1

The need for seat-belts and child restraints

THIS MODULE provides the user with background material on why seat-belts and child restraints are needed. Such information is important in persuading political leaders and the public to support seat-belt programmes and policies and in increasing overall restraint use by drivers and passengers around the world.

The sections in this module are structured as follows:

1.1 Road traffic death and injury as a worldwide public health problem. The module begins by describing the magnitude of the problem of motor vehicle crashes, and the resulting injuries that are sustained by occupants. It explains the global distribution of the problem, noting that if present trends continue, many low- and middle-income countries are likely to experience an increase in the number of crashes in the near future as the level of motorization increases.

1.2 How seat-belts and child restraints prevent or minimize injury. This section describes how seat-belts and child restraints protect vehicle occupants and reduce the impact of a collision.

1.3 Recommended types of seat-belts and child restraints. The various types of seat-belts and restraints are described in this section.

1.4 Effectiveness of seat-belt and child restraint use in preventing death and reducing injury. This section presents evidence from studies that have evaluated the effectiveness of seat-belts and child restraints in reducing death and injury.

1.5 Effectiveness of seat-belt and child restraint programmes at increasing wearing rates by vehicle occupants. This section shows how legislation on compulsory seat-belt use coupled with supportive programmes and enforcement have been effective in increasing wearing rates.

1.1 Road traffic death and injury as a worldwide public health problem

1.1.1 Worldwide trends in road traffic death and injury

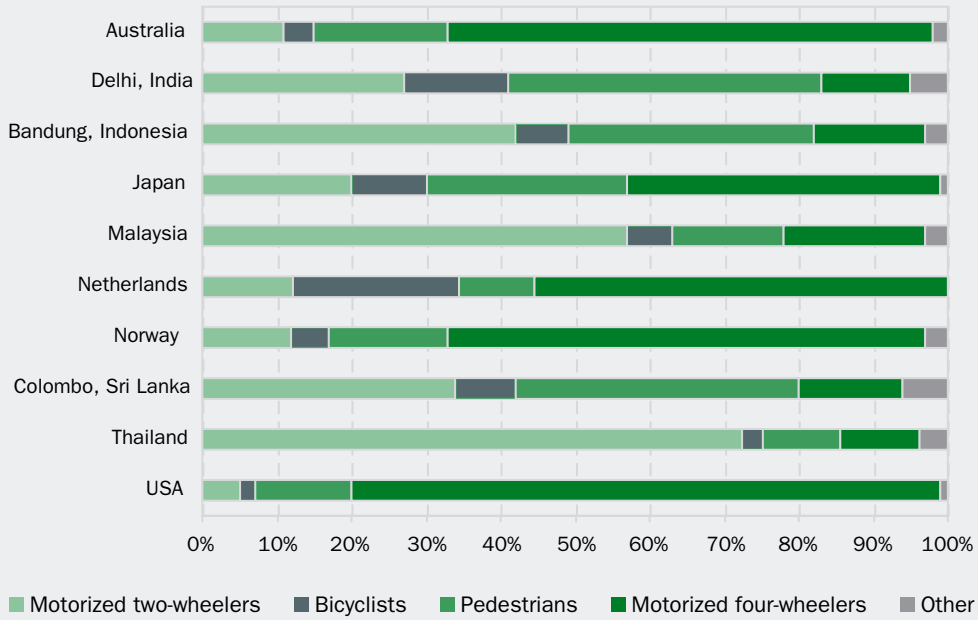
Road traffic injuries are a major public health problem and a leading cause of death and injury around the world. Approximately 1.2 million people are killed each year in road crashes worldwide, with up to 50 million more injured. Over 95% of these deaths and injuries occur in the low- and middle-income countries of Africa, Asia, Latin America, the Caribbean and Eastern Europe (*1*).

