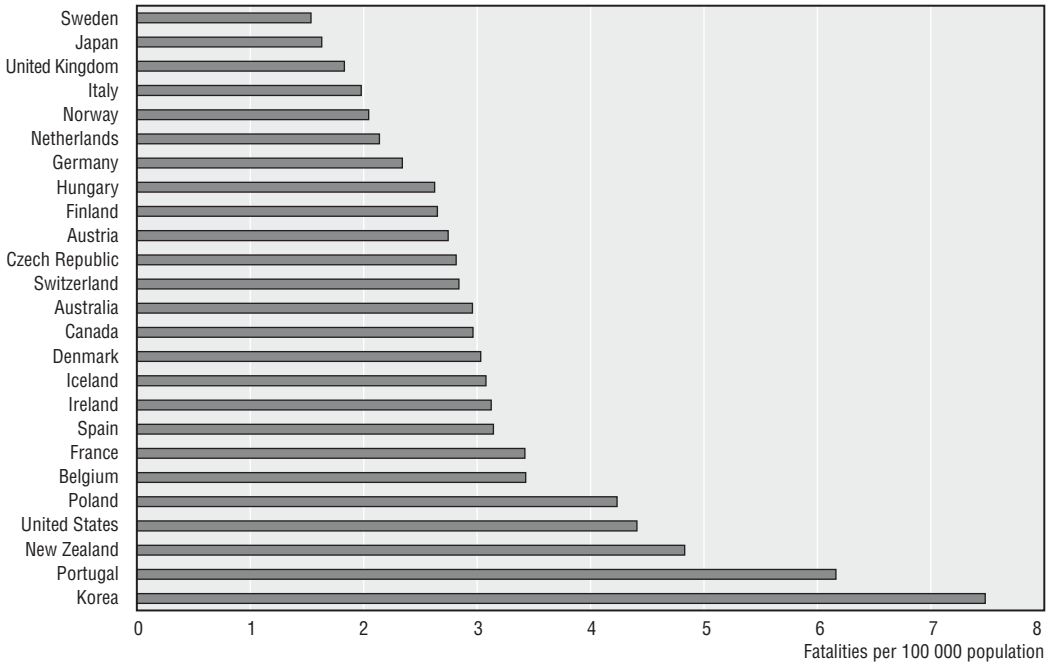
Source: OECD (IRTAD).

Fatal road accidents among children by country

Children's road traffic fatality rates vary widely among OECD countries (Figure 6). On average, 3.5 children per 100 000 population die in traffic crashes. Sweden has the lowest fatality rate at about 1.5 children per 100 000 population, and Korea has the highest at about 7.5 children per 100 000 population.

Figure 6. Total traffic fatality rate among children aged 0-14

Mean for 1996-2000



Note: Only includes countries providing population and accident data for at least three years between 1996 and 2000.

Source: OECD, IRTAD.

Countries can be roughly sub-divided into four groups with similar fatality rates: the first (Sweden to Germany) ranges from 1.5 to 2.3 fatalities per 100 000 population, the second (Hungary to Canada) from 2.6 to 2.9 fatalities per 100 000 population, the third (Denmark to Belgium) from 3.0 to 3.4 and the fourth (Poland to South Korea) from 4.2 to 7.5 fatalities per 100 000 population. The highest child fatality rates were reported for New Zealand, Portugal and Korea, where between 4.8 and 7.5 children aged 0-14 per 100 000 population die in traffic crashes.

Figure 6 shows differences in fatality rates in various countries. In some cases, they are substantial and require further analysis. In addition to aspects such as road safety, infrastructure design, driver training, and vehicle standards, the question arises as to the extent to which differences in cultural background, mobility patterns, population distribution, etc., contribute to the incidence of road traffic crashes.

Children's fatality rates tend to increase with age (Table 1). The highest mean fatality rates are for children aged 10-14.

Countries with lower fatality rates for children aged 0-5 generally have lower rates in the other two age categories. The greatest difference between the highest and lowest rates appears for children aged 0-5 years: Korea has 9.02 child fatalities per 100 000 age population compared to Sweden's 0.84. The differences are less marked for the other two age categories.

For children aged 0-5, fatality rates are low for northern European countries and medium-high to high for eastern European countries. Child fatality rates are highest in New Zealand, Portugal, Korea and the United States.

Table 1. Children's road traffic fatalities and fatality rates by age group

Mean for 1996-2000

	Children's road traffic fatalities	Fatalities per 100 000 population by age group		
		0-5 years	6-9 years	10-14 years
Sweden	25	**0.84**	**1.45**	2.46
United Kingdom	208	1.16	1.60	2.81
Netherlands	62	1.24	1.73	3.62
Italy	167	1.36	1.66	2.90
Finland	25	1.48	3.33	3.47
Japan	311	1.68	2.11	**1.24**
Denmark	29	1.85	3.14	4.66
Norway	18	1.85	2.52	1.88
Germany	306	1.94	2.27	2.81
Czech Republic	51	1.98	3.31	3.23
Austria	38	2.30	2.30	3.61
Ireland	26	2.47	3.43	3.56
Belgium	62	2.53	3.21	4.67
Hungary	47	2.56	2.25	2.99
Spain	192	2.63	2.84	3.86
Canada	177	2.63	2.95	3.36
Switzerland	35	2.95	2.40	3.07
France	384	3.07	2.89	4.23
Australia	116	3.12	2.23	3.36
Poland	333	3.50	5.11	4.25
Iceland	2	3.85	2.22	2.86
United States	2 565	4.09	3.96	5.16
New Zealand	42	5.02	3.98	5.33
Portugal	97	6.05	5.53	**6.78**
Korea	773	**9.02**	**8.87**	4.53

Note: Only countries providing population and accident data for at least three years from 1996 to 2000. The lowest and highest figures for each age category are printed in bold.

Source: OECD, IRTAD.

The statistics on fatality rates can also be broken down by road user type (Table 2). Typically, the car passenger fatality rate is higher than the pedestrian fatality rate, but there are exceptions. The pedestrian fatality rate is distinctly higher than the car passenger fatality rate in Hungary, Japan, Korea, Poland, Switzerland and the United Kingdom.

In many countries, there was little difference in child fatalities across various modes. However, a few countries deviated significantly. South Korea had a fatality rate of 5.41 for child pedestrians, and New Zealand had a rate of 2.74 for child car passengers. The Netherlands is the only country to have a much higher rate of fatalities for bicyclists than for car passengers. Given that more children bicycle there than in other countries, their exposure to risk is greater.

Denmark, Finland, Hungary, Iceland, Korea, Spain and Switzerland showed relatively marked differences in ranking with respect to fatality rates for different types of road users. This is probably due to differences in levels of exposure by mode, owing to differences in the use of various transport modes and the fact that fatality rates are related to a certain extent to the amount of exposure (see below).

The above hypothesis is supported by an analysis which shows that the rate of pedestrian fatalities has a relatively strong negative correlation with the number of cars per 1 000 inhabitants ($r = -0.58$, $p < 0.003$). Although it is somewhat counterintuitive, pedestrians in countries with *fewer* cars are at greater risk. For example, Korea has a high rate of pedestrian fatalities but only 156 cars per 1 000 inhabitants, whereas Poland has 232, the Czech Republic has 338, Hungary has 223 and Ireland has 323.

In contrast, countries with low fatality rates for pedestrians have more cars. Italy has 539 cars per 1 000 inhabitants, Germany has 510, Austria has 470 and Sweden has 422.

Table 2. Road traffic fatality rate among children aged 0-14 by mode of travel

Mean for 1996-2000

	Fatalities per 100 000 population by mode of travel		
	Pedestrian	Car	Bicycle
Sweden	**0.35**	0.76	0.22
Netherlands	0.44	0.51	**1.09**
Italy	0.53	0.90	0.25
Finland	0.67	0.94	0.73
Germany	0.69	1.01	0.54
Denmark	0.72	1.18	0.93
Japan	0.75	**0.37**	0.40
Austria	0.75	1.29	0.35
Canada	0.77	1.09	0.35
Belgium	0.82	1.49	0.86
France	0.83	1.77	0.42
Norway	0.83	0.78	0.20
Australia	0.86	1.69	0.39
Iceland	0.92	1.54	0.31
United States	0.96	1.84	0.36
Spain	0.97	1.48	**0.19**
United Kingdom	1.02	0.48	0.28
Czech Republic	1.20	1.06	0.44
Hungary	1.21	0.89	0.35
New Zealand	1.22	**2.74**	0.69
Ireland	1.29	1.05	0.55
Switzerland	1.33	0.47	0.56
Poland	2.14	1.29	0.55
Portugal	2.62	2.46	0.48
Korea	**5.41**	1.10	0.31

Note: Only countries providing population and crash data for at least three years from 1996 to 2000.

Source: OECD (IRTAD).

Exposure to risk and safety indicators

The previous section discusses fatality rates when using different modes of transport for children per 100 000 population. While this is not an ideal measure, it remains the best available indicator for the largest group of countries since adequate exposure data are rarely available. The findings suggest that exposure, defined as "the level of an individual or group's activity that is exposed to traffic as a pedestrian, bicyclist or car passenger", has a fairly significant influence on fatality rates.

This study uses fatalities reported per population group as a way to indicate the level of safety in a given country. Even when such data are collected, they are often invalid for children or not comparable among countries. An alternative and arguably better measure is to calculate fatality rates based on exposure as defined above. Exposure can be based on distance, time or number or trips.

Where exposure data exist, the following equation applies:

Fatality rate = Number of fatalities / Unit of exposure

Even when exposure data are included, differences in fatality rates among countries cannot be unequivocally explained because exposure data from several countries may not be comparable owing to differences in the way information is collected (*e.g.* in terms of distance travelled, time spent in traffic or the number of trips made). These activity-based measures do not provide the full picture on children's exposure to risk.

For example, a study of children's exposure to risk as pedestrians and their rate of involvement in crashes in three European countries (Bly *et al.*, 1999) found a higher fatality rate among children in Great Britain than among children in France and the Netherlands, although they spent marginally less time in traffic situations as pedestrians and crossed the road less frequently than children in the other two countries.

This study found that the total exposure rate does not explain the increased risk of fatality. It was determined that children in Great Britain spend more time on main roads and busy streets than children in the other two countries, that they cross roads between rather than at intersections, and that they are more likely to be accompanied by other children than by adults. These specific examples of exposure are, in turn, connected with the country's residential and traffic infrastructure and, not least, with typical national modes of behaviour (*e.g.* adults accompanying children to school).

Therefore, differences in risk cannot be explained solely by differences in levels of exposure. Safety is also a result of behaviour and the presence of safety measures. Traditionally, these measures fall into three groups:

- Education (*e.g.* road safety instruction in school).
- Engineering (*e.g.* structural measures in streets and surroundings, and vehicle safety measures such as safety belts).
- Enforcement (e.g. laws, frequency of speed checks near schools).

Except for engineering-related measures, it is difficult to measure objectively the impact of safety measures and to compare countries. Moreover, it is not proven, but only assumed, that there is a direct correlation between such measures and crash involvement.

Exposure to risk

The International Survey of Children's Road Traffic Safety conducted in preparation for this report collected data on the level of children's exposure to traffic in different OECD countries (Christie *et al.*, 2004). For the 21 countries that responded, it was possible to compare exposure and casualty data for ten countries. Table 3 displays the distance covered and number of kilometres travelled by children aged 10-14 by mode of travel, while Table 4 shows the percentage share of distance and trips. Children aged 10-14 in the United States make the most trips and travel the farthest. They make 65.9% of their trips as car passengers and 84% of the total kilometres they travel each year are by car.

Table 3. Trip distance and numbers of kilometres travelled by children aged 10-14 by mode of travel

	Kilometres per child per year						Number of trips per child per year					
	Walk	Bicycle	Car	Public transport	Other	Total	Walk	Bicycle	Car	Public transport	Other	Total
Germany	431	518	4 369	785	766	6 869	n/a	n/a	n/a	n/a	n/a	n/a
Hungary	303	10	1 113	2 026	3	3 302	216	6	88	307	6	623
Netherlands	180	2 200	3 600	850	250	7 100	180	630	210	55	15	1 090
New Zealand	n/a	232	6 791	2 008	104	n/a	408	121	773	139	11	1 452
Norway	550	370	6 650	1 890	30	9 490	461	206	355	182	11	1 215
Sweden	275	423	6 763	1 121	742	9 325	212	182	222	77	83	776
Switzerland	773	535	5 398	1 943	236	9 044	443	232	250	99	25	1 095
United Kingdom	396	79	4 720	1 071	638	6 904	322	33	403	106	36	901
United States	123	n/a	12 780	321	1 997	15 222	151	n/a	899	19	296	1 365

Source: Christie *et al.*, 2004.

Table 4. Percentage share of distance and trips for children aged 10-14 by mode of travel

	% kilometres by mode per child per year						% trips by mode per child per year					
	Walk	Bicycle	Car	Public transport	Other	Total	Walk	Bicycle	Car	Public transport	Other	Total
Denmark	n/a	n/a	n/a	n/a	n/a	n/a	15.0	62.0	17.0	6.0	1.0	100
Germany	6.3	7.5	63.6	11.4	11.2	100	n/a	n/a	n/a	n/a	n/a	100
Hungary	9.2	0.3	33.7	61.4	0.1	100	34.7	1.0	14.1	49.3	1.0	100
Netherlands	2.5	31.0	50.7	12.0	3.5	100	16.5	57.8	19.3	5.0	1.4	100
New Zealand	n/a	n/a	n/a	n/a	n/a	100	28.1	8.3	53.2	9.6	0.8	100
Norway	5.8	3.9	70.1	19.9	0.3	100	37.9	17.0	29.2	15.0	0.9	100
Sweden	2.9	4.5	72.5	12.0	8.0	100	27.3	23.5	28.6	9.9	10.7	100
Switzerland	8.5	5.9	59.7	21.5	2.6	100	40.5	21.2	22.8	9.0	2.3	100
United Kingdom	5.7	1.1	68.4	15.5	9.2	100	35.7	3.7	44.7	11.8	4.0	100
United States	0.8	n/a	84.0	2.1	13.1	100	11.1	n/a	65.9	1.4	21.7	100

Source: Christie *et al.*, 2004.

One of the survey's key findings is the huge variation in the travel patterns of 10-14 year olds in different countries. To some extent, these differences may be due to data collection methods. For example, Swiss data include walking done off public roads, while the United Kingdom's data set does not. Differences in the "other" category may also reflect the inclusion or exclusion of air travel.

Although a method for fully standardising the data might modify the extent of the discrepancies, it seems likely that major differences would remain. In Table 4, it is notable that the car accounts for at least half of all distances travelled by 10-14 year olds, except in Hungary.

Countries' risk figures can be calculated using travel patterns and fatality rates. For countries with data on known travel patterns, fatality rates have been drawn from the IRTAD database. The resulting death rates used for the calculations are presented in Table 5.

Table 5. Fatality rates for children aged 10-14 by mode of travel

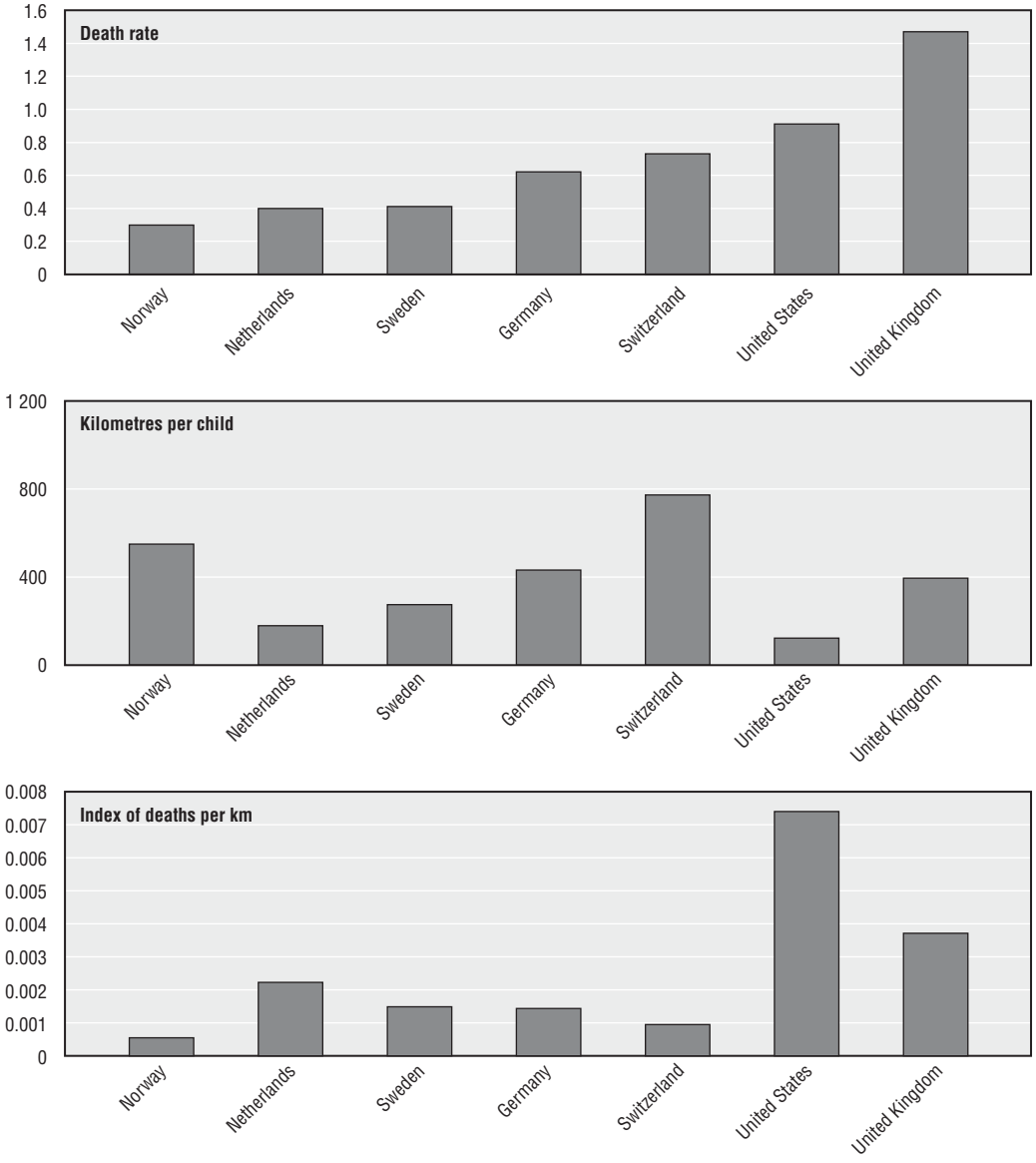
	Deaths per 100 000 10-14 year olds (1996-2000 average)			
	Walk	Bicycle	Car passengers	Total
Germany	0.62	0.98	1.03	2.63
Hungary	1.09	0.70	0.96	2.75
Netherlands	0.40	2.56	0.45	3.41
New Zealand	1.00	1.00	3.02	5.02
Norway	0.30	0.50	0.73	1.53
Sweden	0.41	0.45	1.13	1.99
Switzerland	0.73	0.97	0.58	2.28
United Kingdom	1.47	0.58	0.64	2.69
United States	0.91	0.62	1.99	3.52

Source: Christie *et a*l., 2004.

The relative risk of using the various transport modes in different countries can be calculated on the basis of exposure data and data on fatalities. In spite of differences in data collection methods and definitions, the calculations can provide insight into children's transport safety in OECD countries.

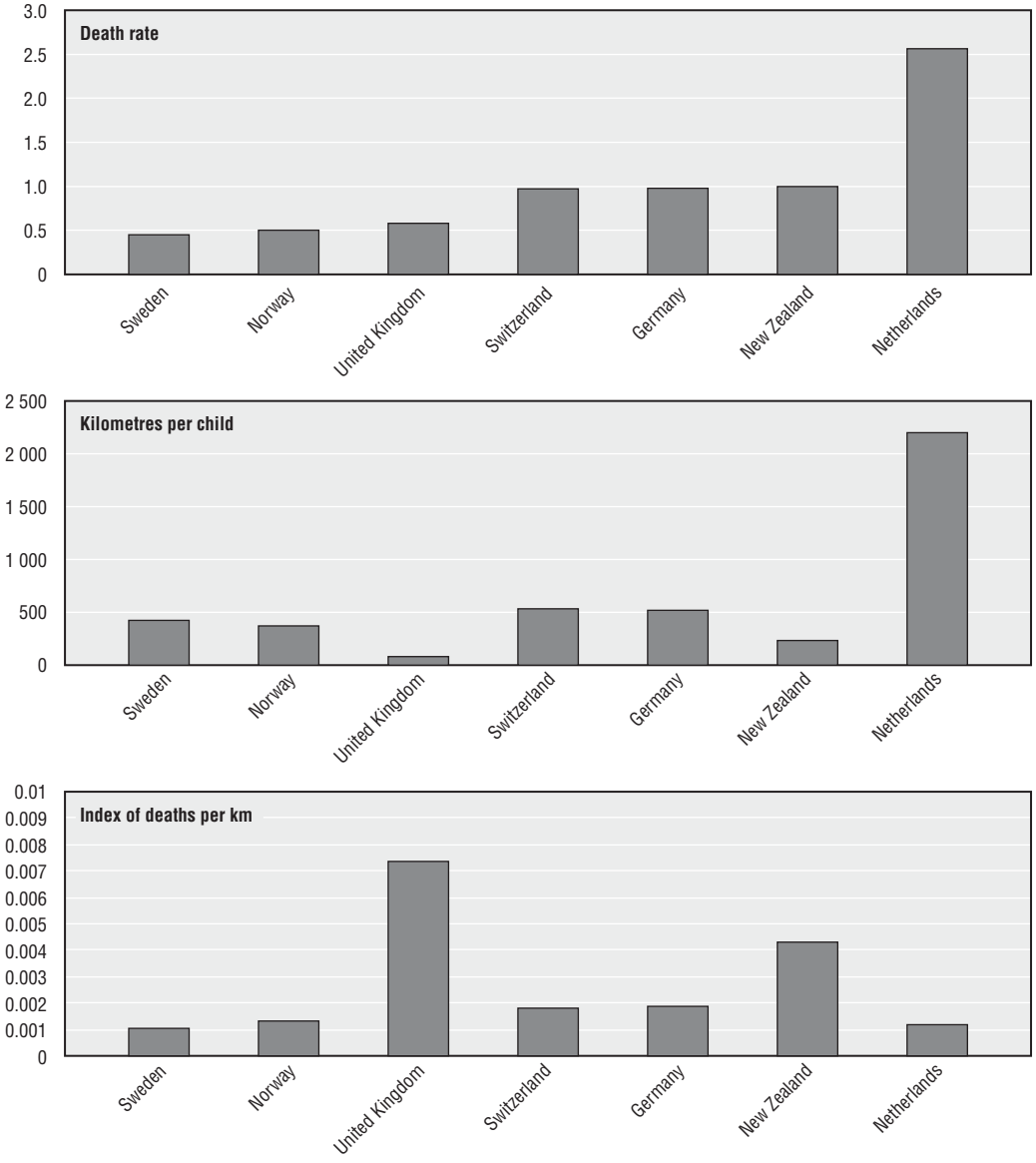
The first general finding is that when viewed on the basis of per kilometre travelled, travel by car is safest by an order of magnitude, followed by travel by foot or on bicycle, which are at approximately the same level. This result confirms earlier research for adults. National differences are substantial (see Figures 7, 8 and 9).

Figure 7. Death rates and kilometres travelled for 10-14 year old pedestrians



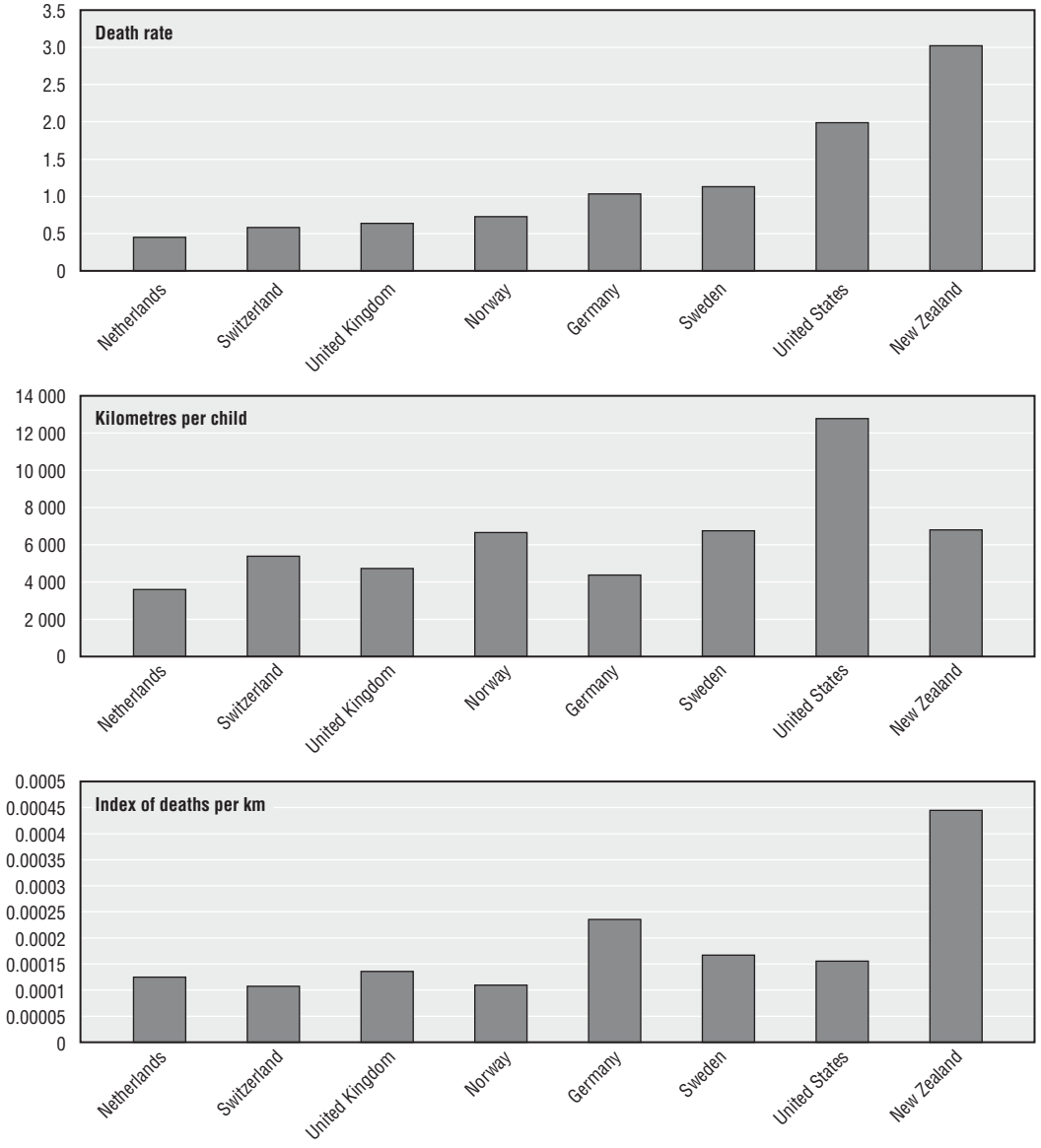
Source: Christie *et al.*, 2004.