Although the global trends in road traffic fatalities over the past 20–30 years have shown an overall increase, the situation varies considerably between different regions of the world. In the high-income countries of North America, Western Europe and

Japan, road deaths fell by approximately 20% between 1980 and 2000. In contrast, over the same period road deaths increased in low- and middle-income countries by between 50% and 100%. Data suggest that these trends will continue and that by 2020 road traffic deaths will increase by 83% in low- and middle-income countries, and decrease by 27% in high-income countries. These figures amount to a predicted global increase of 67% by 2020 (*1*).

The extent to which different road users are affected by road traffic injuries also differs between countries. The distribution of those killed in various modes of transport in different countries is shown in Figure 1.1. Of those killed on the roads in high-income countries, the majority are drivers and passengers in cars (*2*). The data in Figure 1.1 show that vehicle occupants account for as much as 80% of all road traffic deaths in the United States of America, but only 10–20% in countries in South-East Asia, where two-wheeler motorized traffic predominates. However, although in low- and middle-income countries car occupants do not comprise the majority of fatalities on the road, experience from high-income countries suggests that as car ownership rises so too will the number of vehicle occupant deaths and injuries. Experience from rapidly motorizing nations to date concurs with these trends: for example, in 2003 more than 12 000 new cars were registered every day in China, while in Viet Nam official sources report that 600 new cars are being registered every day (*3*). The use of seat-belts and child restraints could prevent many of these deaths and serious injuries that occur among four-wheeled vehicle occupants.

Figure 1.1 Road users killed in various modes of transport as a proportion of all road traffic deaths



Adapted from reference 1

1.1.2 Types of injuries sustained by vehicle occupants

There are three "collisions" that occur in every crash where occupants are unrestrained. The **first collision** involves the vehicle and another object, e.g. another vehicle(s), a stationary object (tree, signpost, ditch) or a human or animal. The **second collision** occurs between the unbelted occupant and the vehicle interior, e.g. the driver hits his chest on the steering wheel or his head on the window. Finally, the **third collision** occurs when the internal organs of the body hit against the chest wall or the skeletal structure. It is the second collision that is most responsible for injuries, and can be reduced significantly by the use of seat-belts and child restraints.

The most frequent and most serious injuries occurring in frontal impacts to occupants unrestrained by seat-belts are to the head, followed in importance by the chest and then the abdomen. Among disabling injuries, those to the leg and neck occur most frequently (*4, 5*).

NOTE

Norway study of head injuries

A study in Norway calculated that head injuries make up some 60% of all injuries to vehicle occupants. The study concluded that drivers and front seat passengers who do not use seat-belts suffer almost the same percentage of head injuries as non-users in rear seats (*6*).

Failure to use a seat-belt is a major risk factor for road traffic deaths and injuries among vehicle occupants. Passengers who were not wearing their seat-belts at the time of a collision account for the majority of occupant road traffic fatalities. In addition, passengers who do not wear seat-belts and have a frontal crash are most likely to suffer a head injury.

Although of paramount concern, there is more than just the human suffering associated with non-use of seat-belts. The financial burden of increased death and injury severity can have a major impact on the finances of the government and local communities who are paying for the resources that are required to deal with road crash victims and their families in the aftermath of a crash.

1.2 How seat-belts and child restraints prevent or minimize injury

This section describes what happens during a motor vehicle crash and how seat-belts and child restraints prevent or reduce the severity of injuries sustained.

1.2.1 What happens in a crash?

When a crash occurs, a car occupant without a seat-belt will continue to move at the same speed at which the vehicle was travelling before the collision and will be catapulted forward into the structure of the vehicle – most likely into the steering wheel if they are driving, or into the back of the front seats if they are rear seat passengers. Alternatively, they can be ejected from the vehicle completely. Being ejected from a vehicle drastically increases the probability of sustaining severe serious personal injury or being killed (*7*).

Seat-belts as a protection against ejection

The American College of Emergency Physicians advocates the use of seat-belts as the best protection against ejection in a crash. Ejection from a vehicle is one of the most injurious events that can happen to a person in a crash, with 75% of all vehicle occupants ejected from a vehicle in a crash dying as a result. Seat-belts are effective in preventing ejections: overall, 44% of unrestrained passenger vehicle occupants killed are ejected, partially or totally, from the vehicle, as compared to only 5% of restrained occupants (*8, 9*).

The use of seat-belts and child restraints is one of the most important actions that can be taken to prevent injury in a motor vehicle crash. While seat-belts and child restraints do not prevent crashes from taking place, they play a major role in reducing the severity of injury to vehicle occupants involved in a collision. An occupant's chance of survival increases dramatically when appropriately restrained.

1.2.2 How a seat-belt works

Seat-belts and child restraints are **secondary** safety devices and are primarily designed to prevent or minimize injury to a vehicle occupant when a crash has occurred. Seat-belts and child restraints thus:

- reduce the risk of contact with the interior of the vehicle or reduce the severity of injuries if this occurs;
- distribute the forces of a crash over the strongest parts of the human body;
- prevent the occupant from being ejected from the vehicle in an impact;
- prevent injury to other occupants (for example in a frontal crash, unbelted rear-seated passengers can be catapulted forward and hit other occupants).

A belted occupant will be kept in their seat and thus will reduce speed at the same rate as the car, so that the mechanical energy to which the body is exposed will be greatly reduced.

1.2.3 How a child restraint works

(Richard Stanley/FIA Foundation)

Infants and children need a child restraint system that accommodates their size and weight, and can adapt to cope with the different stages of their development.

The three-point lap and diagonal seat-belt used by adults is not designed for children's varying sizes, weights, and the different relative proportions of children's bodies. For example, a smaller portion of a child's abdomen is

covered by the pelvis and rib cage, while a child's ribs are more likely than an adult's to bend rather than break, resulting in energy from a collision being transferred to the heart and lungs (*10*). Consequently three-point lap and diagonal seat-belts may lead to abdominal injuries among children, and will not be optimally effective at preventing ejection and injury among them.

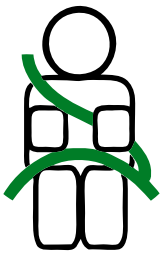
Appropriate child restraint systems are specifically designed to protect infants and young children from injury during a collision or a sudden stop by restraining their movement away from the vehicle structure and distributing the forces of a crash over the strongest parts of the body, with minimum damage to the soft tissues. Child restraints are also effective in reducing injuries that can occur during non-crash events, such as a sudden stop, a swerving evasive manoeuvre or a door opening during vehicle movement (*11*).

1.3 Recommended types of seat-belts and child restraints

1.3.1 Seat-belt design

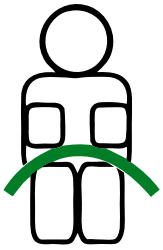
This section describes the main elements of seat-belt design. Seat-belt designs should comply with national or international standards (covered in Module 3 of the manual). Designs that ensure ease of use will serve to increase wearing rates.

The three-point lap and diagonal seat-belt is the safest and most commonly used in cars, vans, minibuses, trucks and the driver's seat of buses and coaches, while the two-point lap belt is most commonly used in buses and coaches. Seat-belt standards set out requirements for the width of webbing and buckles, and the ease of operation and adjustment. In more recent years seat-belts have become integrated into overall vehicle safety systems that include such devices as pretensioners, load limiters and airbags.



Three-point lap and diagonal seat-belt

Rated highly for effectiveness and ease of use, the three-point lap and diagonal seat-belt is the most commonly used in cars, vans, minibuses and trucks and in the driver's seat of buses and coaches. The seat-belt tongue clips into the buckle, which in the front seats of cars is usually placed on the end of a stiff stalk or directly attached to the seat. A retractor device is included as part of the belt system as this ensures unnecessary slack is taken up automatically. This system allows the occupant to connect the tongue and buckle using one hand, preventing ejection after maintaining the seating position of the occupant.



Two-point lap belt

A two-point lap belt (sometimes called a "single lap belt") using a retractor device is inferior to the three-point lap and diagonal seat-belt described above but can be sufficient to maintain the seating position of the occupant, particularly in coaches or buses.