Figure 8. Death rates and kilometres travelled for 10-14 year old bicyclists



Source: Christie *et al.*, 2004.

Figure 9. Death rates and kilometres travelled for 10-14 year old car occupants



Source: Christie *et al.*, 2004.

These results highlight the fact that looking at relative crash risk (*i.e.* the number of crashes per kilometre travelled) alters to some degree the assessment of a country's "good" and "bad" safety performance.

For walking, the United States and the United Kingdom appear to perform relatively poorly, while the other countries do relatively well (particularly Norway and Switzerland, where 10-14 year olds walk relatively long distances).

For child fatalities, when travelling as car passengers, figures for Germany, Sweden and New Zealand are relatively high, while the other countries all do reasonably well (with no outstanding performers).

For bicycling, the situation is very different. Inclusion of exposure factors entirely alters which countries can be classified as "safe" and "unsafe". In particular, countries with low levels of bicycling are generally relatively unsafe. The United Kingdom and New Zealand emerge as relatively poor performers, while the others do reasonably well (with no outstanding performers).

Recommendation: The importance of good casualty and exposure data for identifying areas for action must not be underestimated. Investment in establishing high-quality, internationally standardised recording systems for the collection of casualty and crash data and for data on children's travel patterns is a clear necessity.

Conclusion

This chapter provides an overview of children's transport safety using different transport modes, some of the risk factors associated with them, and changing mobility trends. In most OECD countries, traffic crashes are the number one killer of children below age 15, and on average, 3.5 children per 100 000 population die in traffic crashes each year.

Better and more comprehensive casualty and exposure data would improve the analysis of traffic crashes and fatalities involving children. At present, it is difficult to assess the safety level offered by different transport modes.

Mobility trends indicate that children increasingly reach their destination by car rather than by walking or bicycling. In many OECD countries, trips by car now account for at least half of all distances travelled by 10-14 year olds in all OECD countries. As any decrease in physical activity is linked to increases in childhood diabetes and obesity, such a change suggests the need for further consideration of overall levels of physical activity as well as some rethinking of how children travel.

Over the past two decades, considerable progress has been achieved in road safety. While the number of child transport-related fatalities has been halved over the period from 1984 to 2000, much work remains to be done. The following chapters offer case studies and best practices to make children's travel even safer in the new century.

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Chapter 2

THE ROLE OF EDUCATION, TRAINING AND PUBLICITY

Abstract. Most OECD countries endorse the importance of road safety education, training and publicity. Chapter 2 considers the aims and objectives of road safety education for children and describes the role that safety and education play in promoting children's safe behaviour on the road. It explores the risks children face in the traffic environment and their ability to negotiate those risks and the road environment safely. The chapter reviews alternative approaches to improving road safety through education, training and publicity and focuses on those responsible and best able to contribute. It also identifies the circumstances in which road safety education and training are likely to be most effective.

Introduction

Road safety education, training and publicity are an important part of a holistic approach to keeping children safe in traffic. They complement sound infrastructure design, vehicle engineering and vigilant enforcement of road regulations.

Road safety education is a lifelong learning process. For children, education typically involves specific road safety education programmes introduced at different stages of development: practical child pedestrian training for young children, basic skills and traffic training for young bicyclists and higher-level skills for children as they transfer from primary to secondary education and are likely to travel more independently, through to preparation of the adolescent for the use of motorised vehicles. Understanding the basic elements of the traffic system and the behaviour of traffic implicitly underpins the skills and rules-based approach to training.

Internationally, the importance of child safety and education is acknowledged in the United Nations' Convention on the Rights of the Child and in Article 3 of the UN's 1968 Convention on Road Traffic which states that: "contracting parties should take necessary steps to assure systematic and continuous traffic education on all school levels" *(www.unicef.org/crc/crc.htm).* The UN Consolidated Resolution on Road Traffic (1998) amends this and has a more detailed chapter on child traffic education.

Most OECD countries endorse the importance of road safety education, training and publicity for children. Road safety education is compulsory in many OECD countries and most countries support national education, training and school education (see Annex A; Christie *et al.*, 2004).

Road safety publicity and information activities are a form of education. They impart information that can influence attitudes both directly and indirectly, and consumer information and promotion campaigns may ultimately affect behaviour or influence social norms. Such activities complement other traffic safety measures such as lifelong traffic education, legislation, engineering and accident surveillance. They are essential if many road safety measures are to be accepted and understood by the public and professionals.

Promotional and publicity campaigns take many different forms but are typically focused activities undertaken for a specified period of time. They are often associated with high-profile advertising and media campaigns. In addition, many countries have on-going information activities to raise awareness and inform the public and professionals on a continuing basis.

Television, cinema and radio advertisements may have large audiences and be widely accessed by children, young people, drivers and parents. They offer the opportunity to deliver short, clear and simple messages. Alternative forms of publicity can also deliver messages, *e.g.* leaflets and Web sites can provide more information for those with specific needs or interests.

For the purpose of this report, road safety education includes training and publicity and information campaigns.

Aims and objectives of road safety education for children

The ultimate aim of road safety education is to prepare road users to manage the risks they face while in traffic and thereby facilitate their safe mobility. This requires developing and deploying the appropriate skills and understanding and developing positive attitudes to personal safety and the safety of other road users. According to Elliott (2000) and Thomson *et al.* (1996), road safety education programmes need to identify clearly the safe behaviours being targeted. These are best identified by: analysing the task and defining the psychological skills underpinning behaviour; determining the level of skills that can be developed in children of different ages; and evaluating the impact of education and training on the performance of these skills.

Education also contributes to the development of appropriate attitudes towards aspects of road safety behaviour such as speeding, seat belt wearing, drinking and driving, etc. Knowledge-based approaches play a positive and complementary role in connecting and reinforcing skills and raising awareness and understanding of risks, responsibilities and safe behaviour. Education and publicity can be used to encourage safe behaviour by influencing knowledge and attitudes and providing young people with the skills and strategies to move about safely in their environment. Education may be used to raise consciousness about the safety characteristics of the built environment. Moreover, it may encourage children to become actively involved in shaping and improving their environment (especially within residential areas and on important routes).

It is important to be realistic about what road safety education can achieve (Pettit, 1994; Thomson *et al.*, 1996). Road safety education programmes have typically relied on greater knowledge as the sole catalyst for behavioural change, a strategy that has not necessarily been effective. Coupled with the overall breadth of its aims and the relative lack of measurability, it is understandable that road safety education's effectiveness has been questioned and has suffered from low status among parents, educators, and others.

Comprehensive evaluations of road safety education are rare, and reductions in casualties can rarely be directly attributed to a road safety education programme (Elliot, 2000; Towner *et al.*, 2001; Dupperex *et al.*, 2002). Of the few evaluations undertaken, many do not address the educational process and longer-term road safety outcomes (Bailey, 1995). However, "training [for] specific skills involved in safe road crossing has consistently revealed changes in behaviours" (Elliott, 2000). This view is consistent with that of Ampofo-Boateng *et al.* (1993) and Dupperex *et al.* (2002).

Campaigns addressing children can convey information about risks faced on the road and the consequences of crashes and remind children how to behave safely and therefore complement education and encourage safer attitudes. Many countries have on-going information activities as well as specific campaigns targeting parents, drivers and professionals. For many parents and caregivers, protecting their children from danger and minimising risk is an over-riding priority. Many countries use their systems of driver testing and licensing, as well as tax or vehicle maintenance requirements to inform and remind drivers regularly of their legal responsibilities. Information on safety equipment, such as child restraints and bicycle helmets, is made available in various formats, *e.g.* leaflets, video and the Internet. Leaflets on new signs and changes to the law may be mailed directly to car owners. Campaigns and on-going activities are typically complementary and can encourage road safety advocacy.

Two-way flows of information (*e.g.* between local authority engineers and local communities) on mobility and risks (actual and perceived) are essential if many "hard" road safety measures are to work. For example, it is good practice to engage all sectors of the local community in the redesign of local areas to improve road safety and access. Local communities and groups have expert knowledge of local traffic flows, danger spots, etc. It is becoming more accepted to engage children as well as adults and drivers in this process, most notably for safer routes to school (Children and Young People's Unit, 2001). Innovative approaches to engaging young people include supervised Web chats, focus groups and youth parliaments. The last has the additional educational benefits of encouraging responsibility and citizenship.

Understanding risk and dealing with risky situations

Injury prevention begins by identifying risk factors and how they vary across population groups in order to develop appropriate intervention measures. Children's ability to negotiate the complexities of the road environment safely develops with their age and stage of development. There is no specific age at which children can be said to be safe road users. Their skills develop at different rates and individual differences can be quite large; however, some broad conclusions on children's developmental abilities have been prepared on the basis of recent empirical studies:

On average, children aged 5-7 possess a global understanding of danger but often lack the ability to know what is relevant and irrelevant to the road crossing task and to give relevant cues adequate priority (Lewis *et al.*, 1998; Thomson *et al.*, 1998). While such children have much to learn about road safety, they show a clear readiness to learn when appropriate training is offered (Thomson and Whelan, 1997).

At about ages 7-8, children show clear improvements in strategic thinking and in the ability to undertake exhaustive visual searches of the road environment (*i.e.* make predictions rather than sample the road environment from moment to moment).

At around ages 8-9, children experience developmental shifts in their understanding of the pedestrian task and the ability to reason causally (Thornton *et al.*, 1998). The ability to switch between tasks was found to improve with age, but not the ability to concentrate. This suggests that education may help to improve skills that require focusing on the crossing task (Lewis *et al.*, 1998).

Young children generally take conservative decisions in crossing, *e.g.* only accepting large gaps, but they still lack the ability to judge speed and speed differences. They may assume that a nearby bicyclist will pass before a speeding car which is somewhat further away. They find it hard to focus attention on the situation for a lengthy time span, and to select the most relevant cues in complex situations. They also find it hard to stop a movement which has been started and to detect the exact location of traffic sounds. Therefore, their "intellectual" understanding of traffic and traffic risk may easily run ahead of their perceptive, information-processing and psychomotor abilities and give them a false feeling of safety. Generally children experience developmental shifts in strategic thinking and understanding at around the age of 8-10, although they may still have much to learn about safety in more complex road environments. Generally, children in the United Kingdom approach adult levels of performance as pedestrians by around 11-12 years of age (Thomson *et al.*, 1996). These findings are based on empirical studies undertaken in the United Kingdom. It would be interesting to know whether such differences can be observed in other OECD countries.

Even when children possess the skills and motivation to behave safely, one cannot expect them to behave as consistently as adults. Children are much more likely to be involved as pedestrians in "dart out" incidents. Peer pressure may lead some children to take risks as pedestrians and bicyclists. Risk-taking behaviour may allow adolescents to feel a sense of control over their lives, to oppose authority and to gain acceptance into a particular peer group (Grossman and Rivara, 1992). Some children and young people may deliberately choose to take risks (*e.g.* "playing chicken"), others may be unaware of the risks they take (*e.g.* by not wearing a seat belt) and still others may be unwilling or unable to avoid taking risks (*e.g.* by not wearing a bicycle helmet) owing to peer pressure. Risk taking may be a natural part of growing up, but risks in the traffic environment need to be continually assessed and managed by all road users to minimise the incidence of accidents and their sometimes devastating effects on young people.

Differences in risk

While all children are vulnerable, some children are more vulnerable than others. Understanding variations in risk is important for targeting intervention measures.

Many countries have identified children under 12 as a particularly high-risk group whether as pedestrians, bicyclists or vehicle occupants. Very young children (under 5) have been identified as a high-risk group when they are vehicle occupants.

There is some evidence of a gender correlation between road safety behaviour and crash involvement. In the United Kingdom, accident patterns for pedestrians reveal a consistently higher rate of incidence for boys than for girls under age 12. In the 5-11 age group, twice as many boys are likely to be killed or seriously injured than girls. In the Netherlands, 64% of the traffic victims under 14 are boys. Teenage male bicyclists exhibit a similar pattern. Teenage female pedestrians may be at particularly high risk once their exposure is taken into account (Ward *et al.*, 1994).

Research by Whitebread and Neilson (1998) and West *et al.* (1998) found that boys took more risks than girls, a characteristic that may also apply to their behaviour as pedestrians. Boys were also found to be more impulsive and quicker to make judgements about when it was safe to cross roads. Boys consistently showed lower acceptance of social values and a higher rate of problem behaviour, and had a higher accident rate. Young boys were also less dependent than young girls on their parents.

"Problem" behaviour (*e.g.* risk seeking, anti-authority/anti-social behaviour) emerged as a significant predictor of involvement in traffic accidents among child pedestrians when age, sex, parental occupation, parents' age, housing type and time spent in traffic were controlled for. This echoes the pattern of relatively high levels of accident involvement among young drivers who exhibit problem behaviour (West *et al.*, 1998).

Children with visual and auditory impairments may be particularly vulnerable in the road environment. Recent evidence suggests that children with visual and auditory impairments have relatively more pedestrian accidents than their non-disabled peers (Williams and Savill, 2002). Children with attention deficit hyperactivity disorder (ADHD) are over-represented among child pedestrian and bicycle casualties.

Injuries disproportionately affect more deprived children as well. Except for sport-related injuries, this is the case for most accidental injuries and is particularly pronounced for young pedestrians. In the United Kingdom, the Black Report noted as far back as 1982 that, using standardised mortality ratios, the risk of death from being hit by a motor vehicle is multiplied by five to seven times in passing from social class I to class V (Townsend and Davidson, 1982). This pattern persists today and is found in many countries (Christie *et al*., 2004).

A study of Brandenburg, Germany, showed that children from poor families were almost twice as likely to be involved in traffic accidents (UNICEF, 2001). Christie (1995a, 1995b) has identified a range of factors associated with this common pattern, including, in no particular order, family size, household income, younger male children, lack of parental supervision, older housing types located on busy through roads, on-street parking, and lack of garden and other play space. There is some evidence that among young people, as compared to children, health inequalities including road accident injuries, are diminishing (West, 1997). It has been hypothesised that this is due to decreasing parental and increasing peer influence, coupled with a wider radius of activities.

A review of the literature (Thomson and Mamoon, 2000) revealed that children of ethnic minority origin are more likely to be involved in a crash as pedestrians than their peers. This is partly attributable to their socio-economic status, differences in exposure patterns and perhaps also to cultural factors.

Such variations in risk need to be taken into account to ensure that education programmes are tailored to take into account socio-economic, demographic and cultural differences, especially those associated with low literacy and language barriers.

Stakeholders in children's safety

When identifying the risks children face in the traffic environment, it is also necessary to identify those responsible for managing the risks. Road safety education should target children, as well as their parents, caregivers and educators. All road users, particularly drivers, need to be educated about the children's capabilities and limitations in terms of their interaction with traffic.

Parents

The idea that road safety education should begin before children start formal education is a concept that is gaining widespread acceptance. The role of parents and caregivers in influencing children's behaviour through experience, discovery and observation is increasingly documented (OECD, 1998). In addition, although parents wish to keep their children safe and often accompany them in the traffic environment, they may not exhibit appropriate road safety behaviour themselves. Children learn by imitation and careful observation of adults and begin developing road safety skills well before they reach school age.

Parents make important decisions about traffic safety for young children relating to level of exposure to risk, levels of accompaniment and independent travel, and the use of safety equipment such as child seats and bicycle helmets. Parents serve as important role models and their behaviour and actions can influence those of children. Childhood experiences build foundations for adult behaviours, attitudes and beliefs. Parents need support and encouragement in undertaking this role, identifying the best approaches to training their children and modifying their own behaviour as a role model.

Children

Children are an active presence in traffic; and as such their education and influence in the traffic environment should not be underestimated. The more behavioural approaches to road safety education take a child-centred approach in which children develop, within their abilities, an awareness of the environment, their interactions with traffic, their abilities to behave safely and how to influence their environment.

As children mature, their parents may have less influence over their actions than their peers. It is therefore important to instil sound safety habits in children early in their development.

For pre-teens and adolescents, safety skills need to be reinforced and positive attitudes towards safe behaviour, such as strategies for handling peer pressure and risks, need to be developed. The emerging responsibility of youngsters for the safety of other road users, like young children, the elderly and handicapped, also offers a subject for discussion.

Teachers

In various countries the subject of traffic safety is part of teacher training. Especially for younger children, teachers, like parents, serve as role models. It is therefore important to adjust strategies that are taught; parents and teachers should offer similar information and model behaviour. The school can serve as a mediating organisation by offering information to parents about safety on the way to school or through communication with the municipality about the safety of the school route. Agreements can be made with

parents on driving and parking near schools, and parents may be invited to organise and serve on school crossing patrols, or for other traffic safety tasks. In the Netherlands, teachers or traffic parents may earn a traffic safety label when they have actively worked on improving the situation near schools or road safety education activities.

In some countries the role of the road safety education educator is strongly supported by the police who actively work with schools to provide road safety education.

Practitioners

Road safety education professionals need to identify all stakeholders. These include transport and highway departments, education departments, planning departments, health departments, police departments, automobile clubs and local councils. Then, the role of each stakeholder needs to be clearly established or defined and the most effective way of working with that institution must be found. Partnerships involving two-way flows of information are essential to ensure that road safety practitioners develop interventions based on the most up-to-date information on a given issue and how it relates to the group they are targeting. The activities of all those delivering road safety messages need to be consistent and complementary.

In addition, a wide range of professionals may be the target of information on road safety. Health professionals may be sent information on the vulnerabilities of specific high-risk groups, *e.g.* people with visual or hearing impairment, elderly or ill drivers. Schemes to inform children, parents, caregivers or other road users at certain events (*e.g.* hospital visits or routine infant health checks) need to obtain professional support before they become established. This channel is widely used in Finland. Educators can be informed about children's road safety and the particular risks they face and sources of support. Others involved in education (*e.g.* school inspectors, school governors and parent-teacher associations) can also promote road safety education and become its champions in their institution.

Education of professionals can take place through partnerships, specific training courses, continuing professional development courses and publicity and information activities. For example, good practice or changes in the law can be disseminated via information campaigns. Teachers, health workers, engineers and planners may be introduced to road safety education as part of their initial training and benefit from continued inputs through in-service training.

Drivers

The need to shift the onus of responsibility towards drivers, at least where children are concerned, is increasingly recognised (OECD, 1998). Drivers also have a moral, and in some countries legal, responsibility to protect their children. Most of the top performing countries (see Annex A; Christie *et al.*, 2004) have legislation that assumes the driver's responsibility in an accident involving a child pedestrian, unlike countries that performed less well. Overall, only seven participating countries had such legislation.

The review of licensing systems carried out by Working Group 3 of the GADGET (Guarding Automobile Drivers through Guidance Education and Technology) Project (Siegrist, 1999) indicates that future driver training should go beyond knowledge and skills of vehicle manoeuvring and the mastery of traffic situations to include more about driving goals and context as well as risk awareness and self-evaluation.

Manufacturers, insurers and retailers

Manufacturers, insurers and retailers have a responsibility to ensure that safety education is provided to encourage the appropriate use of safety equipment, such as child restraint systems and seat belts, bicycle helmets, etc., and that they are affordable and accessible to those most at risk.

Many businesses see the benefits to themselves and society of promoting their safety products and supporting all aspects of road safety education. In many OECD countries, car manufacturers, petrol companies, insurers and businesses targeting parents and children regularly work in partnership with road safety professionals and sponsor road safety education and use their resources to promote safety messages.

Policy makers

Policy makers should take the lead to ensure that there is sufficient capacity to deliver road safety education interventions by facilitating training, research, development, implementation, evaluation and dissemination of good practice. They also play a role in maintaining and advocating the importance of road safety and in engaging stakeholders, for example by ensuring that road safety education is included in traffic safety plans. Such plans are important local and national tools in the broad policy framework established to improve traffic safety. Consideration should be given, in this context, to making road safety education an obligatory part of the curriculum, in primary and secondary school and in teacher training,

Road safety messages can be integrated in related events, such as health, environmental and risk minimisation programmes. One example is the United Kingdom's annual "Walk to School Week", which is organised by a coalition of transport, health and environmental campaign groups. Safe Kids has a high profile and a strong advocacy role in the United States, New Zealand and the United Kingdom. An International Walk to School Committee promotes Walk to School Week. In 2003, more than three million walkers from 29 countries participated in Walk to School Events (cited in 2003 Walk to School Day Report available at *www.walkableamerica.org*). In the Netherlands, a national traffic safety organisation, 3VO, runs the national "street playing day" every year, usually in May; community groups close some residential streets to motorised traffic and organise social and play activities.

Educational approaches

There are a variety of approaches to road safety education. Current research strongly supports a more age appropriate behavioural approach for younger children, while recognising the need for large resources to implement it. Computer-based traffic simulations, role playing and classroom activities constitute complementary approaches that support and enhance roadside learning.

World-wide, there has been a trend towards approaches to education that focus on the outcome of the learning process rather than the input (content). The education process is more learner-centred and uses inquiry-based approaches to learning and teaching, with a greater focus on the development of problem-solving and decision-making skills and strategies. Students actively construct meaning from their own experiences (constructivist theory), education/training is more relevant to students, and co-operative learning strategies are employed. This approach concurs with the most recent interpretations of how children develop and is well suited to the acquisition of road safety skills (Pettit, 1994;

Thomson *et al.*, 1996). A review of child development theories (Thomson *et al.*, 1996), including those of Piaget, Gibson and Vygotsky, reveals a clear consensus that children learn from specific, context-bound actions and move towards increasingly generalised conceptual understanding. This means that young child pedestrians learn best at the roadside or a close approximation. From there, with experience, they develop conceptual understanding. These findings support the promotion of practical skills training for pedestrians, bicyclists and drivers in connection with reflections on emerging ideas and understanding. This differs from the more traditional form of road safety education for young children which involves presentation of abstract rules in the classroom such as the knowledge-based rules of the Green Cross Code (United Kingdom) or Hector the Cat (Victoria, Australia). In addition to skills acquisition, improvement of knowledge and attitudes is implicit in most of the recently developed behavioural programmes.

There is general consensus in the research and among practitioners that *ad hoc* activities, such as visits from experts and road safety enthusiasts, may have mass appeal but are relatively unsuccessful because road safety education should be planned and progressive. Such activities should be used as adjuncts to the road safety programme. Bailey (1995) promotes integrated road safety education that spans several curriculum areas and this approach is also supported by the Good Practice Guidelines for Road Safety Education in Schools *(www.DfT.gov.uk)* which identify and provide examples of road safety education across the curriculum and recommend that road safety professionals support teachers in delivering a progressive programme of road safety education rather than occasional talks on road safety.

In adopting an integrated approach, care must be taken to ensure that both educational and road safety objectives are met. This requires developing a common road safety language that is understood by children and caregivers, an understanding of the formal and informal rules of the road, and positive attitudes to safe behaviours. These rules may include legal requirements (*e.g.* to wear seat belts and, in some countries, not to cross on a red man signal at a designated crossing), as well as knowledge and understanding (*e.g.* of road signs) and also the more intangible "road sense". Training in road safety may go beyond teaching children how to behave safely on the road; in some countries, it includes preventive measures, like choice of time, route and means of transport, or what to do in the event of a crash.

Delivery of road safety education

Some thought needs to be given to the most effective delivery mechanisms at national, community and school levels by the full range of potential deliverers of road safety education described above. Some countries have a group of professionals that facilitate the delivery of road safety education; for example, the United Kingdom's road safety officers are typically employed by the local highway authority or the police. Countries such as Denmark, France, Germany and Scotland rely on road safety councils to co-ordinate road safety education activities. Such councils or professionals can: facilitate partnerships between health, education and transport professionals, and the public, private and voluntary sector; provide up-to-date information on target populations, age groups, road user groups; develop and evaluate interventions and supply them directly to schools, communities parents and others; monitor delivery of road safety education; train professionals and build road safety education skills capacity; and encourage the use of effective materials by promoting easy access, *e.g.* Web-based resources.

Schools are the most common point of delivery, although parents and caregivers are increasingly involved within and outside the school environment. Other opportunities may arise through after-school care, sports and leisure clubs, community-based and religious organisations.

For publicity and information, television and printed materials are the most common method of dissemination but radio, cinema and Web-based information have also been effective. The Web is increasingly used for education, training and publicity and should be thoroughly evaluated.

Intervention approaches

The interventions described below are examples of different approaches to road safety education. They are by no means a comprehensive description of activities in OECD countries. Many have not been evaluated, so that no statement can be made about their effectiveness. Some programmes target particular age groups while others target road user groups.

Driver training and education

Drivers' behaviour is a key factor in children's traffic accidents. Impact speed determines the severity of injury, *e.g.* 5% of pedestrians who are struck at 20 mph are killed, 45% at 30 mph and 85% at 40 mph (Ashton and Mackay, 1979). In many countries drivers are legally responsible for an accident involving a child pedestrian in a built-up area.

Difficulties arise because drivers overestimate their ability to respond quickly enough to avoid an accident or rely on children to take evasive action (Howarth, 1985). Research suggests that drivers are unaware of, or fail to take responsibility for, their role in children's safety (Limbourg, 1994). Research has also highlighted the particular problem of lack of hazard awareness among novice drivers.

Pre-driver training and education

All drivers need to be aware of the limitations of children's ability to behave safely in traffic and of their role and responsibility as drivers to those inside and outside the vehicle. This can be achieved through effective training and testing and continuing reminders via publicity and information activities and, in some cases, further training.

Research has shown that attitudes to safe driving are established early (Waylen and McKenna, 2002) and that they are influenced by parents; therefore pre-driver and driver education must start at an early age. More pre-driver education courses are becoming available in schools and colleges but very few have been evaluated. Some pre-driver and learner driver courses combine behavioural and attitudinal elements with skills training. Courses designed to develop only skills are widely available for a fee, but knowledge of responsibilities, attitudes, identification with other road users, etc., are particularly important for young drivers, in order to counteract peer pressure to behave dangerously when driving.

Australia and the United Kingdom have introduced a computerised hazard perception element in the theory test, one of the two tests novices are required to take to be eligible for a driving licence. It includes a range of examples of vulnerable road users and risky scenarios that learner drivers need to recognise. The long-term safety benefits of

such training and testing need to be ascertained. Other skills, such as reliable self-evaluation of driving behaviour, are very seldom included in driver tests. However, Finland has found that self-evaluation can be successfully implemented in driver testing. Adding more safety-relevant aspects to the practical driving test might help to identify and screen out those with a high likelihood of accidents and to improve training in these areas.

Increasing the amount of formal education and training has not been found to improve safety, but changes to other aspects of the licensing system, such as graduated licensing and increased experience through lay instruction or risk awareness training, seem to have had safety benefits.

Continuing training and retraining may have safety benefits. In addition to training, drivers need to be made aware of changes in the law and in the use of the road environment. Information is often delivered via the licensing or tax system but others, *e.g* insurance companies, could help.

Publicity targeting drivers should encourage drivers to behave more safely by raising awareness of children's behaviour, alerting drivers to their legal responsibilities to protect car occupants and other road users, demonstrating how they can be safer and illustrating the negative consequences of a crash.

Traffic clubs

For pre-school-age children, education tends to focus on child-parent interactions. Traffic clubs have often developed and adapted in response to requirements. They typically have involved sending information, in the form of a series of booklets, directly to parents at home. Only children whose parents have joined the club receive the information/activity booklets. In Scotland pre-school traffic club resources are provided free for all 3-5 year olds and sent to families in their homes and to nurseries. Evaluations of pre-school traffic clubs have reported positive benefits in the behaviour of very young children (Bryan-Brown, 1993).Alternatively, instead of traffic clubs, in Finland, for example, parents receive information about child pedestrian safety primarily during the check-up at four years of age at the child health centre and during registration for school. These channels cover almost the entire age group, *i.e.* about 40 000-50 000 families each year.

Child pedestrian training at the roadside

Children need to be able to integrate complex information about traffic quickly and efficiently, and to judge gaps in approaching traffic from different directions. They also need to be able to identify safe and dangerous places in the environment and construct safe routes before they approach the road crossing task (Foot *et al.*, 1998).

Training in visual search skills encourages children to be systematic and thorough so that with time and practice they can search quickly and eventually develop strategies to predict traffic. Children should be encouraged to use designated crossings and taught how to use them safely.

Research has shown that, in addition to basic skills training, understanding the social context of behaving safely (Thornton *et al.*, 1998) and meta-cognitive processing (Whitebread and Neilson, 1998) are important. If safety skills are well understood they are more likely to be deployed appropriately and transferable to a variety of roadside environments.

There is evidence that, if taught appropriately, children as young as age 5 can begin to develop the basic skills and understanding to be safer pedestrians. According to development theory and empirical studies, pedestrian skills training will be most effective if it takes place at the roadside, adopts a problem-solving approach and requires children to participate actively. Adults guide children to ensure training is focused and encourage interaction with small numbers of peers so that children can build on each others' knowledge.

On the basis of research and evaluations, a number of practical child pedestrian training schemes have been developed for use at the roadside by parents and volunteers and in the classroom using computer-based simulations. Examples are the Kerbcraft programme, Let's Decide Walkwise and Footsteps. With the support of the UK Department for Transport (DfT) and UK charities, the Royal Society for the Prevention of Accidents (RoSPA) has produced guidelines on the management of practical child pedestrian training schemes (RoSPA, 2001). The DfT is currently evaluating a practical child pedestrian training pilot involving over 100 local Kerbcraft schemes, mainly in poorer communities. This evaluation will assess their operation and sustainability and their impact on children's skills and accident involvement, as well as their wider impact on parents, children, schools and communities. It will try to learn why some schemes flourish and identify barriers to success with a view to preparing guidance for local authorities on how to implement such schemes more widely.

Opponents of early training argue that children cannot be expected to travel independently until around ages 8-10 and that early training may encourage over-confidence among children and parents. Supporters of early training counter that developing skills at an early age enables children to use their supervised experience and exposure to traffic as an active learning experience rather than a passive activity and therefore begin to develop important skills, such as self-regulation, which will lead to safer independent travel at an appropriate age. Most early child pedestrian training strongly discourages unsupervised exposure to traffic.

Child pedestrian training in simulated environments

New York City's "Safety City" provides children with a realistic, simulated street environment in which they can learn and practice pedestrian and bicycle safety skills. It is fully equipped with traffic signs and signals, crosswalks and other street markings. Children, generally at 9 years old, begin with classroom instruction and then progress to the Safety City streets to practise what they have learned. The city's six Safety Cities also double as child seat-fitting stations. "Access City", the most recent development in the programme, will provide classes to children with special needs. Similar education centres are found in many countries and are most effective when used as part of a planned and progressive programme. In countries like the Netherlands there are so called traffic gardens, in which children can play various traffic roles (including that of driver in a pedal-car). The benefits of such training in terms of skills and understanding have not been established. A particular problem of training in this type of simulated environment may be that it offers a false sense of safety and security, because the vehicles are not full size and important issues for child road safety, such as visibility for drivers and children, cannot be realistically addressed.

Child pedestrian computer-based training

There are often schemes that provide training opportunities in simulated environments. Today, the use of computers and the Internet is standard in many schools and offers access to a variety of road safety education Web sites. The UK DfT has a specific site which includes lesson plans for teachers to assist them in integrating road safety education into the national curriculum *(www.databases.dft.gov.uk/lessonplans/)*. Simulation games can aid in developing skills and modifying attitudes and behaviour; however, questions remain about the ability to transfer and apply this knowledge to the real traffic environment (Lonero *et al.*, 1995).

More recently, Tolmie *et al.* (2002) have shown that skills acquired through child pedestrian training simulations do in fact transfer to the roadside. In addition, classroom simulations can introduce children to a greater variety of road environments than on-site roadside training. To be effective, classroom-based training also requires adult-led, child-centred problem solving approaches.

Tolmie *et al.* (2002) also found that improvement in disadvantaged students' verbal skills constituted an additional educational benefit of child-pedestrian simulation training. In Spain, however, a video-based training programme for child pedestrians aged 6-12 aimed at training in recognising safe gaps showed no significant differences between those who were trained and those who were not (Bueno *et al.*, 1991, 1993).

School journey safety

School journeys account for a significant share of child road casualties; in the United Kingdom, they constitute 15% of the youngest school age casualties and nearly 25% of those involving 12-15 year olds. The transition from primary to secondary school is associated with particularly high risk. Such journeys present an opportunity to instil healthy and sustainable choices of travel habits while developing important safety awareness skills.

School policies can also influence child road safety. School travel plans can include guidance on required appropriate behaviour and equipment for children, the level of training required for adults who transport groups of children on school trips and the promotion and support of safer walking and bicycling routes to school.

Checklists to promote safer walking and bicycling are important tools for schools and parents (NHTSA, 2001). In the United Kingdom, the Departments for Transport, Education and Health have combined to form a School Travel Awareness Group (STAG) which has commissioned research and education packages to support the development of school travel plans and the safer use of sustainable modes of transport on the school journey. Guides that demonstrate good practice across a variety of road and school environments have been prepared for local authorities and schools.

With regard to safer routes to school, many activities focus on both safety and sustainability. Children, parents, schools and communities are encouraged to make sustainable choices and given guidance on how to improve safety. Guidelines have been prepared in the United Kingdom and New Zealand on "walking buses", meaning a group of children accompanied by an adult *(www.walkingbus.com)*. Initiatives like Sustrans *(www.saferoutetoschool.org.uk)* and Young Transnet *(www.youngtransnet.org.uk)* in the United Kingdom actively encourage children to be involved in identifying dangers on school routes and developing solutions.

The safety of adolescents as pedestrians has received less attention. The move from primary to secondary school coincides with an increase in the level of independence. In the United Kingdom, a before-and-after survey of knowledge and attitudes was used to test the effectiveness of a training programme for children transferring from primary to secondary school. The programme, "Making Choices"[*], includes a resource for primary and secondary schools, a booklet for parents and a magazine for children. It was developed after surveys of parents and children revealed their concerns about and expectations of a resource for this age group. More research is needed to address the specific road safety needs of adolescent pedestrians. In Belgium, the safety of children bicycling to secondary school has been tackled by bicycling in a group, with a special outfit, accompanied by an experienced adult (bicycling coach).

Many children travel to school by bus. Informing parents and educating children are fundamental to school bus safety. Interactive safety awareness programmes teach children about school bus safety rules, including travel to and from the bus stop, waiting for the bus and behaviour on the bus. They give children the ability to play a role in their own safety and provide safety tips for parents to reinforce basic rules of school bus safety.

Theatre, role play and presentations

The use of role playing and theatre to impart road safety information has been found effective when part of a planned programme with detailed discussion, development and follow-up activities (RoSPA, 2002). Role playing and theatrical presentations may be a particularly effective way to focus on motivation, beliefs and social norms, and consequences of actions. Such approaches may be appropriate for older children and enable them to develop strategies to cope with peer pressure. Another approach is to have a peer who has been disabled in a road accident participate in safety discussions (traffic informer). Other schemes to encourage children and all road users to take responsibility for their own road safety and that of others include using them as school crossing patrols or having class champions (Junior Road Safety Officers). However, some concerns have been raised about using children as school crossing patrols because of the risks they may face. In developing responsibility it is important for children to understand that all members of society share responsibility for safety.

Conspicuity initiatives

In addition to training for specific safety skills, many pedestrian education programmes cover issues such as conspicuity. For example, Canada's national educational programme "Be Bright – Think Right", launched in 2002, includes a component on safety in and around school buses. It is an interactive video presentation with accompanying materials for educators and parents, and a Web site. It includes information on getting to the school bus (walking to the bus stop, crossing streets, waiting away from the road) and on leaving the school bus (staying away from danger zones around the bus, crossing in front of the bus if required, what to do if something is dropped near the bus). The programme was created in partnership by the Canadian government, Scouts Canada and the Royal Canadian Mounted Police, mainly for use in schools *(www.scouts.ca/bbtr/ba.html)*. In many counties in Norway, school starters (6 year olds) receive caps, vests or school bags in bright colours and reflective materials that make young road users more visible.

[*] *www.roads.dft.gov.uk/roadsafety/safeside/01/09.htm*

Child pedestrian safety publicity

Drivers have been a key target audience for child pedestrian safety publicity (OECD, 1998). These campaigns place the onus for safe behaviour on drivers and have mainly focused on reducing speed while alerting them to the possible presence and unpredictable behaviour of children. Publicity is a way of alerting drivers to their legal responsibilities, enforcement campaigns, the consequences of non-compliance, the needs and abilities of other road users, and the risks they pose to themselves and others on the road as a result of their behaviour.

Shifting social norms can be a long-term aim of publicity, and may be achieved through a series of campaigns over a number of years that deliver consistent messages. In the United Kingdom, for example, campaigns have aimed to make speeding socially unacceptable. New campaigns are launched on average once a year. Such campaigns give an opportunity to use champions, celebrities, victims, experts or others to raise the campaign's profile. The advertisements have resulted in good recognition and recall (OECD, 1998). The campaigns have involved complementary cinema, television and radio advertisements. Radio advertisements appeal to drivers while at the wheel to reduce their speed.

Street Smart (District of Colombia Metropolitan Area, in the United States) features Metrorail and Metro bus and radio advertisements, television public service announcements and posters. The campaign materials urge drivers to "Imagine the Impact" on the lives and families of both pedestrians and drivers involved in a traffic crash. The advertisements feature real people who tell their stories and stress the rules for driver and pedestrian behaviour at crosswalks.

Child bicyclist safety

Child bicyclist training at the roadside

Basic bicycling skills are generally learned off the road at an early age but training is typically required before bicycling on the road. Older cyclists may benefit from training in dynamic/defensive bicycling techniques (van Schagen and Brookhuis, 1994). Bicycle training is typically practical in nature and often school-based but not necessarily undertaken during school hours.

Bicycling skills are most effectively developed using a supervised problem-solving approach and guided experience, gradually building up to exposure to the road environment (Savill *et al.*, 1996). Evaluations of practical bicycle training schemes aimed at 9-11 year olds were carried out in the United Kingdom in 1996. They assessed the impact of different bicycle training schemes on skills and knowledge by comparing nearly 1 000 trained and 1 000 untrained children. An on-road skills test and knowledge quiz revealed that trained children performed significantly better than untrained children approximately two years after completing their training, an indication that bicycle training has lasting benefits. The detailed results revealed that schemes involving problem-solving approaches and some on-road training and were extensive rather than intensive produced the best results. Most skills training are co-ordinated by professionals and implemented by adult volunteers. Concerns have been raised about the quality of some trainers, and systems for accreditation of trainers are being developed in some countries.

The state of Oregon, United States, has used the Bicycle Education Curriculum, a ten-lesson course, half of which takes place on bicycles in the road environment, to teach 12-14 year olds comprehensive bicycle safety. Lessons cover maintenance, rules of the road, handling, equipment, signs, traffic patterns and intersection issues. On-street rides cover lane position, how to make turns, how to signal, bicycle control, hazard identification, etc. This course consistently receives excellent reviews. The National Highway Traffic Safety Administration in the United States is undertaking a study to determine the effectiveness of school-based, on-bike training components.

The UK DfT supported RoSPA's development and distribution of good practice guidelines for the development and operation of practical child bicycle training schemes. It also raises issues concerning bicycle maintenance, conspicuity, helmet wearing and skills acquisition.

Child bicyclist training in simulated environments

Another approach uses specific locations and custom-built activity centres. For example, at Safety City, which is a replica of a typical town in Puerto Rico with traffic signals, signs and pavement markings, children practise safe walking, bicycling and street safety. Students start the programme by attending a one-hour traffic safety instruction class. Under the supervision and guidance of teachers, students then practice safety skills within the protected Safety City setting. It is aimed at 7-9 year olds and messages focus on helmet use, rules of the road, crossing the street safely.

Child bicycle helmet promotion

Bicycle helmets reduce the incidence and severity of head, brain and upper facial injuries at all ages but particularly among children. A review of the literature has found that promotional campaigns have been effective in increasing the wearing of helmets. Even when children are aware of the risks, barriers to higher wearing rates include peer group/social pressures, cost, comfort and design.

In the United Kingdom, TV advertising in the early 1990s encouraged parents to buy helmets for their children and manufacturers to produce more attractive and less expensive helmets. Value added tax was removed on all bicycle helmets in 2002. Some schools also introduced policies requiring children who bicycled to school to wear helmets. With funding from both the Departments of Transport and Health, the Bicycle Helmet Initiative Trust developed guidelines for promoting bicycle helmet wearing locally among children. A recent campaign to increase bicycle helmet wearing targeting teenage boys used posters in schools showing X-ray images of helmeted skulls.

In many areas where bicycle helmet wearing is compulsory, a combination of information campaigns for children and parents, incentives/rewards for children and enforcement have been used to encourage higher wearing rates (Towner *et al.*, 2001).

Children in-vehicles safety

In the United States, a systematic review was undertaken of evidence on the effectiveness of five interventions to increase child safety seat use. Changes in the use of child safety seats or injury rates were the outcome measures evaluated. The review found strong evidence of the effectiveness of child safety seat laws and distribution plus education programmes. In addition, community-wide information plus enhanced enforcement campaigns and incentive plus education programmes showed evidence of effectiveness.

However, programmes involving education only for parents, young children, healthcare professionals or law enforcement personnel did not show sufficient evidence of success (Zaza *et al*., 2001).

Incentive and education programmes

Incentive and education programmes are effective in increasing child safety seat use in the short term (Zaza *et al*., 2001). For example, in May 1992, the Austrian Committee for Injury Prevention launched an infant car restraint loan programme in all hospital obstetrics departments in the federal province of Styria (Brandmayr and Purtsher, 2002). In the intervention area, 87% of mothers transported their children safely restrained in car seats, compared with 65% in the control area. In the intervention area, 58% of the mothers obtained their car seat through the hospital loan programme; there was no corresponding programme in the control area.

Results of another infant car seat loan scheme in Greece (Dedoukou *et al.*, 2002) showed that the target group did not always take up the scheme, particularly in disadvantaged areas where those in greatest need had the lowest rates of take-up.

Strategic partnerships with interested parties may help to overcome some potential barriers to the implementation of such interventions (*e.g.* cost of purchasing incentive rewards, initial training of personnel). Manufacturers and retailers play a key role in making child restraint systems accessible to those least able to afford them. In the United States, the Ford Motor Company and 29 leading national stakeholder organisations created "Boost America", a highway safety campaign "designed to send the message to parents and children that booster seats are the safe and fun way to ride in a vehicle" *(www.boostamerica.org).* The campaign includes a video sent to over 150 000 preschools, day-care centres and elementary schools. In 2001-02 it distributed 1 million booster seats to needy families through the United Way and through vouchers from dealerships and partner organisations. It has also committed to increasing the number of fitting station programmes and trained child-seat instructors and inspectors. The programme also calls for an increase in the number of states with booster seat legislation (there are currently twelve).

Efforts can target children in addition to parents. Children often resist using child safety seats, booster seats, and safety belts. According to Klassen *et al.* (2000), "Some of the most successful community-based interventions aimed at increasing child safety restraint use focus primarily on increasing compliance with children, with the theory being that children may be trained to serve as monitors of the family's motor vehicle restraint behaviours." Programmes targeting children include the "Bucklebear" programme for pre-school children which achieved some success. This US programme is designed to increase the use of child passenger restraints. It seeks to change the behaviour of children through use of a child-size "talking" bear, videos, games, stories and other incentive products. Child restraint use increases, at least in the short term (Grossman and Garcia, 1999; Klassen *et al*., 2000).

More research needs to be undertaken to determine the long-term effectiveness of combined education and incentive programmes. Some recent analysis suggests that the use of child safety seats declines when the incentive is removed. The decrease may also point to the importance of consistent reinforcement and messages to sustain child safety seat use (Grossman and Garcia, 1999).

Education and enforcement programmes

In another American study (Stuy, cited by Klassen *et al*., 2000) the intervention combined an education programme (which included stickers for children, among other incentives) in day-care settings with an opportunity for parents to sign a policy statement in which they agreed to comply with state laws regarding child restraint use. The combination significantly increased child restraint use.

Education-only programmes

Perinatal education programmes have not been associated with a significant increase in correct use of child restraints at the time of hospital discharge (Zaza *et al.*, 2002). Such programmes typically include an educational session by a medical or injury prevention professional on child restraint systems. Parents may prefer to receive information on injury prevention from their doctors (Health Canada, 1996). Research suggests that counselling on the importance of properly fitting child restraint systems is not as frequent as it should be (Insurance Institute for Highway Safety, 1999). Moreover, family doctors do not have the capacity to provide timely and accurate information to parents (MacKay and Dawson, 2003).

In Blekinge, Sweden, a traffic safety campaign among parents with children aged 0-3 years who voluntarily joined a traffic safety club was evaluated. The aim of the project was to determine the level of safety among children travelling by car. The evaluation indicated that, in some respects, the campaign had a positive effect on the frequency of the use of child restraint systems (Anund, 2001). It also pointed out that more has to be done so that every child in the region uses the recommended type of restraint systems.

Educational programmes for professionals have proven effective, depending on the goals. For hospital nurses, such programmes resulted in an increase in hospital policies on the use of child restraint systems upon discharge and in patient education programmes on the subject. Educational programmes for law enforcement officers have been shown to increase the number of citations for child restraint system violations for at least up to six months following training.

Community-based approaches

A growing number of community-based approaches deal with increasing the use of child restraint systems either solely or in combination with other safety measures. A recent evaluation of the Waitakere Safe Community in New Zealand showed that children's hospitalisation rates had decreased in the intervention community and that adult seat belt wearing rates improved as did the rates of child restraint system use (both up 7%) (Coggan *et al.*, 2000).

Transport Canada developed the "Car Time 1-2-3-4" video, brochure and poster programme to help groups and schools to educate parents and children about the correct use of child restraints *(www.tc.gc.ca/roadsafety/childsafe/cindex_e.htm)*. The materials have been widely distributed, particularly through programmes offering car-seat checks, and are used to supplement other activities. A survey found that the video reached an audience wider than its distribution, with copies viewed in groups, and given away to family, friends, colleagues or caregivers of children (Binarius Research Group, 2001). The section of the video dealing with seat belt use and the rear seating position is directed at children themselves.

In a number of countries, many national government departments and organisations produce materials and programmes for use in communities (*e.g.* Safe Kids at *www.safekids.org*; American Academy of Pediatrics, at *www.aap.org*; Scottish Road Safety Campaign, 2001). Increasing attention is being given to the production of materials in multiple languages and at language or reading levels appropriate for the target audiences.

Child safety in-vehicle publicity

Many community-based promotion campaigns to improve restraint use involving print and electronic media advertisements revealed an immediate increase in child restraint use following the campaign, but a decrease following its conclusion (Grossman and Garcia, 1999).

Publicity plays a role in maintaining awareness of the importance of using restraints. The European Commission, in its efforts to increase the use of child restraints, conducted a "10 seconds that can save your life" media campaign between April and October of 1998. This Europe-wide campaign focused on four simple actions that take less than 10 seconds to perform and could save a life in a crash. These were: attach a seat belt; correctly adjust the seat and head restraint; stow loose luggage in the boot; place children in a safety seat/harness (European Commission, 2000). This type of campaign is a way to raise awareness of these issues and a step in the ongoing process of enhancing child restraint legislation in member states.

Besides basic messages about using child restraints, campaigns need to focus on the appropriate restraint for the various ages and stages of a child's life. Because use of child restraints falls off as children reach school age, parents' attention is drawn to ages and weights. Examples of positive messages include: "40 to 80 pounds", "4 to 8 years", "8 [years] or 80 [pounds]", "Too big for a booster seat? Think again", and "Not big enough for lap-shoulder belts". It is worth noting that messages involving scare tactics were considered compelling by some and controversial by others.

Great Britain has used education and publicity as a long-term strategy to increase seat belt wearing prior to the introduction of legislation and such publicity and enforcement programmes continue. A recent hard-hitting advertisement depicting a son killing his mother while he was unrestrained in the back seat of the car and she was driving has been aired on television since 1998. An evaluation of this campaign indicated a sharp increase in understanding what would happen to an unbelted backseat passenger and the other vehicle occupants in a crash. An on-going observation wearing rate survey revealed a substantial increase in seat belt wearing among adult and child passengers in the back seat from around 45% and 80% respectively before the campaign to nearly 60% and 90% within a year of the launch. These wearing rates have been sustained, and knowledge of what can happen in a crash has continued to increase as a result of regular replaying of the advertisement, reinforced by radio advertising.

Good practice

In addressing best practice in road safety education, it is necessary to assess the aims and objectives of effective road safety education, such as the target, whom to teach and how. It is also necessary to review, to evaluate alternative sources and deliverers of road safety education and establish what works.

However, few of these issues have been adequately addressed as demonstrated by the lack of evidence on the effectiveness of road safety education initiatives. In fact, lack of evaluation is a major issue in this field. The UK DfT funded a review (Pawson and Myhill, 2000) that identified 21 key lessons for designing evaluations. Ultimately, the question that any evaluation must answer is: what works, for whom and in what circumstances? The DfT, UK, is currently developing guidelines for road safety professionals to facilitate the evaluation of road safety education schemes.

There are good practice guides for the design and evaluation of road safety publicity campaigns (Elliott and Shanahan Research, 1989; Morris, 1972; Elliott, 1991; Järvinen, 2002). Effective campaigns such as those that raise awareness of problems, solutions, etc., among the general public and special target groups, offer people new information or a fresh viewpoint or alternatives to consider, and view the target groups as active participants. It is important that the language used in the campaign is the language of the recipients and that this is particularly important for children and ethnic minority groups, although for the latter, dual language facilities are often preferred. The channels used to distribute the information must be familiar to the target group and the campaign should be supported at the local level. The effects of a campaign are domino-like or hidden in nature; in order to control these effects, the campaign has to be evaluated in phases and modified on the basis of feedback. Furthermore, messages need to be simple and client-oriented and long-term campaigns are recommended. Finally, the campaign needs to be implemented by people who are fully committed to its aims and objectives.

The current evidence shows that road safety education is most effective when it is part of a holistic approach to children's traffic safety and is viewed as planned and progressive and part of a lifelong learning scheme; when it is part of the curriculum and local champions promote high-quality education; when those involved in road safety education, from road safety professionals to parents, have access to high-quality resources, training and information; when it is based on an understanding of the risks children face in traffic and how these risks vary across different population groups. Road safety education needs to be targeted and tailored to take in to account these differences.

Road safety education should be evaluated on the basis of its objectives. The objectives should be realistic and achievable and based on risk assessment, the local environment, children's roles and abilities and pedagogical and organisational means. There is good evidence that a behavioural approach to skills training is effective at developing and maintaining appropriate behaviour. Besides, a problem-solving approach and social interaction can lead to understanding of the traffic system, motivations and attitudes. Pedestrian and bicycle skills programmes are best undertaken at the roadside, in small groups supervised by trained adults or by referring to real or imaginable context situations. Research also supports the use of some simulated environments to complement and build on roadside experience.

Recommendations

- Road safety education should be part of the national curriculum at all levels from pre-school on, with regular planned and progressive high-quality inputs to develop children's skills, risk awareness, attitudes and knowledge.
- Drivers must be made aware of their responsibilities to their passengers and other road users, and they need to understand the limitations of children's behaviour in traffic. These outcomes can be achieved by effective education, training and publicity.
- There is clear evidence of what works among younger children. Research is now needed on adolescent and young people's road safety education needs, taking into account their abilities.
- The status of road safety education needs to be improved through integration with other disciplines and better evaluation of measures.
- Parents need to be involved more effectively in the delivery of road safety education both informally and formally. They must be informed in particular about the safety devices that can protect their children.
- Publicity, when used in conjunction with other measures, is a powerful tool for delivering information and influencing attitudes and behaviour in all areas of road safety from environmental improvements to changes in legislation to vehicle modifications. It can be used to engage all sectors from policy makers, professionals and businesses to communities and consumers.

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Chapter 3

CHILDREN IN THE ROAD ENVIRONMENT

Abstract. Chapter 3 considers how the built environment affects children's safety and the broad approaches that can be followed to maximise children's safe mobility. The chapter discusses the contribution that sound planning practices, traffic engineering principles and urban design features can make to supporting children's safety in the road environment. It highlights the importance of the built environment being constructed in ways that stimulate children's growth and safe interaction with traffic. The chapter also explores some important measures including legislative action and enforcement, the development of construction and planning regulations, and the design and implementation of protective infrastructure. Examples are given of effective programmes and measures in OECD countries which can be tailored to fit the characteristics and circumstances of specific communities.

Introduction

Keeping children safe in traffic requires an understanding of their mobility needs, travel behaviour and differences in perceptual and reactive capabilities. Traffic engineers, urban designers and planners may design systems that overestimate children's ability to comprehend aspects of the built environment and expect children to react to stimuli in the same way as adults. The differences between children's and adults' cognitive development and decision making warrant reconsideration of roadway environmental design in order to facilitate children's safe mobility.

This chapter discusses sound planning practices, traffic engineering principles and urban design features that address these important factors, as well as measures to support children's safety in the road environment. These include legislative action and enforcement, the development of construction and planning regulations, and the design and implementation of protective infrastructure. Examples are given of effective programmes and measures in OECD countries which can be tailored to fit the characteristics and circumstances of specific communities.

Matching children's needs and capabilities to the built environment

Children's safe mobility within the built environment is essential for their well-being, development and social integration. Young children need space to play together. Somewhat older children require safe and secure routes to school, playgrounds and other recreational destinations, both as pedestrians and as bicyclists.

Children's acquired intellectual skills and knowledge in terms of understanding movement in space, time and distance relationships, and physics and the law of mechanics continue developing through adolescence. Until they reach an adult level of understanding, children do not understand and react to complex traffic situations in the same way as adults.

Children's motor skills and responses do not easily adapt to visual and auditory stimuli. Younger children have difficulty controlling their movements; for bicycling, they only fully master balance at ages 13 or 14 (CROW, 2000). Children's observational and reactive capabilities are different from those of adults, and their senses are not fully developed or well co-ordinated. In addition, their smaller physical stature can pose safety challenges, because it limits their ability to see or be seen over certain heights. A car blocking a pedestrian crossing can mask the child and his/her view of oncoming traffic and present a safety hazard.

Some infrastructure design may exceed children's intellectual and physical capabilities. Young children may become confused if green crossing lights for pedestrians are combined with green turn signals for vehicles.

Moreover, principles of the built environment that are well understood by adults are often incomprehensible to or misinterpreted by children, leading to potentially dangerous situations in traffic. When a car's headlights are on, children may mistakenly assume that the car is "looking" at them and believe that they are out of harm's way. Children may think that red traffic lights compel cars to stop and expect them to come to a halt automatically at signalled intersections. Because such misunderstandings can endanger children in traffic situations, early education on such matters is important to instil good road safety practices (see Chapter 2).

Research has shown that a combination of community/environmental interventions and education is likely to reduce the rate of childhood pedestrian injury (Stevenson *et al*., 1999).

A planning process that includes a multidisciplinary project team and a holistic approach can address the needs and interests of all road-user groups, particularly the most vulnerable (Methorst and van Vliet, 2002). Planners' and engineers' increased awareness of and consultation with those involved with youth policy or welfare should facilitate this process.

Recommendation: Designing a road environment that recognises children's capabilities as well as their limitations will benefit all road users, since what constitutes a safe road environment for children will usually be safe for the public at large.

Planning and designing to keep children safe in traffic

Children's safety should be part of road plans and traffic designs. Unfortunately, because of design oversights and planning omissions, infrastructures later receive cosmetic alterations or adaptations to accommodate their needs. Widening the pavement, adding a zebra crossing or installing safety bumps to slow traffic are most effective when combined with a holistic approach to accommodating all road users safely. It is important to take a strategic approach to urban safety management so that local transport is effectively integrated in local transport plans (DfT, 2003).

Road design should include landmarks to enable children to familiarise themselves with their surroundings and help them find their way. When constructing or improving the road environment, planners should note that children's travel behaviour and choice of routing differ from those of adults. Observational studies reveal that while many adults safely coexist with traffic on the road, children's behaviour is different and their attention is more easily distracted. The ability to concentrate on a single thing for lengthy periods of time only fully develops at 13-14 years of age (see Chapter 2). In the road environment, adults tend to have purposeful journeys while children may not always travel with a distinct purpose or destination in mind. Children may loiter or stop along the way to observe something, and the next moment impulsively run or jump away.

For these reasons, children need to be considered when planning and designing foot paths, bicycle lanes and crossing zones. Different planning schemes used by OECD countries demonstrate ways of creating safer road environments for children. "ABC" planning is a strategy used in the Netherlands to locate functions according to the traffic generated by such functions. Destinations with a high volume of people, like shops and offices, should be located in "A" areas (central areas), with good facilities for pedestrians and bicyclists and good public transport, combined with less accessibility for cars. For residential areas and a belt around the city centre, "B" areas offer medium accessibility for cars and public transport. Transport-intensive enterprises and enterprises generating heavy vehicle traffic should be located in "C" areas, with a high level of car accessibility.

The Netherlands' proximity-in-planning principle aims to locate services and facilities close to the public they are intended to serve. For children, this includes neighbourhood locations they are apt to frequent, such as schools, playgrounds, sport facilities, cinemas and public transport stations. Norwegian studies indicate that children in urban areas begin to travel independently by public transport at age 10; this highlights the importance of providing children with safe access to transport services near their homes (Lodden, 1998; Øvstedal, 2002).

Japan offers another example of well-planned areas for walking and bicycling. Japan's Sixth City Park Seven-Year Improvement Plan, implemented in 1996, promotes the creation and improvement of small parks in residential and city areas. By linking various public facilities such as city parks and schools, the Japanese government is promoting the development of "green belts" and facilitating children's safe mobility (Central Traffic Safety Policy Council, 2001).

City planners in Houten, the Netherlands, have created "green districts" and roads where human activities take precedence and cars play a minor role. Pedestrian and bicycling routes reach key destinations directly, while cars must detour around the area. These design features have made walking and bicycling the dominant transport modes in Houten and facilitate children's safe mobility. A similar principle known as "home zones" is being adopted by the United Kingdom. (DfT, 2001, 2002).

For larger metropolitan areas, focused regional planning and a good public transport system offer feasible alternatives to the car and also support children's safe mobility. Studies show that mixed-use developments with high-density residences can reduce car use by 20% and increase bicycling and walking (MuConsult, 2000; Connekt, 1999).

Using data to plan for children's needs

Well designed planning tools are needed to address issues from the early stages of planning to the actual design and construction phases. In particular, good data are essential for identifying children's mobility needs and planning for them. However, little is known about young children's travel patterns, as mobility figures are usually collected for children from age 12 and take little account of non-motorised travel. Moreover, children are under-represented in traffic safety figures (Monheim and Frankenreiter, 2000; Methorst and van Vliet, 2002), and, as Chapter 1 makes clear, exposure data on children are often lacking or incomplete. The dearth of such information makes it difficult to plan appropriate safety strategies and measures, determine the consequences for children and evaluate the results.

Problem areas and areas where better data are often required include: data are often not available for short travel distances and for trips with no specific purpose; estimates of car kilometres travelled are often better than those for kilometres travelled on non-motorised modes; when using different travel modes, the walking or bicycling portion of the trip is often included in the car movement or use of public transport; children are less often questioned than adults on their motives, ideas and suggestions for mobility, environment and unsafe practices; users of non-motorised travel modes (often children), are under-represented in police crash reports; and children's crashes often go unreported by police, even if police officers are present at the scene of the crash.

Empirical studies can be of great use in revealing where and how children travel (Bly *et al*., 1999; Stevenson *et al*., 1996). Information can be gathered on mobility, exposure, problems and trends involving children in traffic. In the Netherlands, several primary schools sponsor a programme in which children walk to school accompanied by adults, and the children indicate points of interest and difficult or dangerous areas along the way. The adults note these observations, and the results are shared and discussed by programme participants.

General assessment instruments, such as the Walcyng Quality Scheme (WQS), offer a comprehensive analysis of safety, mobility, comfort, aesthetics, social climate and pedestrian and bicyclist security as well as a detailed assessment of facilities, communication and incentives (Hydén *et al*., 1998).

Road safety audits have been developed in various countries as a procedure for independent assessment of the accident potential and likely safety performance of a specific road design or traffic scheme (ETSC, 1997). They are generally seen as a tool for better managing new or existing road design. They can be used during all stages of design – feasibility or initial design, draft design, detailed design, pre-opening and post-opening. The first audits were part of a comprehensive accident programme. They aim to identify potential safety problems in order to prevent the occurrence of crashes or to lessen their consequences. They are often used by professionals concerned with the safety of all road users under all conditions (DTLR, 2001). Audits can be a powerful instrument to support children's safety, provided their interests and characteristics are taken into account.

In addition to audits, some authorities and practitioners have sponsored focus groups and other forums to allow safety auditors to discuss common problems and identify solutions. The inclusion of children in such consultations can benefit this process and provide further insight on children's travel needs and behaviour.

Urban design features to maximise children's safe mobility

The characteristics of the built environment are diverse, often reflecting a city's historical development. Historical city centres often have circular layouts with small, narrow and winding streets while modern metropolitan areas typically feature larger, wider streets in a grid pattern, allowing for increased traffic flow and speed. Wider boulevards to accommodate greater traffic volumes and increased traffic flows can affect children's safe passage and travel within their surroundings. Higher traffic volumes, high speeds and visual obstacles at the roadside are positively related to child pedestrian accident involvement (Stevenson *et al*., 1997).

The physical layout of a city or village can structure children's movement and activities and help them to create a mental map of their surroundings. Walking and bicycling allow children to discover the structure and characteristics of their neighbourhood and progressively extend their mental map and boundaries. Some older cities that form the central core of modern, metropolitan cities have been adapted to meet the demands of modern traffic, while others have maintained their traditional structure and give pedestrians priority over vehicles. Pedestrian malls facilitate in-city living, shopping and recreation and provide a protected environment for children to pursue a variety of activities independently. However, the central core of some older cities has been remodelled to accommodate commercial development and cinema and entertainment venues, while rarely taking children's needs into account. In newer districts, where through traffic is discouraged and where speed limits are lowered for passage of local traffic, children's safety in traffic is greater (Roberts *et al*., 1995).

Living conditions in districts built after the turn of the 20th century, especially those constructed some decades ago may thwart children's mobility and spatial and social development. Their independent travel and activities may have to be curtailed owing to unsafe conditions. In such environments, children may be exposed to poor traffic safety models which influence their behaviour and choices when they are older.

Recommendation: Because features and characteristics of the built environment greatly influence the possible movement and range of children's behaviour, the built environment should be constructed in a way that stimulates children's growth and safe interaction with traffic. Urban design features can be used to support and complement children's safety in the road environment.

Urban design features should complement the physical and environmental characteristics of a given area to maximise traffic safety. In areas with wide streets, "countdown" signals at intersections can help children by indicating the amount of time available to complete a safe crossing. Separate bicycle and pedestrian lanes allow children to move freely and unconcerned, protected from vehicular traffic, while special care is needed for designing the street crossings. Central refuges (pedestrian islands) may enable children to consider one crossing direction at a time (Lupton and Bayley, 2001). Raised crossings can increase safety, but otherwise raised sidewalks should be lowered to street level at intersections to enable children to cross. Street lamps, post boxes and phone booths should be carefully placed so as not to obstruct children's view of intersections. Cars should be towed from non-designated parking areas and enforcement monitored to ensure that vehicles do not obstruct pedestrian crossings or bicycle paths. Traffic calming

methods to decrease vehicle speeds can also improve children's safety in the road environment. (Webster and Mackie, 1996).

Infrastructure design features include construction guidelines for pavements, bicycle paths and crossings. Clear distinctions between sidewalks, bicycle paths and roadways help children to recognise areas in which to move or play. Young children may prefer zebra crossings because the decision where to cross is taken for them and they promote consciousness of the crossing activity (Tolmie *et al*., 2003, Øvstedal and Ryeng, 2000).

In the urban environment, vehicle speeds affect a driver's ability to see and react to children in traffic. At lower speeds, a driver detects the presence of children more easily and has more time to react. At higher speeds, both the driver and the child have less time to react and it becomes more difficult to take appropriate avoidance action (Taylor *et al*., 2000). Moreover, speed can affect the consequences of a collision; the higher the speed, the greater potential for severe injury (Finch *et al*., 1994). Traffic calming measures have been effective in reducing speeds (Retting *et al*., 2003).

Adults' actions and behaviour to support children's safe movement

As discussed in Chapter 2, adults' actions and behaviour can support children's safe mobility in traffic, for example through education and supervision of bicycle helmet use, safe bicycling and safe walking practices. Appropriate actions for adults to take to protect their children in traffic depend on the cultural and physical context and the potential for modifying existing practice. In the city of Leeds (United Kingdom), parents and their children of high-school age collected data on the shortest and safest paths to school (City of Leeds, 2003). Their findings resulted in developing the Safe Routes to School scheme. Following these guidelines, students were encouraged to bicycle to and from school as often as possible. Special bicycle training programmes were initiated, bicycle storage facilities were provided, and some shared foot/bicycle paths near the school were constructed.

As a result, car use dropped from 20% to 16%, and bicycling increased by 5%. In other cities, special promotional activities such as the "Walk on Wednesday" campaign initiated in Somerset's primary schools resulted in more dramatic modal shifts, with car use dropping from 38% to 22%. On-going support of such activities by schools and community members is needed to maintain these results.

Legislation and enforcement to protect children in traffic

Transport and traffic legislation regulate motorised traffic, but it often fails to focus on children's safe mobility as bicyclists and pedestrians. Few laws address children's transport safety, with the exception of regulations governing crossing zones near schools and some passenger safety requirements, such as seat belts and children's car seats. Typically, planning and housing regulations do not take children's mobility needs into account in the design of new developments. However, a number of OECD countries are enacting progressive legislation that benefits children's safety in the built environment (see Box 1).

Box 1. Legislation benefiting children's safety in traffic

Denmark

- Children under age 6 who bicycle in traffic must be accompanied by a person at least 15 years of age.

Norway

- Planning and construction law requires providing sufficient children's recreation areas when constructing new homes and housing developments. Guidelines are provided for the recreation area's type, size and location with respect to entrances. The law also requires safeguarding children's play and activities against traffic danger, pollution, health risks and noise.
- Each municipality appoints one department head or other civil servant to be specifically responsible for children's interests when designing development plans and building proposals.
- Some cities have adopted requirements for a minimum pavement width of 1.5 meters (including accommodating the placement of lamp posts, traffic signs and post boxes), a width of 2 meters for one-way bicycle paths and of 3 meters for two-way paths.
- Norwegian children up to age 6 living 1 km or more from school, or older children living more than 3 km from school are entitled to free school transport. When the route to school is deemed unsafe, the municipality is required to provide children free transport for shorter distances.

Belgium and the Netherlands

- "Woonerfs" are residential streets or areas dedicated to foot and bicycle traffic. They have no sidewalks and pedestrians and bicyclists have the use of the entire street. Vehicle speed is reduced to a walking pace and parking is allowed only in designated places. Over time, the concept has become less popular owing to its high implementation cost and young children's difficulty in restricting their use of such areas to the sides of the street to avoid collisions with bicyclists.
- Some Dutch schools prohibit parking in front of schools. Parking prohibitions near school crossings or zebra crossings usually benefit children by giving them an unobstructed view of intersections.
- Some cities have adopted requirements for a minimum pavement width of 1.5 meters (including accommodating the placement of lamp posts, traffic signs and post boxes), a width of 2 meters for one-way bicycle paths and 3 meters for two-way paths. This allocation of space facilitates the circulation of pedestrians and bicycles in urban areas.

France

- France has adopted the "Badinter Law" which places the burden of responsibility on drivers involved in a collision with a child. In the OECD survey, the top-performing countries on children's safety in traffic have similar regulations (Germany, Iceland, the Netherlands, Sweden, etc.).

Germany

- Children up to 10 years of age are allowed to use the sidewalk for bicycling, and children under 8 years must bicycle on the sidewalk if there is not a separate bicycling lane.
- Drivers have to respect children's safety by curbing speed and yielding to children in traffic.
- Drivers are required to honk their horn to provide a warning signal when they perceive children in traffic who are not paying attention.

Poland

- Children under 10 years of age are allowed to bicycle on the sidewalk.

Switzerland

- As a safety precaution, children of pre-school age are not permitted to bicycle on public through roads.

Road transport legislation is most effective when enforced and supported by local road administrators and/or a vast majority of road users; however, enforcement can be resource-intensive and sometimes difficult to manage. In some countries, crash victims can hold the road administrator liable if their injuries are found to be attributable to poor road design, construction or maintenance. Enforcement of drivers' behaviour towards children and the behaviour of the children themselves usually take low priority. Stricter penalties and increased enforcement of existing legislation should be considered to reduce traffic infractions such as not stopping for red lights and speeding on motorways and traffic arteries. Police often monitor school crossing zones and fine road users who disobey the posted speed limit or safety rules.

Support of legislation to protect children can be provided at the planning level by designating traffic calming areas in major destinations for children, such as schools and playgrounds and by providing direct and safe pedestrian and bicycling routes to such destinations and including nearby meeting places and provisions for children to congregate and play. At the environmental level, support can be provided by setting noise and exhaust standards within living areas. At the design level, it can be provided by providing obstacle-free, safe and clear crossings, providing facilities to separate pedestrians and bicycles from vehicular traffic on major arteries and setting a minimum width for bicycle paths and sidewalks. At the enforcement level, it can be provided by traffic surveillance near school crossings and playgrounds, reduction of speed within built areas, inclusion of traffic safety information in school curricula, adapting liability laws to meet children's capabilities and constraints and strictly enforcing rules that benefit children, such as no parking zones, lower speeds, yield to pedestrians and bicyclists, red light violations. Such elements of children's rights could be laid out in agreements or at international (charter), national (legislation) and local (regulation) levels.

Developing strategies and solutions

Children's mobility is an important consideration when developing traffic safety strategies and objectives. The proactive and preventive approach advocated by the Vision Zero concept (see Chapter 1) is an exemplary inclusive strategy for reducing fatalities and serious road traffic crashes for all road users including crashes involving pedestrians, which often have very serious consequences. Another strategy, called "durable safe vision", also focuses on unprotected road users. Both strategies target speed reduction as a key objective in recognition of the fact that chances of survival are greater when collision speeds are below 30 km/h. Above this speed, the risk of death or serious injury increases rapidly. Both strategies describe a number of safety planning principles, which may benefit children (Koornstra *et al.*, 1992; Langeland, 2002).

Vision Zero's strategy involves a hierarchy of streets or roads with various requirements for design and speed limits and promotes a differentiated street system with corresponding limits. For local streets where pedestrian and bicyclist traffic is heavy, it recommends a speed limit below 30 km/h. For access streets with separate facilities for pedestrians and bicyclists and crossings without conflict (light-regulated or overpass/underpass), it applies a 50 km/h speed limit and a reduction of speed to 30 km/h at crossings. For main roads with car traffic in both directions and regulated crossings, it applies a 70 km/h speed limit. Higher speeds are allowed when the traffic in two directions is separated.

The durable safe vision concept includes three road categories, each requiring a design compatible with its function to ensure optimal safety on the basis of three principles: functionality (preventing unintended use of infrastructure), homogeneity (preventing major variations in speed, direction and mass), and predictability (preventing uncertainty among road users). The three durable safe categories are: roads with a through function (rapid movement of through traffic), roads with a distributor function (distributing or collecting traffic to and from different districts or residential areas), and roads with an access function (providing access to homes and shops, and enabling the street to be a safe meeting place). Within urban areas, it is recommended that access streets have a maximum speed of 30 km/h. Some municipalities have a general speed limit of 30 km/h for the entire built area.

A second principle involves separation of road users on streets where the speed is above 30 km/h. Particularly well designed provisions for pedestrians and bicyclists are important on such roads. Through traffic of cars in city centres and residential areas is discouraged. Safe routes for pedestrians, bicyclists and users of public transport should encourage use of these modes. Public transport should have separate lanes and streets in central areas, and care should be taken in locating bus stops to ensure the safety of passengers boarding and alighting.

Parents, children, relevant organisations and other user groups should be consulted during the planning process. Children are not generally consulted, although they can provide vital information on how and where they use public space. Yet it is not difficult to involve children, for example by contacting primary schools, community centres, children's organisations (scouting, youth chorus, youth council), or youth chat groups on the Internet. Information can also be obtained by walking with children in their neighbourhoods and talking about their experiences on the way.

When eliciting information from children, questions should be clear and concise. They can be asked how they feel about their environment, how they travel to school, which are the pleasant and unpleasant spots in the neighbourhood and what makes them so. Maps or scale models of the residential area can be used as a basis for discussion with one or several children. The aim of the consultation should be made very clear, because children often assume that they can express wishes that will be fulfilled on short notice. It is important to keep asking questions, in order to understand fully the children's views. Following such a discussion, it is useful to walk with the children and look at sites they consider important. It is useful to take photos (preferably with the children in action) and further questions can be asked relating to children's safety. The information gained can then be included in planning discussions. Guidance exists on how to involve children in consultations (CYPU, 2001; Horowitz *et al*., 2003).

Different schemes of observing and registering how children actually behave in the traffic environment, for example on way to school, give detailed and useful information for planning physical safety improvements, as well as developing targeted traffic safety education and information measures (Lupton and Bayley 2001, Øvstedal and Ryeng 2000, Tofte 2001).

After measures have been taken, their effects should be evaluated, not only in terms of accidents or victims, but also in terms of change in modal split, social activities, experiences, appreciation of the situation by various groups (including children), and maintainability. The evaluation can be used to make further changes that benefit children.

Traffic engineering

Traffic engineering generally makes use of data on population, vehicle speeds, and number of vehicles in an area, along with data on origin and destination (origin-destination matrices) and modal split. Important issues for routing and road planning are capacity, flow and parking space for cars, routes for public transport and safety. However, the needs of bicyclists, pedestrians and children are often given lower priority than those of motorised traffic. Space for pedestrians and children is often treated as an afterthought once space for motorised traffic has been decided. Engineering a safe road environment on behalf of children requires the following actions:

- Mapping important destinations for children: schools, playgrounds, shops, library, youth club, sports club, etc.
- Mapping origins: neighbourhoods with large numbers of children or locations where they gather.
- Connecting origins and destinations; in particular, find short routes.
- Indicating nodes on various routes (where many children meet or gather).
- Formulating quality standards for routes and nodes taking into account the needs of the child as a pedestrian or bicyclist.
- Implementing quality measures.
- Evaluating outcomes as they affect the children and their community.

When mapping important destinations, they can be linked via a logical, coherent and safe walking and bicycling network.

A recent review of traffic engineering measures designed to reduce pedestrian-motor vehicle crashes found that single-lane roundabouts, sidewalks, exclusive pedestrian signal phasing, pedestrian refuge islands and increased intensity of roadway lighting were most effective in reducing pedestrian crashes, although the research was not directed exclusively at children (Retting *et al*., 2003).

In terms of quality standards for routes and nodes, it is important to consider children and ensure that they have a clear view and ample walking or bicycling space. Attention should be given to the attractiveness, safety and security of routes and nodes, crossings should be logically located (along the route) and children should have safe playing space and attractive landscaping on/near nodes and destinations, while making sure that their view is not obstructed. In terms of traffic engineering for children, most effort has been put on routes to (primary) school. A distinction is made between two relevant areas. One is the area directly surrounding the school building, where a largely car-free area can be established and enforced by barriers or supervised by staff. In this case, cars should be able to leave children near the school, without hampering children arriving or leaving on foot or by bicycle (for instance, providing stopping zones for passenger drop-off and pick-up). If a car-free area is not realistic, parking near the school entrance can at least be prevented, and reduced speed can be imposed and enforced with speed bumps and safe crossing passages in front of the school. Such crossings should be well-lit. Also, signs can draw drivers' attention to the presence of children.

The second area of concern is the route followed by children to go from home to school (origin-destination relations). School routes can be mapped, and routes where traffic and risk of conflict are rare can be indicated (every child should have at least one safe route to school). It may be possible to improve road safety and at the same time make routes more direct with shortcuts, but care must be given to avoid increasing other risks to personal safety and security. Such routes must be made attractive and secure by providing good lighting, landscaping, playing spaces or public art. Such areas can be designated using special pavements or surfaces or by coloured walkways and bicycle paths.

If children's routes parallel those of motorised vehicles, either vehicle speed should be reduced and high vehicle intensities should be avoided, or there should be a well-marked space for pedestrians and bicyclists, with ample room and protection from motorised vehicles, for instance by a barrier-separated medium or strip of grass or other landscaping features.

Based on a literature review of children's abilities and behaviour in traffic situations, a checklist was developed guiding Norwegian authorities on safe routes to school, taking into account the facilities for pedestrians, the traffic speed level and particular elements distracting children (Midtland 1995, Norwegian Public Roads authorities 1998). Examples of risk factors include change of speed close to pedestrian crossings, lack of space for pedestrians waiting to cross, intersection design encouraging diagonal crossing etc.

In addition, special attention must be given to planning for child safety in rural areas, where relatively more children are killed or injured as car passengers (Christie *et al*., 2002). It is important to reduce speed on small rural roads (a maximum of 60 km/h) and make foot and bicycle paths available. Good highway design and appropriate speed limits are necessary to address problems of rural roads. Reduction of speed near crossings (rumble strips, speed bumps) may further improve safety.

It is important to ensure that children walking or bicycling are protected where possible. Hedges, trees or verges can help but may not always be a realistic option. In this case, transport or guidance of children may be necessary, although conditions enabling independent mobility should be the goal. In most cases, a child's route to school inevitably crosses a route with motorised traffic. Safe crossing provisions have to be made for children's logical travel paths to and from school. Reduced speeds and a sufficiently clear view of the road environment are essential. Speed reducing measures can be combined with measures preventing blocking of view, such as pickets that prevent parking.

The roadway can be narrowed to slow traffic. Zebra crossings and signalised intersections offer children security and legal protection. Crossing of busy traffic arteries or motorways should be avoided as much as possible. However, if inevitable, safety should be ensured in the following ways where possible: crossings should be provided with pedestrian islands, so that children can cross in two phases; traffic should be regulated with traffic lights (avoiding any conflict with vehicles turning); bridges and tunnels should be available where practicable (for very busy arteries and motorways); and school crossing patrols provided where necessary. Bridges and tunnels must be well lit and socially safe and secure.

What has been said about the school environment and school routes applies to other important children's destinations as well.

Road environment and playing areas

Ideally, children should not play in the road environment (except within home zones), but should have sufficient provision and access to designated play areas. One consideration should be to ensure suitable separation between play areas, roadways and driveways (Roberts *et al*., 1994). Maintenance of roads and play areas is important for encouraging safe and appropriate use of local environments.

Children need room to move about and spaces in which to play and interact, as well as protection and orientation. Several criteria for play spaces have been identified which could also be adopted when considering the safe use of the road environment, *e.g.*:

- *Safety:* the surroundings must be safe and the playground constructions must be safe (no sharp or protruding parts, no concrete tiles under climbing frames, protection of gates near swings).
- *Security:* as feelings of insecurity can depend on specific events or rumours, planning for security will mean creating conditions that optimise feelings of security: shelter that does not give a feeling of being closed in, good line of sight, enough light, and knowing that there is always a way out.
- *Solidity:* children will test objects so they must be user-resistant.
- *Understandable:* children must know the purpose of certain constructions. For instance protection gates should not be used as objects for play. It is best if the use or meaning of devices and objects is obvious; otherwise the necessary information should be given.
- *Fitting:* different age groups and sexes have different needs and behavioural repertories. For instance, very young children like playing objects that are nearby, like swings, seesaws or sandbox. As children grow older they need space for exploring or social games, like ball games, roller-skating, bicycling or riding scooters, building huts, etc. Youngsters also need spots to meet together, without being observed. It should be possible to modify constructions, for example, as the children in an area grow. Some places can be multifunctional, such as school grounds as a meeting place in the evening, or play objects for young children combined with meeting space for the elderly.
- *Attractiveness:* the objects for children must be attractive; children must want to use them. It is not always easy to say what determines attractiveness. For instance, a clean and uniform playing ground may be little used because children find it dull. It is useful to consult children on this issue.
- *Non-interference with interests of other user groups:* If adults or youngsters find the activities of younger children inconvenient, this may lead to social tension. Noise, destruction, danger and clutter caused by children must be limited, either by limiting negative interaction with others or through agreements.

There should be a regular maintenance schedule involving cleaning, emptying of waste bins, repair and repainting of sidewalks and other street infrastructure and upkeep of green areas. Many cities have a complaints department for reporting problems. Reporting should be made as easy as possible, so that children can present problems they encounter.

This chapter has described a number of planning practices and principles and urban design and traffic engineering features that support children's safety in the road environment. It has offered strategies and solutions, legislative action and other measures that have been undertaken to address children's safety in OECD countries.

Recommendations

- Designing a road environment that recognises children's capabilities as well as their limitations will benefit all road uses, since what constitutes a safe road environment for children will usually be safe for the general public.
- Children should be involved where practicable in the design of the built environment.
- Because features and characteristics of the built environment greatly influence the possible movement and range of children's behaviour, the built environment should be constructed in a way that stimulates children's growth and safe interaction with traffic. Urban design features can be used to support and complement children's safety in the road environment.
- Safety audits should be performed from a child's perspective.
- Traffic calming is effective in reducing speed and should be advocated as a key measure to improve the overall safety of road users, including children.
- In the development of new educational facilities, consideration should be given for safe access using all travel modes; especially bicycling, walking and use of public transport.

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Chapter 4

VEHICLE STANDARDS AND SAFETY EQUIPMENT

Abstract. Chapter 4 outlines safety standards and equipment for a variety of travel modes. It reviews current approaches to child passenger restraint systems, vehicle standards, bicycle standards and helmets, and visibility of child pedestrians and bicyclists, and the effectiveness of these approaches. It discusses the role of legislation and enforcement in optimising the correct use and effectiveness of the various safety features. It also highlights the importance of vehicle design to protect children as pedestrians. The chapter includes a number of recommendations concerning vehicles and safety equipment which are important components of an integrated strategy to keep children safe in traffic.

Introduction

Earlier chapters discuss children's physiological, cognitive and developmental characteristics to distinguish their capabilities and mobility needs from those of adult road users. Their particular characteristics warrant designing and adapting road environments, traffic strategies and safety equipment for their use. Governments and society at large are responding to the call for greater attention to children's safety needs with new and safer vehicle and equipment design.

This chapter reviews current approaches to child passenger restraint systems, vehicle standards, bicycle standards and helmets, and visibility of child pedestrians and bicyclists. It also discusses the role of legislation and enforcement in optimising the correct use and effectiveness of these safety features. These are important components of an integrated strategy to keep children safe in traffic.

Measures to reduce child injury in vehicles

Traditionally, safety measures involving vehicle standards are divided into "primary safety" measures, which reduce the risk of a crash occurring, and "secondary safety" measures which are designed to minimise injury to vehicle occupants when a crash occurs. This section focuses on secondary safety measures that are specifically designed to address children's safety. While children also benefit from primary measures, they are not specifically designed for them.

Measures to reduce children's injury in vehicles can be classified as either "active" or "passive". Active approaches rely on vehicle occupants to play a role in ensuring their own safety and that of others, through actions such as wearing a seat belt. They require human action and create a potential for inappropriate or incorrect use of safety equipment. Passive approaches require no action on the part of vehicle occupants to activate

the in-vehicle safety features. They include changes in equipment design and environmental modifications to the interior of vehicles to minimise both the likelihood of a collision and the potential severity of injury should a collision occur.

Active approaches to children's transport safety

This section covers various methods and safety equipment for protecting children in cars and larger vehicles *e.g.* minibuses, coaches and buses, including seat belts, child restraint systems, and booster seats. It also discusses standards, regulations, enforcement and incorrect and/or inappropriate use of this safety equipment.

Since the 1983 OECD report, *Traffic Safety of Children*, much has been learned about the need to restrain child passengers in motor vehicles to prevent serious or fatal injuries in the event of a collision. While vehicle safety in general has improved significantly over the years, child passenger safety continues to present challenges owing to the many factors that play a role in achieving the maximum safety benefit.

Seat belts

When correctly positioned, a seat belt is designed to spread the force of a crash over the strongest areas of the body. Motor vehicle seat belts have been designed and tested on the basis of the properties of adult-size crash dummies. Consequently, seat belts are suitable for adult passengers. Children who wear a seat belt are marginally safer than those who do not, but risk serious injury in the event of a collision owing to the incorrect positioning of the seat belt across their smaller bodies.

Seat belts represent the final stage in the progression of restraint systems for child passengers. A child is ready to wear a seat belt when the belt fits low across the hips and the shoulder belt comes over the shoulder and across the chest. When sitting up straight against the seat back, a child's legs should bend over the edge of the seat. Generally, children are insufficiently physically developed to use seat belts until they reach approximately 27 kg (60 lb), unless a booster seat is used in conjunction with the seat belt. Regulations and advice on the use of seat belts by children varies among countries. In the United Kingdom, it is recommended that an additional restraint, such as a booster seat, should be used for children 13 years old and younger or until they reach 150 cm in height or 36 kg in weight and can safely use a seat belt. In the United States, the National Highway Traffic Safety Administration (NHTSA) has published guidance stating that booster seats should be used until the child is 8 years of age, unless the child is at least 4'9" tall.

Three-point seat belts with a lap and shoulder portion come as standard features in most vehicles. European requirements on seat belts have been updated in recent years, in terms both of technical requirements and the vehicles and seating positions covered. Since April 2003, the latest European Directive on seat belts (2000/3/EC) requires all new car models to be fitted with three-point belts on all forward-facing seats. In North America, where vehicles are almost exclusively fitted with front passenger airbags designed to protect adults, it is strongly recommended to restrain children age 12 and under in the rear seat of the vehicle.

The safety advantages of correctly worn three-point belts compared with two-point or lap belts have been noted in the literature. Three-point belts provide superior protection from injury in crashes, particularly by comparison with a small child using a lap belt

(Lane, 1994; Lapner *et al*., 2001). However, in the absence of a three-point seat belt, it is safer to use a lap belt than to travel unrestrained.

In order to restrain children properly in vehicles, an additional child restraint system is needed in the passenger seat. These systems are fully described in the following sections.

Child restraint systems and their regulation

Child restraint systems (CRS) have been designed to secure the child to the vehicle in a way that distributes the forces of a collision over broad areas of the body. Restraint systems for child passengers include the major categories of rear-facing restraints for infants or older children, forward-facing child restraints and booster cushions or booster seats. Other CRS systems include car beds (carry cots) for infants and restraint systems for children with special needs.

Child restraint systems are designed and manufactured to meet the safety standards applicable to a particular region or country. Australia, Canada and the United States have instituted national standards for the design of child restraint systems; European countries are governed by the ECE's Regulation 44.

Safety standards prescribe test protocols and permissible results for required dynamic and static tests. In addition, standards set minimum requirements for restraint systems' labelling and instructions, the force required to release a buckle, flammability of materials, resistance and ageing of harness straps and adjusting devices, etc. Under these standards, the requirements, while not identical, vary only slightly, as do the testing procedures and test devices. The design of CRS may differ from one country to another, owing in part to differences in requirements, but mainly to consumer preferences, lifestyle, or culture.

Most countries use weight as the criterion for determining the appropriate child restraint system and the appropriate time to progress from one type of system to the next. The concept of a progression through stages of child passenger restraints has been used to link child safety with the health model of stages of child development that is familiar to parents of younger children, as seen in Canada through Transport Canada's "Car Time 1-2-3-4" materials promoting the four stages of rear-facing infant seat, forward-facing child seat, booster seat, and seat belt (Transport Canada, 2003 a). This approach is also advocated in the United States through NHTSA's "Don't Skip a Step" programme. Moreover, public education and awareness campaigns impart the important information that each restraint type corresponds to an age range that may span several years (DTRL, 2002).

Currently, most child restraint systems are designed to be installed using the vehicle's seat belt. Other systems, ISOFIX (International Standards Organisation FIX), UAS (Universal Anchorage System), and LATCH (Lower Anchors and Tethers for Children) in North America, have been developed in order to improve the fit of child restraint systems in vehicles. ISOFIX was created and advanced by an international working group of the International Organization for Standardization (ISO). It eliminates the need to use the vehicle seat belt to restrain the CRS, and instead relies on purpose-designed mounting points provided in the vehicle which attach to the CRS with a rigid mechanism. ISOFIX is increasingly prevalent. It is used in Australia, and similar systems have been adopted in Canada and the United States. A relatively small number of ISOFIX restraints are in use

in Europe. Amendments to European legislation will facilitate obtaining approvals for ISOFIX, with an expected increase in its use.

In Europe a "universal" (*i.e.* suitable for use in all cars) approved ISOFIX CRS requires a third fixing point, known as a top tether, which is intended to prevent rotation of the CRS. Two-point systems achieve this control using the seat cushion. Although slightly more complicated to fit, the three-point system has advantages that have resulted in its inclusion in the latest update to UN-ECE Regulations. In the United States, an alternative to the ISOFIX concept is referred to as LATCH and was required to be fully implemented in new vehicles and most child restraint systems (Note: not required on booster seats, car beds, and vests) by September 2002. In Canada, ISOFIX is known as the UAS and is identified by a universal symbol. The systems mandate rigid lower anchorages and top tethers in vehicles, and infant and child restraints must be fitted with compatible connectors, either rigid or attached to webbing and a top tether strap in the case of forward-facing restraints.

Rear-facing restraint systems for infants and children

Apart from the Nordic countries, children in most OECD countries are restrained in rear-facing CRS until about 9 months to one year of age or until they reach the upper weight limit of available rear-facing systems. The advantage of the rear-facing restraint system is that in a head-on collision – the most common and most severe type – the child's body and head are supported by the restraint's seat back, with little or no strain to the child's neck. Under UN-ECE Regulation 44.03, child restraints fall into five "mass groups", group O for carry cots and rearward facing seats for children less than 10 kg in weight, and group O+ for rearward facing seats for children less than 13 kg in weight.

The Nordic countries continue to provide rear-facing CRS for children up to 3-4 years of age, with seats for older children normally designed to use support from the dashboard. These seats can also be used in the rear seat with or without supporting legs, depending on the design. The superior safety performance of such systems has been demonstrated by in-depth analysis of dynamic tests of CRS, Sweden's collision and insurance reports (Kamren *et al.*, 1993), and Volvo's collision and insurance database (Isaksson-Hellman *et al.*, 1997).

The child is secured in the restraint using the system's integral harness. A rear-facing restraint system must never be installed in a seating position with an active airbag, as serious or fatal injury may occur when the airbag deploys in a collision. As with all designs of CRS, the user must read and follow the instructions for installation, and both the harness and seat belt must be correctly positioned and tightened, as applicable.

Rear-facing restraints are installed in vehicles using the vehicle's seat belt or the child restraint anchors (ISOFIX, LATCH, UAS). While rear-facing child restraints for older children offer excellent protection, they can only be fitted in larger vehicles and are therefore not suited to all consumers. OECD countries provide varying guidance as to the placement of the restraint. In North America, it is placed in the rear seat away from the front passenger airbag; in Europe, it may be placed in the front passenger seat, if the airbag is disconnected. Some EU countries require CRS to be placed in the rear of the vehicle, others recommend that the rear seat be used where possible.

In Canada and in the United States, safety messages directed at children's parents and caregivers advocate keeping children rear-facing for at least the first full year and up to

20 lbs (9 kg) or as long as possible. In recent years, rear-facing CRS that accommodate children up to 13.6-16 kg (30-35 lbs.) have become more widely available.

Design of forward-facing restraint systems

Forward-facing child seats have an integral harness for securing the child to the CRS while the CRS is secured to the vehicle seat with the vehicle's seat belt or the child restraint anchors (ISOFIX, LATCH, UAS). In Australia, Canada and, more recently, the United States, a top tether strap is used to anchor the top of the CRS to the vehicle, limiting forward movement in a frontal crash. In these countries, the tether anchorage must be installed in the vehicle by the vehicle manufacturer.

The recommendations for child weight, height and approximate age for forward-facing child seats also vary across countries. In general, these CRS are appropriate for children aged 1-4 years, provided the child is within the height and weight range of the particular model of child restraint.

Booster seats are designed to fill the gap between the child restraint systems and the seat belt. The objective is to raise the child to enable proper positioning of the vehicle seat belt across the child's body. With the aid of a booster seat, it is possible to fit a seat belt correctly (*e.g.* the lap belt low and snug over the hips and the shoulder belt across the chest) for a child from approximately 4 years old to 8-11 years. Depending on the country, booster seats are approved for children weighing from about 15 kg and should be used until a correct fit of the seat belt can be achieved, provided the child fits within the size limitations of the booster seat.

Effectiveness of child restraint systems

To develop effective designs for CRS, researchers study the mechanisms of child injuries and the performance of CRS in real world and simulated crashes. In the European Child Restraint Systems for Cars Programme (CREST), researchers studied the physical parameters corresponding to child injury mechanisms with the objective to develop new test procedures and instrumented crash test dummies that would ultimately lead to making CRS more effective in crashes. Analysis of actual collisions showed varying levels of effectiveness of CRS approved for use under the current EU standard (ECE Regulation 44) owing in part to the increased vulnerability of the neck in the youngest children and the pelvis in older children (Trosseille, 2001). The results of the project provide a valuable step towards better understanding of the biomechanics of child injuries and the development of test dummies and procedures to improve standards for child restraints. This work is continuing under the CHILD programme.

Various crash databases give detailed data on the nature of injuries children sustain in a crash. Head, neck, abdomen, pelvis and spine injuries are the most common. The severity of injuries can be compared with the type of restraint system used. More injuries are sustained with seat belts only than with belt-positioning boosters (Isaksson-Hellman *et al*., 1997).

The Norwegian Traffic Safety Handbook offers a comprehensive study of the injury-reducing effects of different kinds of CRS (Elvik *et al.*, 1997). The results of several studies were analysed and weighted according to their quality. For children between the ages of 0 and 4, correct use of a CRS reduces the probability of injury by approximately 50% for forward-facing seats and approximately 80% for rear-facing seats. Use of seat belts alone for children 0-4 years reduces the probability of injury by approximately 30%.

For children aged 5-9 years, the use of a restraint system reduces the probability of injury by about 50%, while vehicle seat belts alone reduce it by 20%. Children over 10 years old can, in most cases, use the car's standard seat belt which reduces the probability of injury in a crash by around 45%.

According to various US studies (Zaza *et al.*, 2001), safety seats that are correctly installed and used for children (0-4 years) can reduce the need for hospitalisation by 69%, the risk of death by 70% for infants and by 47-54% for toddlers (1-4 years). The US National Highway Traffic Safety Administration reports that an estimated 485 lives could have been saved in 2002 if there had been 100% child safety seat use for children under 5 years (NHTSA, 2003b, Traffic Safety Facts 2002: Occupant Protection). Clearly, appropriate restraint systems, when properly installed and used, save lives. A number of research studies have been conducted to examine injury patterns in child casualties with respect to factors including seating position, presence of an airbag, and whether the child was appropriately restrained, inappropriately restrained or unrestrained (Durbin *et al*., 2003; Arbogast *et al*., 2002, 2003).

A study by NHTSA (Kahane, 1986) estimated that child restraint systems are potentially 71% effective in reducing the risk of death. However, the extent to which this level of effectiveness is achieved in actual use depends upon a number of factors, including how well motorists are able to adapt the vehicle seat belts for the installation of the child restraints, and upon the compatibility between child restraints and vehicle seats and seat belts. As a result of improper installation of child restraints in vehicles and incorrect placement of children in them, the actual average effectiveness for all child restraints in use in preventing fatalities was estimated to be 59%. Moreover, reviews of research on child restraint systems and injury prevention highlight the importance of correct use of restraint systems that are appropriate for the size and development of the child, and note the need for continued and informed guidance for parents and caregivers of children (Weber, 2000; Howard, 2002).

Inappropriate and incorrect use

Although rates of CRS usage are on the rise in many OECD countries, children's injuries and deaths continue to occur owing to lack of or misuse of appropriate restraint systems in vehicles. Such inappropriate or incorrect use reduces the level of protection the systems are designed to provide in the event of a collision. Reviews of research on child restraint systems and injury prevention highlight the importance of correct use of restraint systems that are appropriate for the size and development of the child, and note the need for continued and informed guidance for parents and caregivers of children (Weber, 2000; Howard, 2002).

In some OECD countries, a tendency has been noted for parents to move their young children to the next stage or type of available restraint system before the children are sufficiently developed. Children are moved on to the next stage when it would be appropriate to maintain them longer in the current stage. The phenomenon has been observed at each stage of progression: infants from rear-facing to forward-facing restraint systems; children from a forward-facing child seat to either a booster seat or seat belt; and children from booster seats to seat belts.

Canada's 1997 national roadside survey of child passengers showed that 40% of 3-4 year olds were restrained in child seats and 31% were using seat belts. Among 5-9 year olds, 4.5% were in booster seats, 78.9% were restrained by seat belts and 15.4% were unrestrained (Transport Canada, 1998). The US 2002 National Occupant Protection Use

Survey revealed that 32% of infants under one year were observed in rear-facing restraint systems and 66% were in forward-facing child seats, 62% of 1-3 year olds were observed in forward-facing child seats and 29% were in booster seats or seat belts (Glassbrenner, 2003). In the CREST review of collision data, nearly 25% of infants under 12 months were inappropriately restrained in forward-facing instead of rear-facing CRS and 47% of 7 year olds and 79% of 8 year olds were restrained in seat belts rather than booster seats (Trosseille, 2001).

Studies indicate that the potential for injury is greater for children who are moved too early to a seat belt. Injuries arise as a result of poor fit of the seat belt over the child (*e.g.* children slouch because their legs do not bend over the edge of the vehicle seat, resulting in the lap belt rising over the hip bones into the soft tissue of the abdominal area). The risk factor was significantly higher for children 2-5 years of age moved from a forward-facing child restraint to a seat belt rather than a booster seat than for children in child seats (Winston *et al.*, 2001). Booster seats improve seat belt fit by positioning the lap belt across the pelvis which can withstand considerable force (German *et al.*, 1999).

Increases in injuries have also been noted at CRS changeover points (*e.g.* neck injuries for 4 year olds in booster seats and abdominal injuries for 10 year olds in seat belts), likely because children are not physically ready to progress to the next type of restraint system when age is the only factor considered (Isaksson-Hellman *et al*., 1997).

Incorrect use of child restraint systems remains a concern in many OECD countries, as incorrect use figures are as high as 85-90% depending on the study (Zaza *et al*., 2001; Anund *et al*., 2003). Three major steps are involved in selecting and using a CRS, each of which generally involves a number of actions, each of them susceptible to errors:

- Choosing an age, height and weight-appropriate CRS for the child.
- Installing the child restraint system in the vehicle as directed by both the child restraint manufacturer and the vehicle manufacturer.
- Securing the child in the child restraint system in accordance with the manufacturer's instructions.

To use a CRS correctly, a number of actions must be carried out in each of the above steps. As these actions are susceptible to errors, parents and caregivers may inadvertently install the CRS incorrectly. At worst, serious errors may arise that could render the restraint system completely ineffective in a collision; other errors are minor and less likely to degrade performance in a collision. A number of OECD countries have instituted inspection clinics to assist with the correct installation and fitting of CRS. These clinics have reported incorrect use levels in the 90% range for the infant, child and booster seats that they have inspected. The Royal Society for Prevention of Accidents (RoSPA) website (*www.rospa.org.uk* or *www.childseats.org.uk*) offers a summary of the common problems encountered and solutions applied. There is also an extensive network of inspection clinics and certified child safety seat technicians in the United States *(www.nhtsa.dot.gov/CPS/index.cfm).*

The issue of correct installation and use is further complicated by the myriad of models available and lack of universal design of passenger seats and seat belt systems by vehicle manufacturers. This situation offers great potential for incorrect use. The ISOFIX, LATCH or UAS systems address the issue of incorrect installation by establishing a universal attachment system. The ease of attachment and ability to achieve a correct fit

with the new system has been examined in the US (Insurance Institute for Highway Safety, 2003) and research will continue as such systems are more widely implemented.

Efforts continue to find ways to make CRS easier to use. Research has been conducted on usability issues concerning design and label/warning effectiveness. Results to date indicate the importance of taking human factors into account in product design in order to promote successful outcomes in installation and use of CRS (Rudin-Brown *et al*., 2002, 2003).

Recommendation: Auto manufacturers should be encouraged to design integrated seating systems that would "grow" with the child, eliminating the need for external attachment systems.

Passive approaches to children's transport safety

Vehicle standards such as quality, performance, safety and reliability are developed to improve vehicle design and passenger safety. Such standards are maintained and regularly reviewed by various national and international technical committees. A safe vehicle is one that provides excellent protection from injury in a collision for all occupants including children.

Today's vehicles include safety measures designed to save lives: improved crumple zones, impact front and side airbags, and child safety door and window locks. These measures are briefly described in the following sections.

Crumple zones

In the event of a frontal crash, it is of vital importance that the body of the vehicle should absorb as much energy as possible from the crash to reduce the potential for injury to the vehicle's occupants. The impact causes both the vehicle and its passengers to experience rapid deceleration, and this can cause injuries and fatalities, particularly to children.

Modern vehicles are designed with energy-absorbing crumple zones to minimise deceleration, limit intrusion and so reduce injury. Kinetic energy is absorbed through deformation of the bumper, the front of the vehicle structure, and in severe cases the forward section of the passenger compartment, while axles, wheels and the engine limit the deformation. In rear impacts, the integrity of the fuel system must be preserved. The effect of the crumple zone is to minimise potential injury to occupants of the vehicle by reducing the amount of energy available to damage the passenger compartment.

Airbags

Airbags are designed to deploy in the event of sudden deceleration, and are supplementary restraint systems designed to work in conjunction with seat belts. Frontal airbags prevent the head and the chest from hitting the steering wheel and the interior surfaces/fittings by inflating rapidly when a frontal crash occurs.

Some vehicles are fitted with additional airbags for protection in side impacts and for the safety of rear seat passengers. While airbags have been credited with saving lives and preventing serious injuries to drivers and front seat adult passengers, they may present a risk to those close to the airbag at the time of its deployment. In some cases, frontal

airbags have caused serious injuries and deaths, mainly for small-statured adults and improperly restrained children. European airbags tend to be much smaller than those used in North America, and thus pose less risk of injury to a restrained occupant.

In the United States and Canada, a rear-facing infant seat must never be used in a front seat with active airbags. It is also recommended that children age 12 and under should travel correctly restrained in the rear seat especially when there are active airbags in the front seat to reduce the risk of injury in the event of a collision. In the United Kingdom, parents are advised to avoid installing a rear-facing infant carrier in a seating position with an active frontal airbag. For older children restrained either by a forward-facing child restraint or a seat belt, it is advised that the vehicle seat be moved back as far as is practical.

Since the introduction of airbags in North American vehicles, both driver and passenger airbags have been extensively studied and modified to reduce their aggressiveness. In North America, changes to airbags have resulted in less aggressive systems. Included among the changes are changes of location, such as the recessing of the driver airbag module in the steering wheel, design changes with respect to folding and tethering of the airbag, and reductions in the force of deployment. These modifications are believed to cause less harm to occupants seated out-of-position at the time of deployment.

Advanced airbags use sensors and algorithms to determine the need for airbag deployment based on collision severity, seat fore-aft adjustment, and seat belt use. To further minimise the risk of injury from airbag deployment, research continues to find technological solutions to deactivate the airbag automatically in the presence of young children, or to cause it to deploy in a manner less likely to cause serious or fatal injury to children who are out of position in their seats. In the United States, motor vehicle manufacturers are working towards the development of airbag systems that will meet regulatory requirements to minimise the risk of passenger airbag-induced injury to children, either through automatic suppression or low-risk deployment.

Child locks for doors and windows

Passenger vehicles are equipped with separate child safety locks to prevent children from opening rear doors. Although this is not a requirement in Canada and the United States, many vehicles are sold with a child lock system. When activated, the passenger doors can only be opened from outside the vehicle. A 1999 article from the Transport Research Laboratory (TRL) in the United Kingdom argues that child locks should be fitted and that only doors allowing access to the side away from oncoming traffic be opened.

The locking systems of vehicles sold in the United States and Canada are different in that regulations require that the rear doors be locked from both the inside and the outside when the locking systems are engaged. In contrast, European vehicles usually only lock to the exterior when the door locks are engaged. For this reason, the demand for child locks has been less pronounced in the United States and Canada. International efforts are under way, through the United Nations WP-29 committee, to develop world requirements for door locks. This committee is addressing the different locking systems used throughout the world in an attempt to develop a harmonised approach.

Power-operated windows that may trap a hand, arm or head if there is no sensing mechanism to detect an obstacle and stop the window's closure pose another potential hazard to children. Solutions include: the installation of a switch to operate the power

windows only from the front compartment, the installation of power windows solely in the front compartment, the use of a sensing mechanism that immediately stops the window from being raised or lowered when motion is detected, or other types of window reversal safety features.

Vehicle design to protect children as pedestrians

Approximately one-half of the motor vehicle fatalities worldwide are due to collisions involving pedestrians and motor vehicles (Rivara *et al*., 1998), and children are among those at highest risk of pedestrian injuries. In the European Union, there are about 6 000 pedestrian fatalities and 53 000 serious injuries annually. Of these crash victims, a significant number are children.

A scientific working group reporting to the European Commission has devised a crash test procedure to simulate the impact of car fronts on pedestrians at speeds equivalent to 40 km per hour (25 mph). The procedure uses instrumented leg and child and adult head forms which are impacted against the part of the vehicle most likely to be struck by that body part in a real crash, and assesses the outputs against established biomechanical criteria. The issue of pedestrian protection is included in the European NCAP, which rates new models on their safety features.

In early 2003, the EC proposed a Directive based on this crash test procedure, intended to apply to all new cars and car-derived vans above 2.5 tonnes. The Directive calls for interim Phase I requirements applicable to new car models from 2005, with the full Phase II requirements applying to new car models from 2010. This Directive has now been agreed by the European Council and Parliament. If implemented in its proposed form, the Directive could ultimately reduce pedestrian fatalities by 10%, and serious injuries by 20% with 21% of the fatal savings and 31% of the serious injury savings likely to be to children under 15.

As about 60% of pedestrian fatalities are the result of being hit by car fronts, the greatest potential for reducing casualties lies in redesigning the front of the vehicle, bumpers and A-pillars of cars. Pedestrian detection and collision avoidance systems are other important design features to increase safety, including vehicle-mounted sensors that allow vehicles to "look ahead" and better detect pedestrians and bicyclists in their surroundings. Some current concept vehicles already employ video-based detection systems with stereovision, infrared sensors and radar or laser range finders. However, the technical challenge of reducing false alarms remains. Considering the progress achieved with sensor-based solutions over the past few years, this constitutes a promising approach to increasing safety.

In addition to front-end collisions, a significant number of children are injured by reversing vehicles, especially larger ones. Many of these accidents occur in the driveways of private residences. Development and use of better visibility aids, such as cameras, have the potential to improve crash prevention. Audible alarm and reversing lights are other important safety features that reduce crashes.

Legislation concerning child passenger safety and its enforcement

Most industrialised or higher-income countries have mandated the use of child restraint systems (OECD, 2002). Applicability of the legislation often depends on the child's seating position, the availability of a CRS and the type of roadway. Many laws allow use of the seat belt, particularly in the rear seat, for children well before they are the appropriate size for it.

Legislation generally requires use of an "approved" child restraint system, *i.e.* one that meets the production standards of that country or governing body. These restraints are labelled with information stipulating the relevant height and weight of the child occupant, and diagrams illustrating correct installation are provided.

The EU Directive of 8 April 2003 (2003/20/EC) updates the 1991 Directive on the use of seat belts and child restraints. It mandates the use of seat belts (when provided in the vehicle) for all drivers and all passengers and specifically:

- Prohibits children under 3 years from travelling in any vehicle (even if not fitted with seat belts) unless an appropriate child restraint is used.
- Requires children from age 3 up to 150 cm in height to use child restraints, with very few exceptions.
- Requires the use of child restraints to UN.ECE 44.03 standard (or later versions).
- Prohibits the use of rear-facing child restraints in seats protected by frontal airbags.
- Requires all passengers age 3 and over to use seat belts or child restraints (where available) in buses and coaches.

One of the effects of requiring everyone to use seat belts is that families with six or more members will need a large vehicle, or two vehicles, if they travel together.

In North America, some jurisdictions have enacted or are considering laws and/or regulations mandating the use of booster seats. Some are also reviewing the issue of seating position, with the idea of mandating the seating of children 12 and under in the rear seat.

To the detriment of child safety, exemptions to mandatory use of child restraint systems are common. These include cases where drivers are not licensed in the jurisdiction, vehicles are registered in another jurisdiction, vehicles belong to someone other than the parent or caregiver, drivers are unrelated to the child being transported, and taxis or vehicles where all seating positions with seat belts are occupied. Medical exemptions are often available and allow children with special needs to travel unrestrained, although in recent years it has become possible to obtain child restraint systems that accommodate physical disabilities and other special health care needs.

A recommended approach to developing laws to protect child passengers is to provide coverage at all ages, without exemptions, so that children's protection is not related to variations in driving circumstances. Elements of effective legislation governing use of child passenger restraints include: age and weight restrictions; seating position; comprehensive application; ease of enforcement; significant penalties and sanctions, including fines and/or loss of points; and insurance rate increases. Such legislation would include the following provisions:

- All vehicle occupants must be restrained in the vehicle using the vehicle seat belt or a child restraint system.
- Children must be correctly restrained in child restraint systems, booster seats or seat belts as appropriate for their size.
- Coverage of all drivers and all vehicles equipped with seat belts.
- The driver is responsible for ensuring that all passengers under the age of 16 are correctly restrained in the vehicle.

Enforcement of child passenger safety legislation

The preparation of this report included a review of recent evaluations of evidence from OECD countries regarding the effectiveness of interventions aimed at improving the use of child restraint systems. Legislation alone and legislation with enforcement have proven to be the most effective means of ensuring use of CRS. Other methods are discussed in Chapter 2.

Many of the reviews of evidence identified significant limitations in the methodology used to collect the evidence. Many community-based interventions do not easily lend themselves to a randomised control trial approach for evaluation purposes. In addition, many interventions to increase the use of child passenger restraints have not been evaluated but may be effective. Even with these limitations, there are enough studies to provide evidence of the effectiveness of child restraint systems.

Academic reviews of the evidence of effectiveness highlight the importance of legislation requiring the appropriate restraint of child passengers in motor vehicles (Zaza *et al.*, 2001; Towner *et al*., 2001). Most OECD countries have some form of legislation requiring restraint of children in cars, along with varying degrees of enforcement (Towner and Towner, 2002). While child passenger restraint legislation may vary between jurisdictions in terms of seating location, age and weight requirements and enforcement, it is clear that its use is one of the most effective means for improving the safety of children in motor vehicles, particularly when combined with enforcement interventions.

The effect of compulsory use of child restraint systems in cars has been studied in Norway and the United States. A study by Elvik *et al*. (1997) shows that the best estimate of the effect of compulsory use of child restraints in cars is a 15% decrease in the number of children injured in cars in the age groups covered by the legislation.

In Norway, using drivers as comparison group, the number of children injured in cars declined by around 17% from 1983-87 (before compulsory use of child restraint systems) to 1989-93 (after compulsory use was introduced). The average share of children using restraints increased from 42% in the earlier period to 82% in the later one.

Primary enforcement of child restraint laws allows police to stop drivers for the sole purpose of citing and fining them for failure to comply with child safety seat laws. Most enforcement for this infraction is coupled with an awareness or education campaign. Community-wide information and enhanced enforcement campaigns increase the use of child restraint systems (Zaza *et al.*, 2001). In many cases, information campaigns included, but were not limited to, paid advertisements, public service announcements, public involvement by key community leaders and media coverage. Elements of enforcement interventions included, but were not limited to, police checkpoints, police resources dedicated to child restraint systems enforcement and alternative penalties to official

citations. Community organisations and government agencies (*e.g.* public health, police services, schools, parent groups, family resource centres) partner to deliver these campaigns.

A programme in the province of Alberta, Canada, called "Think, Think Again" (TTA), provides an example. Under the auspices of the Alberta Occupant Restraint Program (AORP), partners in the programme include local and provincial enforcement agencies, regional health authorities, provincial and federal transportation ministries, the Insurance Bureau of Canada, the Alberta Motor Association, the Alberta Centre for Injury Control Research (ACICR) and other provincial and local injury prevention organisations. The goal of the programme is to reduce the number and severity of children's injuries as a result of motor vehicle crashes through a uniform and effective education and enforcement programme. The programme focuses on well-advertised check stops where police, with the help of volunteers, verify proper child restraint usage. Offenders are fined but can have the ticket revoked by attending an educational session.

Findings from the five-year evaluation of the TTA programme include:

- Incorrect use of child passenger restraints for children under age 6 and non-use for children over age 6 constitute 80% of all violations.
- Since implementation, there has been a steady increase in the number of persons attending educational sessions.
- The non-compliance rate averaged close to 40% (and in some areas up to 90%) at the beginning of the project. At the end of the study period, approximately seven out of ten drivers correctly restrain children when travelling in a vehicle.
- Drivers are becoming increasingly knowledgeable about how to restrain children correctly. The proportion of drivers who believed they were correctly restraining children but were not decreased from over 50% in 1997-98 to 22% in 2001-02. The proportion of drivers who stated that they were correctly restraining their children increased from 31% in 1997-98 to over 57% in 2001-02, and this was confirmed by inspection (Larsson, BIM and Associates, 2002).

Standards for bicycles, bicycle helmets and carriers

Over the past decade, health and safety professionals have worked to improve the safety of child bicyclists. Government-regulated standards mandating the safe manufacturing of bicycles and helmets, are essential to increasing the safety of child bicyclists. However, as legislation cannot work in a vacuum, a comprehensive approach utilising the three "E's", engineering, enforcement and education, has the greatest potential for increasing safety.

Bicycles are one of the most common modes of independent travel, particularly for children. Unfortunately, traffic-related bicycle crashes are a leading cause of serious head and abdominal injuries for children. Governments, non-governmental organisations (NGOs) and private corporations need to work together to increase the safety of child bicyclists through better environmental engineering, enforcement and public information/education for parents and children.

Manufacture and design standards for bicycles

While the definition of a bicycle differs slightly from country-to-country, there are some consistencies. The Vienna Convention of Road Traffic recently amended its original 1968 definition of a bicycle to be "any vehicle which has at least two wheels and is propelled by the muscular energy of the persons on that vehicle, in particular by means of pedal or hand-cranks" (European Conference of Ministers of Transport, 2000). The US Consumer Product Safety Commission (CPSC) standards define the bicycle as a "two-wheel vehicle having a rear drive wheel that is solely human powered" (US Code of Federal Regulations, 2002).

Internationally, there has been a push to harmonise bicycle standards. Construction is fundamental to ensuring the safety of child bicyclists; however, the benefits of bicycle design and construction are not clearly measurable. In August 2002, the International Organization for Standardization published ISO 8098, specifying safety requirements for bicycles suitable for children aged 4-8 (International Organization for Standardization, 2001). The standard governs manufacture, design, assembly and testing, as well as sub-assemblies. However, ISO 8098 does not govern the manufacture of off-road and special bicycles such as BMX bicycles and other sporting bicycles.

As many European countries have existing national standards for bicycles, the European Committee for Standardisation (CEN) is working to harmonise standards for on-road, off-road and racing bicycles, as well as upgrading standards for children's bicycles. Such standards will address the safety components suggested by the European Conference of Minister's of Transport's (ECMT) ten point system described below.

The ECMT has outlined ten points for ensuring that bicycles are strong and safe (European Conference of Ministers of Transport, 2000). They address avoidance of sharp, injury-causing edges; use of designs to reduce injury in the event of contact or fall; use of markers to designate the limits of saddles and handlebar support; design and performance of two independent braking systems; front wheel quick-locking devices; strength of frame, handlebars, fork and wheels; ease of part tightening and adjustment; and availability of clear and complete instructions. In sum, European standards for the design and manufacture of bicycles have three key components to enhance safety: efficient and effective brakes, a sound frame and reflective materials.

Similarly, the US CPSC regulations for bicycles include specific manufacturing requirements on nine aspects: braking systems, drive chain, protective guards, tires, wheels, wheel hubs, front fork/frame assembly, seat and reflectors. Additionally, the standards specify test and performance standards (US Code of Federal Regulations, 2002, pp. 556-576). The United States does not have specific regulations mandating bells and lights. However, most states have laws requiring front lights when riding at night.

In the United Kingdom, new regulations that come into force in May 2004 require that bells must be fitted to new adult bicycles at point of sale. Although this does not cover children's bicycles the regulations can be extended in the future. Child bicyclists and pedestrians will benefit from audible warning of the presence of other bicyclists.

Manufacturing standards for bicycle helmets

Uniform manufacturing standards are designed to ensure that helmets protect the head in the event of a crash. For example, the US CPSC sets standards for peripheral vision, positional stability, retention systems and impact attenuation, and defines the need of uniformity in the design and manufacturing of helmets to:

> "[…] ensure that bike helmets will adequately protect the head and that chin straps will be strong enough to prevent the helmet from coming off in a crash, collision or fall. [Additionally they require] that helmets intended for children up to age five cover more of the head to provide added protection to the more fragile areas of a young child's skull" (US Consumer Product Safety Commission, 1999).

Internationally, helmets for children are categorised as follows: pre-school helmets for children under 5 years; and youth helmets, generally for children over 5 years of age. Child helmets are manufactured to cover more of the child's head to provide greater protection than youth or adult helmets. Youth helmets are governed by the same manufacturing standards as adult helmets, but are available in smaller sizes.

While comprehensive manufacturing standards help ensure safety (see Towner *et al*., 2002, for a comparison of various national standards) following a collision, this level of safety is compromised. Fortunately, some manufacturers and countries committed to increasing helmet use offer helmet replacement programmes.

In an analysis of helmet standards, the Bicycle Helmet Safety Institute (2003) noted that standards for the design and manufacture of helmets have been in effect in Australia, Canada, the United States, the European Union, New Zealand, Sweden and the United Kingdom for a number of years. Europe now has a European Committee of Standardisation (CEN) standard that should cover all CEN member states, even though some countries retain aspects of their national standard (Bicycle Helmet Safety Institute, 2003). Some countries have modified their standards over time. For example, New Zealand has adopted the Australian standard (Bicycle Helmet Safety Institute, 2003) and Australian standards have been modified to allow for a broader range of lighter, cooler helmets (Cameron *et al*., 1993).

Fitting bicycles and helmets for children

Children's bicycles are often purchased without determining the appropriate size and fit for the child's height. When a bicycle is not properly fitted, loss of control is more apt to occur while riding potentially resulting in serious injury to the rider. Schwinn, an American bicycle manufacturer, suggests in its owner's manual and safety handbook that "stand over height is the basic element of bike fit". However, correct saddle (seat) positioning, handlebar height and angle, control position adjustments and brake reach should also be checked for appropriate sizing (Schwinn, 1999, p. 6).

For the rider's safety, a properly fitted helmet is equally important. It should lie flat and level on the child's head with two fingers width between the eyebrow and the helmet. The strap should form a "V" under the ears and should fit snug to the child's chin. Parents should also ensure that the helmet is the proper size for the child by using the pads included with the helmet to ensure that the helmet is snug on the child's head. Bicycle helmets must fit and be worn correctly to protect against injury.

Bicycle child carriers and trailers

Bicycle child carriers and trailers are used to carry young children, but public health professionals discourage the use of bicycle carriers and trailers for children under 12 months of age. Child carriers are defined as "child seats mounted to the front or back of the adult rider's bicycle". A child trailer is an apparatus that sits low to the ground and is connected to the lower section of the bicycle. If a crash should occur in a trailer, the

child is closer to the ground and has a shorter distance to fall, thus decreasing the potential for serious injury. Travelling in carriers has been associated in one study with a higher rate of injury, when compared with trailers (Powell, 2000), but there is a lack of research evidence on the relative risks of carriers and trailers. However, both bicycle carriers and trailers may give the child a rough ride, and this in itself may result in injury. The CEN investigates standards for all bicycle accessories, including trailers for children's transport. Consumer information is available on these products and consultation with family physicians on the use of carrying devices and infant/child helmets is recommended.

Bicycle-related injuries and fatalities

The Canadian Hospital Injury Reporting and Prevention Program (CHIRPP) estimates that most youth bicycle injuries are a result of falls or loss of control. Canada's emergency room data indicate that an estimated 53% of bicycling injuries were abrasions or lacerations, 26% were fractures and 7% head injuries (MacKay *et al*., 2001).

The US CPSC's National Electronic Injury Surveillance System (NEISS) query system indicated that of children's bicycle-related injuries that occurred in 2001, 7.4% of victims experienced brain trauma, and 13% experienced head trauma (NEISS, 2003).

In the United States, traumatic brain injury is the leading cause of death in all bicycle collisions annually, as head injuries account for more than 60% of bicycle-related deaths, more than two-thirds of bicycle-related hospital admissions, and about one-third of hospital emergency room visits for bicycling injuries. In 2001, children age 14 and under accounted for approximately 36% of bicyclists injured in motor vehicle collisions. It is estimated that collisions with motor vehicles account for nearly 90% of all bicycle-related deaths and 10% of all non-fatal bicycle-related injuries (National Safe Kids Campaign, 2003).

Linn *et al.* (1998) conducted a longitudinal examination of bicycle injury using British Columbia Children's Hospital data from 1991 to 1995. Most injuries were caused by a loss of control of the bicycle and subsequent falls. More than 70% of the injured bicyclists did not use a helmet, and bicyclists not using helmets were more likely to be admitted to the hospital. While over a third (38.9%) of the injuries were to the head and face, the majority of injuries affected the upper and lower extremities at 46.4% and 32.5%, respectively.

Recent evidence indicates that children attempting to break their fall in bicycling collisions are hitting their abdominal area on the handlebars, causing serious injury. A longitudinal review of hospital data from Children's Hospital in Philadelphia, United States, examined the relationship between handlebars and injuries and concluded that certain types of serious abdominal injuries would be greatly reduced if bicycles were redesigned, particularly limiting rotation of the front wheel and developing handlebars that retract upon impact (Winston *et al.*, 1998; Arbogast *et al.*, 2001).

Research clearly demonstrates that use of helmets greatly reduces traumatic brain injury to children and adults (Thompson *et al.*, 1989; Sosin, *et al.*, 1996; Thompson *et al*., 1996; Rivara *et al*., 1998; Schieber *et al*., 2000). Moreover, studies indicate that up to 88% of head and traumatic brain injuries could be prevented by helmet use (Thompson *et al*., 1996, 1989; Schieber *et al*., 2000).

Thompson *et al*. (1989) reviewed emergency room records from five major hospitals in an urban centre in the United States. Researchers reviewed the records of 776 bicyclists admitted for bicycle-related collisions and conducted self-administered questionnaires with 235 of those who sustained head injuries and 433 who did not. They concluded that helmets reduce head injuries by 85% and brain injury by 88%.

Studies in Sweden show that 50-75% of all bicycling fatalities are caused by head injuries, and that approximately 40% of fatalities and 20% of injuries could be prevented by helmet use (European Conference of Ministers of Transport, 2000, p. 20). Towner *et al.* (2002) analysed 16 studies and concluded that helmets are effective in reducing the incidence of head, brain and upper facial injury for bicyclists of all ages, and deemed particuarly effective for children's safety.

Rutherford (2002) used US NEISS data to identify bicycle injuries between June and November 2001. Results showed that child bicyclists treated in emergency rooms for bicycle-related head injuries were three times more likely not to have been wearing a helmet.

On the basis of a 1997 analysis of bicycle-related head injuries in the United States it was estimated that universal helmet use would have prevented approximately 327 fatal, 6 900 hospitalised and 1 000 emergency department cases (Schulman *et al*., 2002). The study also noted the high cost of associated healthcare for these preventable injuries.

Thomas *et al*. (1994) studied the role of helmets in reducing head injuries among children 14 years of age or younger admitted to a children's hospital in Brisbane, Australia. Results showed that wearing a helmet reduced the risk of head injury by 63% and loss of consciousness by 86%.

Effect of legislation requiring helmet use

Victoria, Australia, was the trailblazer in legislating mandatory helmet use for all riders in July 1990. An Australian observational study assessing helmet use before and after the legislation was introduced showed an immediate increase in helmet use rates from 30% pre-legislation (March 1990) to 75% post-legislation (March 1991) (Cameron *et al*., 1993).

Of the 19 OECD member countries that responded to the bicyclist questionnaire in the International Survey of Children's Transport Safety, eight indicated that bicycle helmet legislation has been enacted on a national, provincial or state level. Moreover, the survey showed that helmet use was highest among the youngest children and declines as children age (Christie *et al*., 2004).

The United States currently has bicycle helmet legislation in 20 states and 130 local jurisdictions (*e.g.* counties or cities) (NHTSA, 2003a) with 43% of children under 15 years of age covered by a bicycle helmet law (Schieber *et al.*, 2000).

Six Canadian provinces have bicycle helmet laws. British Columbia, New Brunswick, Nova Scotia and Prince Edward Island have laws covering all riders; Alberta and Ontario have helmet laws only for children and youth. An observational study identified a dramatic increase in helmet use following enactment of the law in British Columbia (*e.g.* from 40% in 1995 to 70% in 1999, three years after introduction of the law) and has remained near that level (Foss and Beirness, 2000). A Nova Scotia observational study demonstrated increases in helmet use after legislation from 36% in 1995 to 84% by 1999 (LeBlanc *et al.*, 2002).

MacPherson *et al.* (2002) used Canadian hospitalisation data from 1994 to 1998 to conduct a country-wide study comparing the rate of head injuries in provinces with and without mandatory helmet legislation. Of the 9 650 children (5-19 years) hospitalised for a bicycle-related injury, 35% (3 426) sustained injuries to the head and face and 65% (6 224) had other injuries. The analysis noted that the bicycle-related head injury rate declined significantly (45% reduction) in provinces with helmet legislation compared with provinces and territories without (27% reduction).

A New Zealand study also showed an increase in helmet use after passage of a helmet law in 1994. New Zealand had high usage rates prior to the legislation, with a number of agencies carrying out helmet use promotional campaigns. Before the introduction of the law, about 60% of adults and 90% of elementary school students wore helmets voluntarily (Povey *et al.*, 1999).

The literature on the effectiveness of bicycle helmets is conclusive as to their benefits in terms of reducing the incidence and severity of head injury particularly to children. Legislation has been associated with increases in helmet wearing and reductions in head injuries. It is recognised that the introduction and enforcement of legislation requiring helmet use may raise concerns in some regions about some reduction in bicycling amongst teenagers. However, experience in many countries suggests that the overall safety benefits of increasing levels of bicylcle helmet use will be strongly positive.

Enforcement and education: a comprehensive approach

In 1995, the US Centers for Disease Control and Prevention (CDC) issued recommendations for increasing the use of bicycle helmets. The recommendations addressed state and local injury prevention programmes, including data collection, strategy development, coalition building, legislation and evaluation, and recommended that all bicyclists should wear helmets every time they ride The recommendations emphasise the need for comprehensive programmes that include education and enforcement strategies (CDC, 1995).

Developing enforcement strategies for bicyclists, however, has been difficult. The literature review only documented one US study evaluating greater enforcement. In a small rural community in the southern United States, law enforcement officers confiscated bicycles of young people riding without a helmet; this resulted in a 71% increase in helmet use. The young people were unable to regain possession of their bicycle until parents visited the local law enforcement facility with a helmet in hand. This community did not have a law requiring adults to use helmets and the usage rate remained nil for the adult population (Gilchrist *et al*., 2000). Cote *et al.* (1992) examined the combined impact of legislation and education on helmet use in Howard County, Maryland, after passage of a 1990 local ordinance. The observational study noted that compliance is not a given upon passage of legislation; however, the usage rate in Howard County jumped from 4% to 47%. When the study was published, this was the highest recorded helmet use rate for children in the United States. Cote argues that this was due in large part to the combined strength of education campaigns and legislation.

Schieber *et al*. (1996) noted that a combination of information activities and programmes to provide helmets in low-income communities can be credited, in part, for the increase in bicycle ownership among underserved populations. His study further illustrated that the helmet ownership rate for African Americans in Georgia increased following the combined use of legislation, information activities and outreach strategies. The data reveal that the explanatory variable for use within this population was education

about legislation. Parkin *et al*. (1995) conducted a study to measure the efficacy of school-based helmet education and subsidy programmes in lower-income communities and concluded that such programmes did not increase helmet use. However, peer pressure was identified as a having a positive influence on helmet use.

Clothing for children as bicyclists and pedestrians

To increase the visibility of children in traffic, it is recommended to use light-coloured and retroreflective clothing and other aids between dusk and dawn, when visibility is reduced. Pedestrians and bicyclists need to be both visible and conspicuous on the roads so that motorists will easily distinguish them as people rather than objects. White clothing alone is not a sufficient aid to visibility; flashlights, retroreflective bands on the head, waist, wrist, and ankles, jogging vests and dangle tags are more readily detected (European Conference of Ministers of Transport, 2000).

Norway's National Traffic Safety Organisation highlights a study suggesting that wearing a retroreflective dangle tag reduces the risk of being hit by a motor vehicle by 85% *(www.tryggtrafikk.no)*. A review of interventions for increasing pedestrian and bicyclist visibility reported that fluorescent materials in red, yellow and orange improve drivers' detection and recognition of bicyclists and pedestrians in daytime, while lamps, flashing lights and red and yellow retroreflective materials increase detection and recognition at night. Studies examining the optimal placement for retroreflective materials found that observers could more easily identify an object as a pedestrian or a bicyclist when the retroreflective materials were affixed to moving parts of their body or bicycles (Kwan and Mapstone, 2003).

In the United Kingdom, Spain, Poland and Finland, traffic codes recommend increasing the visibility of pedestrians and/or bicyclists with the use of high-visibility materials, and Germany has a schoolbag regulation requiring use of high visibility materials.

Distribution campaigns to increase the use and recognition of fluorescent or retro-reflective dangle tags began many years ago in countries with longer hours of darkness and greater exposure risks (*e.g*. Norway, Finland). In a Norwegian survey of pedestrians, 40% of all survey respondents (30% of persons under 30 years of age and 60% of those over 60) self-reported use of retroreflective material when walking along an unlit street. In Finland, 1982 legislation requires pedestrians to wear retroreflective material or reflectors that meet European standards on unlit roads; their use is now encouraged for all roads. The Norwegian Traffic Safety Plan has identified a number of targets to increase the visibility of child, adult and senior pedestrians by 2011. Public awareness of this issue is promoted in a variety of ways. In some European countries, traffic safety organisations have conducted social marketing campaigns, some in conjunction with manufacturers and retailers of children's apparel to promote clothing with retroreflective material. In the United Kingdom, resources for teachers and students about visibility and retroreflectivity are available at *www.roadsafety-UK.net*. In North America, campaigns are often run during times of heightened pedestrian activity at night (*e.g*. Halloween). In countries that observe Daylight Savings Time, children can be particularly vulnerable as bicyclists and pedestrians travelling in the evenings in darkness during autumn months. Specific campaigns to target safety during this time help to increase awareness. At such times, dangle tags and retroreflective arm and leg bands are available in stores in some countries, sometimes free of charge. Promotional campaigns to increase recognition and use of visibliity aids are important for enhancing the safety of children near traffic,

particularly in countries with longer times of darkness. In addition to the recommended conspicuity aids, other measures (*e.g.* the presence of bicycle lanes or pedestrian paths and traffic signals) are needed to provide a safe environment for mobility when visibility is an issue. Further research is needed to determine the level of effectiveness of conspicuity aids in reducing traffic-related child injury and death.

However, the most difficult issue is probably not the effectiveness of visibility aids, but rather encouraging more widespread use of even the most basic aids in times of darkness. Only a small proportion of bicyclists use their lights; conspicuity aids for pedestrians appear to be used even less. Efforts to increase the use of these aids are recommended.

Children and buses

In some OECD countries, notably in North America, children travel to school by a special (yellow) bus. In North America, these buses are designed specifically for driving children to and from school. In Europe, buses used for transporting children to and from school or on school-related trips, are not specifically designed but are ordinary coaches or buses. Children in most OECD countries who travel to and from school by bus use public transit buses. In using the transit bus, children travel with the general public and generally spend more time as pedestrians walking to and from, and waiting at, the bus stop. No special markings or flashing lights signal the presence of children, and motorists are not required to stop when transit buses are loading and unloading. Additionally, children must cross streets without the help of other safety equipment provided by school buses.

A review of bus occupant protection research and regulatory practices in Canada, the United States, Australia and Europe completed for Transport Canada noted that there is no universally accepted definition for a bus and that this lack of uniformity makes it difficult to compare characteristics and relative involvement in crashes across countries (RONA Kinetics, 2002). A school bus, as defined in the United States and Canada, is a vehicle with a seating capacity of 11 or more persons, including the driver, operated for the purpose of transporting children to and from school (United States and Canada) and school-related activities (excluding chartered and transit buses) (United States only).

In Canada, approximately 40 000 school buses are used for the travel of 2.5 million children to and from school, and in the United States, about 450 000 school buses transport 23.5 million children to and from school and school-related activities (Prentice and Tremblay, 2002; National Highway Traffic Safety Administration, 2002a). Crash statistics show that on average each year less than one school bus occupant under 19 years of age is fatally injured in road crashes in Canada (Transport Canada, 2004). In the United States, seven school-age children (under 19 years of age) are killed in school buses on average each year (National Highway Traffic Safety Administration, 2002b). These safety records result from several factors: special safety standards mandated for school bus construction and operation, design of the buses, special occupant protection, school bus safety education, bus driver selection and training, vehicle maintenance, and school bus route planning.

How children travel to and from school is influenced in part by transport policies. A study by the US Transportation Research Board on the relative risks of school travel presents a risk management framework that can be used to identify, analyse and prioritise the risks associated with student travel, and then formulate interventions to manage these risks (Transportation Research Board, 2002). Clear understanding of transportation-

related risks, and knowledge of current school transportation solutions and technologies, might aid decision makers in establishing policies and guidelines about school travel.

Regulation and design of school buses

In Canada, school buses must meet the requirements of the Canadian Motor Vehicle Safety Standards (CMVSS) while in the United States, the Federal Motor Vehicle Safety Standards (FMVSS) govern the construction of new school buses. In addition to all other vehicle regulations, four regulations apply specifically to school buses in both countries. These are manufacturing requirements related to bus rollover protection, body joint strength, passenger seating and crash protection, and devices for the safety of pedestrians around the school bus.

In the United Kingdom, vehicles constructed to general bus and coach standards are designated school buses only by contract, and coaches so designated must be fitted with seat belts. However, the United Kingdom is also pilot-testing the use of US-style yellow school buses in selected jurisdictions. These pilots feature regular trained drivers, vehicles fitted with seat belts, a guaranteed seat for each child, and pick up-points located close to home. The UK Department for Transport has commissioned an independent evaluation of the pilot tests to compare the safety records of the pilot vehicles with those of traditional vehicles used for school bus services.

North American school buses have safety features that help to make them the safest type of vehicle on the road. For example, enhanced structural integrity and strict fuel system integrity increase their crashworthiness. The roofs of school buses are tested with a load of 1.5 times the weight of the bus to reduce the risk of injury in rollover-type crashes. Strengthened window and roof frames with small window frames are designed to prevent children from being ejected; all-tempered glass in the windows reduces the possibility of injury from flying glass. The integrity of the emergency door and its surrounding body also prevent occupant ejection during a road collision. Special standards ensure that, in case of emergency (*e.g.* fire), the force required to open emergency exits would not exceed the force a child can apply. Interior materials that are slow-burning and of low flammability provide extra time for children to evacuate in the event of a fire.

Occupant protection

In a crash, occupants are in motion until they collide with the interior of the vehicle or are ejected from it. To prevent injuries, child passengers of school buses in North America are protected by a passive restraint system. This system of seating keeps child passengers within a padded, closely spaced compartment surrounded by energy-absorbing material that dissipates the energy of the crash away from the children. This represents a passive restraint strategy whereby children are protected without having to wear a seat belt. Misuse is not possible, unless child passengers are out of position in the seats. To allow for the safe transport of younger children (*i.e.* under age 5) some seats in new school buses in Canada have been equipped with Universal Anchorage Systems similar to those developed by the International Organization for Standardization for the installation of child restraint systems. Although most North American school buses use passive protection rather than seat belts as a restraint system, smaller buses (under 10 000 lbs or 4 500 kg gross vehicle weight) in the United States are equipped with seat belts.

Seat belts on school buses

In the United Kingdom, the fitting of seat belts is required in all coaches used for the transport of school children. Moreover, the United Kingdom requires that all coaches used to transport school children be retrospectively fitted with seat belts (Department for Transport, 2001).

In France, a 2003 circular requires everyone in a bus equipped with seat belts – including children – to wear a seat belt (Circulaire 2003). Although the safety record of school buses in North America indicates a high level of protection for school bus occupants, there have been concerns about whether seat belts should be required. However, investigations of school bus crashes do not reveal greater safety protection when lap belts are installed. The U.S. National Transportation Safety Board has concluded that neither lap nor lap and shoulder belt restraint systems would have been beneficial in reducing the injuries or fatalities in the crashes it examined.

The US National Highway Traffic Safety Administration has studied the issues of passive safety, lap belts and lap/shoulder belts on school buses. It concluded that lap belts have little, if any, benefit and could potentially cause more harm than good (National Highway Traffic Safety Administration, 2002a). Lap/shoulder belts are more effective; however, there are related issues concerning installation costs, reduced seating capacity, maintenance and proper use.

In the United States, statistics show that school buses are nearly eight times safer than passenger vehicles (Transportation Research Board, 2002). There is concern that even a small reduction in the number of children using school bus transportation could result in more child fatalities in traffic-related incidents. Consequently, any proposal for change would need to be thoroughly studied to ensure that it would not result in fewer children riding in school buses.

Children as pedestrians around buses

Children are at greater risk of injury or death while boarding or disembarking from a school bus than while riding in it. Between 1992 and 2001, 26 school-aged pedestrians under 19 years old died and 331 were injured in school bus collisions in Canada, while in the United States, from 1991 through 2001, 210 school-aged pedestrians (under 19 years old) died in school transportation-related crashes. In these school bus collisions, 50% of all the US school-age pedestrian fatalities were children aged 5-7; in Canada, almost 70% were between the ages of 4 and 7.

As discussed in earlier chapters, children often do not have the motor, cognitive and behavioural skills to handle traffic until they are about 9-10 years old. A further factor contributing to pedestrian casualties in the vicinity of school buses is the difficulty for bus drivers to see small children around the school bus. The mirror system provided for the driver presents a view of the interior, the roadway, the tires at ground level and the front door, in an effort to ensure the driver's view of both child occupants and pedestrians. Regulations pertaining to the mirror system include performance-based field-of-view requirements. Newer "transit"-style school bus designs with the front door ahead of the front wheels, and a flat front profile give the driver a better view of children around the front of the bus (Prentice and Tremblay, 2002).

Advances in electronic detection and warning systems have given rise to research to investigate how these advances may be applied to make children who travel by school

bus safer. A study of advanced pedestrian detection systems is under way in Canada; it combines expertise from both the school transportation and intelligent transportation system sectors, with a view to providing new ways to help school bus drivers to detect children around the bus (Transport Canada, 2003 b). Motion sensors that sound an alarm if a person stands too close to the bus have been installed on buses in some US school districts; however, their effectiveness has not been evaluated.

In North America, recognition zones have been created around the bus to alert drivers of other vehicles. In addition to using the distinctive yellow colour, school buses are equipped with an advanced signalling system and an extended stop sign which warn motorists of a mandatory stop when the school bus stops to pick up or discharge passengers. Some jurisdictions require school buses to be equipped with a crossing control arm that extends in front of the bus when the bus stops and requires pedestrians to walk out and around it, remaining in view of the driver.

The North American practice of requiring motor vehicles to stop when a school bus stops to load or unload passengers is not universally accepted. The United Kingdom, for example, considered the practice but concluded that it may lead to dangerous overtaking behaviour in order to avoid stopping behind a school bus. A preferred approach is to improve pedestrian safety by implementing traffic-calming measures in the vicinity of schools, combined with limited interruption of traffic through road-crossing patrols and parking restrictions.

Related issues: driver training and route selection

In Canada and the United States, school bus drivers are required to have a special class of driver's licence appropriate for the type of commercial vehicle being operated. Canadian provincial and territorial governments and US states are responsible for regulations, standards, or policies regarding the operation of motor vehicles, including school buses. These include driver and vehicle licensing, maintenance and inspection, and traffic laws governing school buses. Prior to licensing, school bus drivers must pass specific medical, knowledge and road skills tests. In addition, in the United States they must pass drug and alcohol screening and any required law enforcement background checks, and they can be required to do so in Canada, subject to school board, transport company or provincial/territorial requirements.

Transport managers determine the most efficient school routes around each child's address. Guidelines on safety and security are followed at pickup and drop-off points when designing school bus routes.

Inter-city buses (motor coaches)

Available countermeasures and improvements have the potential to reduce the incidence and severity of injuries to all occupants of these buses in the event of a crash (RONA Kinetics, 2002). In addition to the development of common definitions and classifications of buses, issues such as seat and seat anchorage strength, retentive glazing, rollover strength and the design of emergency exits have been identified by researchers as deserving further consideration (RONA Kinetics, 2002). In Europe, the Enhanced Coach and Bus Occupant Safety project (ECBOS) has concluded a study of motor coach crashes, injuries, and countermeasures. The multidisciplinary work studied crash data, conducted in-depth crash studies and simulations, developed new test methods and formulated new proposed standards to improve occupant protection (European Commission, 2003).

Recommendations concerning vehicles and safety equipment

- Vehicle manufacturers have a role to play in developing improvements for the safety of child occupants. It is recommended that they work with child restraint manufacturers, parents, those responsible for vehicle standards and others to find a balance in terms of responsibility for child safety. Simple, universal designs for child restraint systems that can accommodate the diversity of children with a wide variation in height, age and weight should be encouraged.
- The evidence suggests that the use of combined interventions is effective at improving the use of child restraint systems. The recommended interventions include comprehensive legislation and community-wide information and enforcement campaigns, built around the active participation of public safety officials and safety-oriented voluntary organisations.
- Given the evidence supporting the effectiveness of helmets in preventing head and brain injuries, it is recommended that bicyclists be strongly encouraged to use bicycle helmets.
- Further scientific investigation is recommended to study the interrelationships of legislation, enforcement and outreach programmes in pursuit of the goal of increasing bicycling safety through helmet use.
- Designers and manufacturers of children's clothing and accessories are well-positioned to incorporate retroreflective materials into product lines. It is recommended that parents, as well as public health and safety officials, encourage them to do so, as one component of an ongoing campaign for protecting children in traffic.
- In view of competing resources and programmes concerning travel to school, it is recommended that school jurisdictions develop and implement risk management policies related to the journey to and from school. Issues of importance to the policy include the use of public transit or dedicated buses, the fitting of seat belts, protective measures for child pedestrians outside the bus, protecting children walking and/or bicycling to school, and public awareness messages and campaigns.
- The protection of children as they use private vehicles, bicycles, and buses in traffic is a responsibility shared by all levels of government and many non-governmental organisations, as well as families. It is recommended that strategic partnerships be established and nurtured to create innovative and multidisciplinary approaches to keeping children safe in traffic.

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Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

Abstract. Chapter 5 provides research and policy recommendations for safeguarding current and future generations in the road environment of OECD countries. The issues addressed in the earlier chapters are considered as part of an integrated approach to improving road safety. This chapter builds on the results of the International Survey of Children's Road Safety, conducted in preparation for this report. The chapter focuses on how can children be kept safe in traffic; the contribution education training and publicity can make; measures related to the risks children face in the road environment; vehicle and bicycle standards and safety equipment; and the importance of appropriate legislation. The chapter draws conclusions on best practices able to contribute to reductions in children's transport-related injuries and fatalities. It also highlights possible improvements in the key policy and operational areas affecting children's road safety and makes a series of recommendations for road safety policy.

Despite the fact that the number of children killed on the roads in OECD countries was halved between 1984 and 2000, one child out of every 2 100 will still die in a road crash before reaching 15 years of age. This report considers the relative levels of risks in OECD countries and the casualty reduction programmes and strategies that can improve children's road safety.

How risky is children's travel?

Road crashes in OECD countries account for around 40% of deaths of children due to traffic crashes or acts of violence. However, this average statistic covers a wide range, from less than a third in the United Kingdom and Sweden, to over half in Korea. Since the 1970s, the rise in motorised traffic and the ensuing increase in exposure to risk have contributed to a rise in the share of road-related incidents as a proportion of all child fatalities. However, it is encouraging that the number of fatalities has fallen and that children's safety in traffic has improved more than that of adults. While the number of child fatalities has been halved from 1984 to 2000, adult fatalities have decreased by less than 20% over the same period. It remains unclear how much is due to real relative increases in child safety and how much to changing mobility trends.

International comparisons of child fatalities are made difficult by the lack of consistent exposure data. The relative risk of a given mode of travel in a country would be best demonstrated by a measure based on casualties per distance travelled or on children's time in the roads. Lack of data makes this difficult. Therefore, this report has in the first instance compared risk by using population-based fatality and casuality rates (*i.e.* rates per head of population).

Comparison of child fatality rates with those for adults shows a generally consistent picture with countries with "good" overall road safety performance also performing well for children. Fatality rates for children vary from 1.5 per 100 000 child population in Sweden to 7.5 per 100 000 in Korea, with an average of 3.5 for all OECD countries. Children's fatality rates increase with age in most countries, reflecting their increasingly independent mobility, but the countries with the worst overall rates also tend to have rates for younger children as high or higher than those for older ones.

The lack of exposure data makes comparisons of relative risk by mode of travel particularly problematical. Population-based rates indicate that pedestrians in countries with fewer cars (*e.g.* Korea, Hungary) have higher pedestrian fatality rates than those with high car ownership (Italy, Sweden, Germany). Population-based rates for child bicyclist fatalities are particularly misleading, as the high rate in the Netherlands is more likely due to high exposure than to relatively high risk.

The International Survey of Children's Road Safety, conducted in preparation for this report, collected data on exposure by mode from 21 countries, of which ten provided comparable data for the 10-14 year age group. The survey results showed large variations in mode of travel. In most countries, the car accounted for at least half of all distance travelled. However, in the United States, children (10-14) make 84% of their trips as car passengers. Bicycling accounted for less than 10% of trips for 10-14 year olds in all except the Netherlands where nearly a third of all travel was by bicycle. Walking was particularly low in the United States, at less than 1% of distance travelled, well below the 10% reported in most countries.

The use of exposure data to calculate relative risks shows that, for 10-14 year olds, car travel is the safest by an order of magnitude, but the highest levels of risk are in Germany, Sweden and New Zealand. Pedestrians are most at risk in the United States and the United Kingdom. For bicycling, inclusion of exposure data indicates a very different picture from population-based rates, with countries such as the United Kingdom and New Zealand combining low levels of bicycling with poor safety performance, and the Netherlands combining relatively low risk with high levels of bicycling.

Recommendation: Better and more comprehensive exposure data would improve the analysis of traffic crashes and fatalities involving children.

How can children be kept safe in traffic?

The main purpose of the report was to highlight successful programmes and strategies that could be adopted by OECD countries to improve children's safety on the roads and to identify possible further improvements. Road safety policy and practice was considered in three key areas: education, training and publicity; the road environment; and vehicle standards and safety equipment. No one of these areas is more important than the others, and success in improving safety is likely to involve a holistic approach combining measures across all three groups.

Education, training and publicity

Road safety education is a lifelong learning process and, together with publicity, complements sound infrastructure and vehicle design and enforcement of road traffic laws. Educational measures need to be tailored to the child's stage of development,

starting with practical pedestrian and then bicyclist skills, but increasingly involving higher-level skills to match children's increasing independence as pedestrians, bicyclists and ultimately young adult drivers.

It is important to consider education and publicity in a wider context than simply teaching children how to behave in traffic. All road users have a duty to keep children safe, so that it is also important to target drivers through training and publicity and to make parents aware of their key role in improving the safety of their children. In particular, parents are important role models for their children and can inculcate safe behaviour through example, for instance in the use of seat belts and their behaviour as pedestrians.

Ideally, road safety education in the broadest sense starts before the child starts school. Children learn from imitation and observance of adult behaviour. Therefore, it is important for parents to accompany young children and start the process of developing their skills and encouraging safe behaviour in traffic. Parents need support and encouragement in undertaking this role, and programmes such as traffic clubs can enhance child-parent interaction. Parents can also be encouraged through publicity on the safe use of child restraints in vehicles and on the provision and use of bicycle helmets.

Current research on road safety education strongly supports a more behavioural approach for younger children, focusing on development of practical skills either through roadside training for pedestrians or use of computer-based traffic simulations, role playing and classroom activities. Children learn best when an inquiry-based approach that focuses on development of problem-solving and decision-making skills and strategies. Such an approach contrasts with the more traditional abstract, rule-based approach. Practical bicyclist training involving supervised on-road activity has also been shown to be effective.

Although once children start school, the emphasis switches more to school-based activities, parental involvement can be encouraged through participation in practical pedestrian and bicyclist roadside training and in developing school policies on safe routes to school and bicycle helmet wearing. School travel plans and information on travel, particularly when children change schools from primary to secondary level, can make an important contribution by raising levels of risk awareness and increasing parental knowledge.

As children progress through school, continuing integrated road safety education in several curriculum areas has been advocated in preference to occasional talks on road safety or other less integrated approaches.

Approaches for older children include role playing and theatre as part of a programme of discussion, development and follow-up activities. Such programmes should focus on motivation, beliefs and social norms, and how to deal with peer pressure. Well-targeted publicity that raises risk awareness, particularly among young teenagers, can complement school-based education.

Bicycling skills are first learned off-road, but the skills needed to interact safely with traffic are most effectively developed using a supervised problem-solving approach and guided experience, gradually building up to supervised exposure to the road environment. Such courses have been shown to result in sustained improvements in children's bicycling skills and awareness of bicycle safety. Bicycle helmets reduce the severity of head injuries, and many countries have used publicity campaigns targeting both children and parents to promote bicycle helmet wearing.

The need to shift the focus of responsibility for child road safety towards drivers is increasingly recognised. However well children may be educated and trained in road safety skills, they remain less able than adults to use their skills and knowledge consistently. Drivers must be aware of children's abilities, and driver training needs to increase novice drivers' awareness of hazards, particularly where children are concerned.

Publicity campaigns targeting drivers should encourage drivers to behave more safely by raising awareness of how children behave, alerting drivers to their legal responsibilities to protect car occupants and child pedestrians and bicyclists, and highlighting such issues as choice of speed. Publicity is also important in maintaining drivers' awareness of the importance of correct fitting and use of child restraints and seat belts in cars.

Recommendations

- Road safety education should be part of the national education curriculum at all levels from pre-school on, with regular high-quality inputs to develop children's skills, risk awareness, attitudes and knowledge.
- Drivers must be made aware of their responsibilities to their passengers and other road users, and they need to understand the limitations of children's behaviour in traffic. These outcomes can be achieved by effective education, training and publicity.
- There is clear evidence of what works among younger children. Research is now needed on adolescent and young people's road safety education needs.
- The status of road safety education needs to be improved through integration with other disciplines and better evaluation of measures.
- Parents need to be involved more effectively in the delivery of road safety education both informally and formally. Parents must be informed in particular about the safety devices that can protect their children.
- Publicity, when used in conjunction with other measures, is a powerful tool for delivering information and influencing attitudes and behaviour in all areas of road safety, from environmental improvements to changes in legislation to vehicle modifications. It can be used to engage all sectors from policy makers, professionals and businesses to communities and consumers.

Children in the road environment

Helping children and other road users to adapt their behaviour in order to interact safely with traffic in the road environment is only part of what is needed to keep children safe. Traffic engineers, urban designers and planners have a duty to design systems that take account of children's mobility needs, travel behaviour and differences in perceptual and reactive capabilities in order to maximise their safety and mobility. Children cannot be expected to comprehend aspects of the built environment and react to stimuli in the same way as adults.

Safe mobility in the built environment is essential for children's well-being, development and social integration. In addition to on-road safety, children need play spaces with safe access, both as pedestrians and bicyclists. They need to be considered when planning and designing foot paths, bicycle lanes and pedestrian crossing facilities. Planners and

traffic managers need to take account of the function of urban areas, with good accessibility from residential areas to schools, shops, etc.

Children's safe mobility is facilitated if the design of residential areas incorporates traffic calming techniques and low-speed zones such as "green districts" and "home zones" so that walking and bicycling become the dominant modes.

Strategies such as Vision Zero or "durable safe vision" focus on the needs of vulnerable road users by making speed reduction a key objective. Speed limits are set according to the function of roads within a hierarchy, and roads with high pedestrian and bicyclist activity should have designated limits no higher than 30 km/h.

The needs of bicyclists, pedestrians and children are often accorded lower priority than the needs of motorised traffic; information on all modes needs to be collected, not just traffic flows. The whole community, including children, should be consulted and involved in traffic planning decision making, to ensure that the activities and travel needs of all are fully taken into account. "Safe routes to school" is an approach to planning with children in mind that actively involves children.

Although the urban environment is usually the focus of safety engineering for children, rural areas should not be neglected. Lower speeds on small rural roads and availability of foot and bicycle paths are important.

Outside residential areas where low speed limits are less feasible and roads are wider with heavier traffic flows, attention needs to be given to designing safe places to cross the road. Safety should be ensured by use of zebra crossings and signalised intersections, pedestrian islands and school crossing patrols where necessary. For very busy roads, segregation from traffic and provision of well-lit foot bridges and tunnels may be necessary.

Well-designed, well-maintained and safe play spaces with good accessibility are essential for children's development, as they provide stimulating play facilities designed for a range of abilities and ages.

The survey of 21 OECD countries showed that a child-centred approach to the environment distinguished top-performing countries from those that did less well in terms of child safety. Top performers used traffic calming to a greater extent and had a wider range of infrastructure safety measures.

Recommendations

- Designing a road environment that recognises children's capabilities as well as their limitations will benefit all road users, since what constitutes a safe road environment for children will usually be safe for the general public.
- Children should be involved where practicable in the design of the built environment.
- Because features and characteristics of the built environment greatly influence children's movement and range of behaviour, the built environment should be constructed in a way that stimulates children's growth and safe interaction with traffic. Urban design features can be used to support and complement children's safety in the road environment.
- Safety audits should be performed from a child's perspective.
- Traffic calming reduces vehicle speeds and should be advocated as a key measure to improve the overall safety of all road users, particularly children.
- In the development of new educational facilities, consideration should be given to safe access using all travel modes, especially bicycling, walking and use of public transport.
- Maintenance of the road environment, and in particular play spaces, is also important. Failure to repair damage or clear away obstructions often contributes to further deterioration.

Vehicle standards and safety equipment

The third element in an holistic approach to child safety is the design of vehicles and safety equipment such as bicycle helmets. Vehicle standards cover both "primary safety" measures that reduce the risk of a crash occurring and "secondary safety" measures that are designed to prevent or minimise injury in a crash. It is these secondary safety measures that are most likely to be specifically designed to increase child safety.

Restraint systems

The most important measure to protect child occupants of vehicles is the provision and use of suitable child safety restraint systems. Although compulsory seat belt use is a requirement in almost all OECD countries, actual wearing rates vary. Significant reductions in children's fatalities and serious injuries could be achieved if all countries had the high wearing rates of the best performers. Another problem is incorrect use of restraints, either because the restraint is inappropriate for the age of the child, is badly fitted, or incorrectly used. In the United States, it has been calculated that an estimated 458 lives could have been saved in 2002 if all children under 5 years of age had used a child safety seat.

Systems such as ISOFIX, UAS, or LATCH that provide universal fixings for child restraints should be adopted by car manufacturers, and integrated seating systems should be developed.

Vehicle design

Vehicle design should incorporate passive safety systems such as crumple zones, airbags and safety door and window locks. Where airbags are fitted, care has to be taken with the child's seating position as front seat airbags can present a risk to children. In both Europe and North America, parents are advised that infants and young children should not use the front passenger seat especially if an airbag is fitted.

Pedestrians and bicyclists

In recent years attention has been given to improving the safety of pedestrians and bicyclists by designing vehicles that reduce impact in the event of a crash. Such measures, particularly the redesign of car fronts, have significant potential to reduce deaths and injuries to children.

Bicyclist safety is increased by the development of standards for bicycle construction and bicycle helmets. It is most important that bicycle helmets for children fit properly and are comfortable.

Both child pedestrians and bicyclists benefit from conspicuity aids and the use of light-coloured and retroreflective clothing. Dangle tags, armbands, strips on school bags and use of bicycle lamps are all recommended.

School buses

In some OECD countries, notably in North America, children travel to school in specially designed buses. In Europe, while buses may be used for school journeys, either exclusively for children or as part of normal public transport, the buses are not specially designed.

The North American school buses use a passive safety system of compartmentalisation rather than seat belts. School buses also have safety features such as enhanced structural integrity and strict fuel system integrity that increase their crash-worthiness. The windows are designed to reduce the risk of ejection. In countries where such design features are not usually incorporated, the use of seat belts should be required on buses transporting children.

Attention also needs to be paid to the safety of children as pedestrians when boarding or disembarking from buses. Various measures such as recognition zones around bus stops, detection and warning systems, and improved mirrors for buses can contribute to safety. School bus drivers should be properly trained.

Recommendations

- Vehicle manufacturers have a role to play in developing improvements for the safety of child occupants. It is recommended that they work with child restraint manufacturers, parents, those responsible for vehicle standards and others to find a balance in terms of responsibility for child safety. Simple, universal designs for child restraint systems that can accommodate the diversity of children with a wide variation in height, age and weight should be encouraged.
- The evidence suggests that combined interventions are effective in improving child passenger restraint use. The recommended interventions include comprehensive legislation and community-wide information and enforcement campaigns, built around the active participation of public safety officials and safety-oriented voluntary organisations.
- Given the evidence supporting the effectiveness of helmets in preventing head and brain injuries, it is recommended that bicyclists be strongly encouraged to use bicycle helmets.
- Further scientific investigation is recommended to study the inter-relationships of legislation, enforcement and outreach programmes in achieving greater bicycling safety through helmet use.
- Designers and manufacturers of children's clothing and accessories are well-positioned to incorporate retroreflective materials into product lines. It is recommended that parents, as well as public health and safety officials encourage them to do so, as one component of an ongoing campaign for protecting children in traffic.
- In view of competing resources and programmes concerning travel to school, it is recommended that school jurisdictions develop and implement risk management policies related to the journey to and from school. Issues of importance to the policy include the use of public transit or dedicated buses, the fitting of seat belts, protective measures for child pedestrians outside the bus, protecting children walking and/or bicycling to school, and public awareness messages and campaigns.
- Protecting children as they use private vehicles, bicycles and buses in traffic is a responsibility shared by all levels of government and many non-governmental organisations, as well as families. It is recommended that strategic partnerships be established and nurtured to create innovative and multidisciplinary approaches to keeping children safe in traffic.

Legislation

The international survey considered the role that legislation can play in improving child safety. A country's range of legislation can give some indication of the political will to address the burden of injury to children. The key areas considered were child safety restraints and seat belts, bicycle helmet use, child bicyclist behaviour, driver responsibility in a crash involving children and compulsory road safety education.

Seat belt legislation is almost universal, but high wearing rates of seat belts and restraints by children were a characteristic of countries surveyed which were high performers in terms of child safety. This is achieved by active promotion of seat belt wearing involving education and publicity as well as enforcement of legislation.

Only eight countries had bicycle helmet wearing legislation but experience indicates, even without legislation, higher wearing rates can be achieved through promotional activities. Some countries have legislation relating to the age at which children can bicycle on the road and their competence.

Less than a third of the countries had legislation that assumes driver responsibility in a crash involving a child pedestrian; the presence of such legislation distinguished these countries from countries that performed less well in terms of pedestrian safety. Such legislation places the burden of proof on the driver, and the presence of such a law may have modified driver behaviour in residential areas and created a more child-centred approach to safety.

Many OECD countries reported compulsory road safety education, but its presence did not distinguish top performers from countries that performed less well. More important seemed to be the approach adopted, and top-performing countries shared a number of initiatives, such as teaching pedestrian skills at the roadside and providing materials and advice for parents.

Road safety policy

Individual measures cannot be considered in isolation and best practice for child safety needs to incorporate a variety of different measures. Most OECD countries have had national plans for reducing children's traffic crashes for at least ten years, but the best-performing countries have adopted a holistic approach. These countries use a wide variety of measures covering speed reduction, promotion of secondary safety measures and publicity aimed at children, their parents and drivers.

Only a minority of countries has specific targets for casualty reduction, but many of these specifically target children. In some countries disadvantaged communities and socially deprived groups may be targeted.

Concluding remarks

This chapter has focused on how children can be kept safe in traffic; the contribution education training and publicity can make; measures related to the risks children face in the road environment; vehicle and bicycle standards and safety equipment and the importance of appropriate legislation.

The chapter has drawn conclusions on best practices able to contribute to reductions in children's transport-related injuries and fatalities. It has also highlighted possible improvements in the key policy and operational areas affecting children's road safety and has made a series of recommendations for road safety policy.

Success in improving safety for children is most likely to be achieved through a holistic approach combining measures to address the behaviour of all road users, to improve the road environment and to design vehicles that better protect both their occupants and those at risk outside the vehicle. Key findings of the report include:

- Road safety education and training is a lifelong learning process that neither begins nor ends in schools. All road users have a duty to keep children safe, and parents have a vital role to play through teaching and example in the early years. Driver training is an integral part of the safety education system, and while children need to know how to behave safely on the roads, drivers need to take more care and to recognise that children will not behave in the same way as adults.
- Road safety education in schools should use approaches based on sound educational practice with an emphasis on problem-solving and practical skills training.
- Publicity needs to target all road users and age groups and to raise awareness of how children will behave in traffic. Publicity should also be aimed at driver behaviour, especially in respect of inappropriate speed.
- Traffic engineers and planners have a duty to take children's needs and abilities into account in designing the built environment.
- More priority needs to be given to vulnerable modes through the use of traffic calming and facilities for walking and bicycling.
- All children should be provided with child restraints in vehicles that are suitable for their age and size, and properly fitted and used.
- Vehicle design should incorporate safety features such as crumple zones, airbags and safety locks for doors and windows that take account of the needs of children. Parents need good advice on the correct use of child restraints and the safest seating positions particularly where airbags are fitted.
- Vehicle designers and legislators on vehicle standards should give more attention to protecting pedestrians and bicyclists as well as vehicle occupants from injury and death.
- Road safety policy should include strategies for improving child safety including specific targets for casualty reduction and monitoring and reviewing the evidence base.

Annex A

CHILDREN'S ROAD TRAFFIC SAFETY: AN INTERNATIONAL SURVEY OF POLICY AND PRACTICE

Introduction

A survey of Children's Road Traffic Safety in OECD countries was commissioned by the UK Department for Transport and undertaken in 2002 and 2003 to complement the report from the OECD's Child Traffic Safety Expert Group. Survey results were reported in 2004.

The aim of the survey was to provide basic high-level data, on a consistent basis, from OECD member countries that identifies and accounts for current patterns of child road safety, and identifies current best practices and counter-measures in place to improve child road safety. There were three key survey elements: an analysis of International Road Traffic and Accident Data (IRTAD) fatality data, an analysis of the relationship between socio-economic and demographic indicators and fatality rates, and a questionnaire-based survey.

Study data

IRTAD data

The report includes league tables based on average fatality rates for each country (that contributes to IRTAD) by mode. Trends over 10 or 20-year periods in child traffic fatalities for each country were also constructed.

National socio-economic and demographic indicator data

An analysis of the relationships between child road traffic fatality rates and national indicators of wealth and income inequalities, social structure and urbanization was undertaken. These factors were included because levels of deprivation, urbanization and population density have been associated with high levels of risk in some countries.

Survey data

The questionnaire survey was conducted among high-level officials from national government transport and public road administrations in each OECD country. Full or partial responses were received from 21 of the 30 OECD countries representing a response rate of 70%. The survey comprised a series of five questionnaires entitled: "Children as Pedestrians", "Children as Bicyclists", "Children as Vehicle Occupants", "Children's Travel" and "Policy on Child Traffic Safety".

Findings

IRTAD analysis

Trends in fatalities by age and mode show improvements in the rate per 100 000 children fatally injured in road traffic accidents across the OECD countries for which we have data. However, we know that the exposure of children as pedestrians, bicyclists and passengers across the countries is not homogeneous and this complicates the task of interpretation. The economic prosperity of countries is strongly related to car ownership and use and this in turn often leads to a reduction in the amount walked and bicycled. This effect may not remain homogeneous because several countries, notably the Netherlands, Sweden, Denmark, Finland, Germany, Switzerland and the United Kingdom have been, or are starting to, actively encourage walking and discourage non-essential car trips in the interest of the environment and children's independent mobility.

National socio-economic and demographic indicators

No clear strong relationships were found between macro socio-economic and demographic indicators and overall fatality rate. Although all of the correlations are relatively weak the strongest ones (showing a moderately strong correlation) are those associated with wealth and economic inequality. There was a negative correlation between Gross Domestic Product (GDP) and child road traffic fatality rate and a positive correlation between income inequality and child road traffic fatality rate.

Children's travel, exposure and risk

An analysis of exposure was undertaken for those countries that could supply comparable travel data, namely Germany, Hungary, the Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom and the United States. The analysis focuses on the 10-14 age group as this was the group for which comparable data were consistently available.

A key finding of the analysis of travel data was the large variation in the travel patterns of 10-14 year olds in different countries. For the percentage of kilometres travelled by mode, the range of values for walking were between 1% (United States) and 9% (Hungary), for bicycling it was between less than 1% (Hungary) and 31% (Netherlands), for car travel it ranged between 34% (Hungary) and 84% (United States), and for public transport values ranged between 2% (United States) and 61% (Hungary). In most countries (except Hungary) the car accounts for at least half of all distance travelled by 10-14 year olds.

To look at risk associated with walking, bicycling and travelling by car the fatality rates per head population for children aged between 10-14 were divided by each exposure variable (kilometres travelled and number of trips) to assess fatality rate per kilometre travelled, or per trip made. This analysis shows that looking at fatality rates per kilometre travelled, or per trip made) alters the assessment of "good" and "less good" performance. In particular, for walking and car use, it seems to suggest that the countries could be separated into two groups representing good and less good performers, rather than a graduated league (although the league is not entirely misleading as an ordering mechanism). For bicycling, the situation is very different. Inclusion of exposure entirely alters which countries can be classed as 'good' and 'less good'. In particular, countries with low levels of bicycling are generally relatively unsafe for bicyclists.

Accompaniment

Adult accompaniment of all children aged 0-5 was a shared characteristic of the overall top five performers, namely Sweden, United Kingdom, Norway, Netherlands and Germany, but this did not distinguish them from the majority of countries performing less well because nearly all countries reported that all children between 0-5 were accompanied by an adult. Adult accompaniment of many children aged 6-9 was a shared characteristic of the top five performers, namely Sweden, United Kingdom, Norway, Netherlands and Germany, and this distinguished them from the majority of countries performing less well.

Children as pedestrians

The top five performers in the child pedestrian league are Sweden, the Netherlands, Finland, Germany and Denmark.

Pedestrians: identifying risk

The identification of high-risk groups of pedestrians was not a shared characteristic of the top five performers and therefore did not distinguish them from other countries performing less well. Fewer than half of participating countries said that they had identified high-risk groups of pedestrians. A number of cross-cutting themes emerged; these were the high risks associated with low socio-economic and ethnic minority groups, boys, young children and urban areas.

Pedestrians: infrastructure safety measures

The range and extent of infrastructure safety measures for pedestrians was a shared characteristic of the top five performers, namely Denmark, Finland, Germany, Netherlands and Sweden, and this distinguished them from the majority of countries performing less well. As a group, the majority of top five performers reported that they had a ***range*** of speed reductions measures including environmental modifications (such as road humps), low speed limits (30-40kph) and signalised and non-signalised pedestrian crossings in ***most*** municipalities or local authority areas**.** In particular, the top five performers also reported to have speed reduction measures and low speed limits outside many schools. The provision of outside play areas such parks or play grounds in ***most*** residential areas was a shared characteristic of four of the top five performers, namely Denmark, Finland, Germany and Sweden, and this distinguished them from other countries performing less well.

Pedestrians: education and training

The promotion of child pedestrian education and training initiatives nationally or in most states was a shared characteristic of four of the top five performers, namely Denmark, Finland, Germany, and the Netherlands, but this did not distinguish them from other countries performing less well because most also shared this approach. Most (15) participating countries reported that there are education and training initiatives nationally or in most areas.

Having compulsory road safety education for children aged between 6-9 years nationally or in most states was a shared characteristic of four of the top five performers, Denmark, Finland, Germany, and the Netherlands, but this did not distinguish them from other countries performing less well because most shared this approach.

Pedestrians: national and regional publicity

Conducting national road safety campaigns once a year or more was a shared characteristic of three of the top five performers, namely Denmark, Finland and the Netherlands, and this distinguished them from other countries performing less well. Overall only half (10) of the countries had supported national publicity in the last five years. Conducting regional publicity campaigns for child pedestrians was a shared characteristic of four of the top five performers, namely Denmark, Finland, Germany and the Netherlands, but this did not distinguish them from other countries performing less well because most shared this approach.

Pedestrians: legislation and behaviour

The presence of legislation that assumes driver responsibility in an accident involving a child pedestrian was a shared characteristic of three of the top five performers, and distinguished them from other countries performing less well.

Children as bicyclists

It is very difficult to interpret survey findings for bicyclists because for most countries the levels of bicycling activity are very low. In addition, the inclusion of exposure entirely alters which countries can be classed as 'good' and 'less good'. In particular, whilst the Netherlands appears to perform poorly on the basis of population based fatality rates when exposure is taken into account they are one of the best performers. Moreover, when exposure is taken into account countries with low levels of bicycling are generally relatively less safe for bicyclists. Whilst the ordering mechanism based on population rates is used in the bicycling Chapter, exposure rates are also shown for those countries that were able to provide travel data. In interpreting these findings care has been taken not to emphasise differences between good and less good performers.

Bicyclists: identifying risk

Less than half of participating countries said that they had identified high-risk groups of bicyclists. A number of cross cutting themes emerged; these were the high risks associated with low socio-economic group and ethnic minority groups boys (especially aged 10-14) and young children.

Bicyclists: infrastructure safety measures

Just over half (10) of the participating countries said that they had bicycle lanes separate from other traffic in most or many areas. Just under half reported bicycle lanes shared with other vehicles in ***most*** or ***many*** areas and few countries reported having special measures for bicyclists such as advanced stop lines or priority at traffic lights. The inclusion of exposure information shows that the Netherlands, whilst having the highest population-based fatality rate has one of the lowest exposure-based fatality rates and is one of the few countries that provides an extensive infrastructure for bicyclists.

Bicyclists: education and training

Just over half of the participating countries (10) reported that there are education and training initiatives ***nationally*** or in ***most*** states. A minority of countries including Sweden, Turkey and Switzerland reported that they did not promote any bicyclist safety education or training initiatives. Just over half (10) of the participating countries reported

that child bicyclist safety education was compulsory in most or many areas. This activity was more frequently reported for the 6 + age group.

Bicyclists: national and regional publicity

Just over half (10) of participating countries had run national publicity in the past five years, though two federal countries reported conducting regional publicity. Overall, 12 countries had conducted regional publicity campaigns.

Bicyclists: legislation and behaviour

Only nine countries had bicycle helmet wearing legislation nationally or in some states. The enforcement of this helmet wearing law was mostly described as weak or variable. Notably, Norway and Sweden report high national rates of helmet wearing without legislation reporting rates of 63% and 80% respectively. Higher helmet wearing rates were reported for children under the age of 12 with rates dropping off substantially for teenagers with the exception of New Zealand, who have compulsory helmet wearing, where high rates for all children aged between 5-18 were reported. Interestingly, most countries that reported reasonably high helmet wearing rates including Norway, Sweden, New Zealand and Finland were the only countries that reported that ***most*** or ***many*** schools had policies on wearing bicycle helmets.

Children as vehicle occupants

The top five performers in the child vehicle occupant league are Switzerland, United Kingdom, Netherlands, Sweden and Norway.

Vehicle occupants: identifying risk

The identification of high-risk groups of vehicle occupants was a shared characteristic of three of the top five performers, namely the United Kingdom, Netherlands and Sweden, but this did not distinguish them from other countries performing less well. Under half (9) of the participating countries said that they had identified high-risk groups of vehicle occupants. A number of cross-cutting themes emerged these were the high risks associated with low socio-economic and ethnic minority groups and rural areas

Vehicle occupants: education and training

The promotion of child car passenger education and training initiatives nationally or in most states was a shared characteristic of four of the top five performers, namely the Netherlands, Norway, Sweden and the United Kingdom, but this did not distinguish them from other countries performing less well because most shared this approach. Having compulsory car passenger safety education for children was not a shared characteristic of the top five performers. Just under half (10) of the participating countries reported that child car passenger safety education was compulsory nationally or in most states. This activity was more frequently reported for the 6+ age group.

Vehicle occupants: national and regional publicity

Conducting national road safety campaigns in the last five years was a shared characteristic of three of the top five performers and was reported by the Netherlands, Norway and the United Kingdom, but this did not distinguish them from other countries performing less well. Most (16) of the participating countries had run national publicity in

the past five years, though two participating federal countries reported conducting regional publicity.

Vehicle occupants: legislation and behaviour

All countries had some form of seat belt legislation for vehicle occupants travelling in private vehicles. Most countries provide national data on seat belt wearing rates. High seat belt wearing rates (around 90% or higher) in the front and rear of private vehicles was a shared characteristic of the all top five performers and this distinguished them from the majority of countries performing less well. A number of general patterns emerged. Lower rates of seat belt use were reported in the back of the car compared to the front and among children aged over five compared to children under 5. Most countries describe the enforcement of seat belt wearing as weak or variable. Only one of the top performers, Norway reported strong enforcement. The presence of legislation for seat belt wearing on school buses was a shared characteristic of three of the top five performers, namely Sweden, Switzerland and the Netherlands, and distinguished them from the majority of countries performing less well.

Policy on children's traffic safety

The following analysis is based on overall child traffic fatality rate. The top five performers are Sweden, United Kingdom, Norway, Netherlands and Germany.

Ministries responsible for children's traffic safety

Having shared responsibility for children's traffic safety by two or more ministries with a responsibility for child traffic safety was a shared characteristic of four of the overall top five performers, namely Germany, the Netherlands, Norway and Sweden, but this did not distinguish them from other countries performing less well because most shared this approach.

Agencies responsible for implementing children's traffic safety

Implementing children's traffic safety through a number of agencies including police, schools, local authorities, voluntary agencies and non-government organisations was a shared characteristic of the overall top performers but this did not distinguish them from other countries performing less well.

National plans

Having national plans for reducing children traffic accidents for more than 10 years was a shared characteristic of the overall top five performers, namely Sweden, the United Kingdom, Norway and Germany, but this did not distinguish them from other countries performing less well because most shared this approach. Having implementation plans comprising measures targeted at speed reduction measures, low speed limits, infrastructure, publicity aimed at both the children and drivers and safety equipment were shared characteristics of four of the overall top five performers, namely Sweden, the United Kingdom, Norway and Germany.

Planning guidance for children's traffic safety

Having advisory environmental planning guidance for the safety, security and freedom of movement of children was a shared characteristic of the overall top five performers, namely Sweden, the United Kingdom, Norway and the Netherlands, and this distinguished them from other countries performing less well. Children are rarely involved in the planning process.

Policies on increasing walking and bicycling

Having policies on increasing walking and bicycling among children was a shared characteristic of all of the overall top five performers but this did not distinguish them from other countries performing less well because most shared this approach. The key reasons given for these policies were to reducing car travel and improve health.

Initiatives

The report includes appendices that contain details of road safety initiatives that focus on pedestrian, bicyclist and vehicle occupant safety and on travel and policy initiatives.

Conclusions

This study represents a systematic attempt to examine factors that may have a role in explaining differences in child road traffic fatality rates between countries such as differences in exposure, a country's exposure in terms of demographic and socio-economic indicators, road safety policy and practice, legislation and research. A particular strength of the study is the inclusion of exposure data that shows that it is essential to take into account the amount of walking, bicycling and travelling in cars to really understand whether countries can be classified as good or poor. This is particularly true for bicycling where countries with low levels of bicycling exposure emerge as relatively unsafe.

The study only provides a snapshot of current practice and policy and does not capture how these have evolved. It also clear that it is unlikely that no single policy or intervention will significantly reduce road injuries instead of packages of policies and interventions of a comprehensive nature may be more likely to have an impact on safety.

However, there are a number of characteristics that seem to distinguish the top performers from countries performing less well.

In relation to children as *pedestrians,* top performers:

- Have speed reduction measures (including environmental modification and low speed limits) and signalised crossings in *most* local authorities or municipalities.
- Have these measures outside *many* schools.
- Have outside play areas such as parks or playgrounds in *most* residential areas.
- Conduct national publicity campaigns aimed at child pedestrian safety.

In relation to children as *bicyclists,* our conclusions about top performers are limited, for reasons given earlier in the discussion related to exposure to bicycling.

In relation to children as *vehicle occupants*, top performers:

- Have compulsory seat belt wearing on school buses.
- Measure seat belt wearing rates.
- Achieve high seat belt wearing rates (around 90% or higher) in the front or rear of private vehicles.

In relation to *policy on children's travel*, top performers have the following characteristic:

- Many children aged 6-9 are accompanied by adults whilst travelling.

In relation to *policy on children's traffic safety*, top performers have the following characteristic:

- They have advisory environmental planning guidance for the safety, security and freedom of movement of children.

It is hoped that the study will provide a focus of international action especially in relation to sharing good practice and developing standardised methods of collecting data. This study could serve as a tool for baseline measures to monitor the impact of evolving policy and practice across OECD countries to extend our understanding of the processes that lead to improving children's road safety.

Annex B

MEMBERS OF THE OECD WORKING GROUP ON REDUCING CHILDREN'S TRANSPORT-RELATED INJURIES AND FATALITIES

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