Crash studies have shown that although the lap belt does fulfil the task of reducing ejection, it fails to prevent the occupant's head and upper body moving forward and hitting the vehicle interior. For the driver, this could result in serious head injuries from contact with the steering wheel. However, because of the size and mass of coaches, the severity of injury when involved in a collision with another vehicle is often minor compared to that other vehicle if it is a car or van.

Single diagonal belt

The single diagonal design does provide better restraint for the upper body of the wearer than the two-point lap belt, but has been shown to be poorer at preventing ejection and submarining (slipping under the seat-belt).

Full harness

The full harness (double shoulder, lap and thigh straps with central buckle device) gives very good protection both from ejection and from interior contact. However, it is somewhat cumbersome to put on, and cannot be easily operated with one hand. This is an important factor in achieving a high wearing rate, and thus the harness only tends to be installed in vehicles used for motor sport, where drivers and co-drivers are at high risk.

1.3.2 Types of child restraints

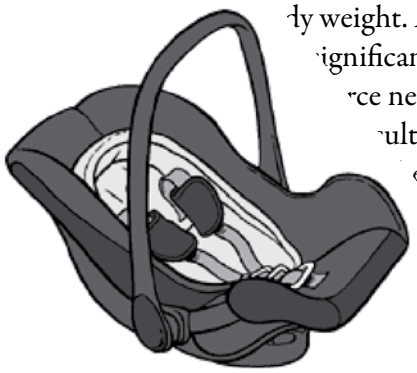
The safest place for children aged 12 years and under is in the back seat, properly restrained in an approved child safety seat. Specially manufactured child restraints should be used for children. There are a number of different types of restraints. The main determining factor for choice of a child restraint is the child's weight (Table 1.1). Older children who are above the height and weight specifications for using child restraints require a properly fitting three-point lap and diagonal seat-belt when riding in a vehicle.

Table 1.1 Weight categories of child restraints

Group	Description
0	For children of a mass less than 10 kg
0+	For children of a mass less than 13 kg
I	For children of a mass from 9 kg to 18 kg
II	For children of a mass from 15 kg to 25 kg
III	For children of a mass from 22 kg to 36 kg

Infants under the age of 1 year (Group 0 or 0+)

At birth, the infant head is around a quarter of their total length and about a third
ly weight. An infant's skull is very flexible, so a relatively small impact
ignificant deformation of the skull and brain. The smaller the child,
ce needed for injury. The infant rib cage is also very flexible. Impact
ult in a large compression of the chest wall onto the heart and
e abdominal organs. The infant pelvis is unstable and cannot
om an adult restraint system. Infants require their own special
them in a crash, and provide protection from many types of
eats are convertible; that is, they can revert to a full child safety
older.



A rear-facing child restraint system (sometimes called an "infant car seat") provides the best protection for infants until they are both 1 year of age and at least 13 kilograms (kg) weight. For the best protection, infants should be kept rear facing for as long as possible. The safest place for infants is in the back seat in an approved rear-facing infant car seat.

Children aged 1–4 years (Group I)

The bone-forming process is not complete until the age of 6 or 7 years, and throughout childhood a child's skull remains less strong than that of an adult. A restraint system needs to limit forward head movement in a frontal impact and provide protection from intrusion in a side impact. A child restraint should therefore distribute the crash forces over as wide an area as possible. Belts and harnesses need to fit well and be properly positioned as designed by the manufacturer. The restraint system should also provide protection from contact with the vehicle interior in both front and side impacts.

The best type of child restraint for young children is the child safety seat. The integral harness secures the child and spreads the crash forces over a wide area. This seat will last them until either their weight exceeds 18 kg or they grow too tall for the height of the adjustable harness.

Children aged 4–6 years (Group II)

e best used only when a child has outgrown a safety seat. They are ights from 15 kg to 25 kg. Children should continue to ride in a il the lap and diagonal belts in the car fit properly, typically when imately 145 centimetres (cm) tall (*12*). Booster seats raise the seating child so that the adult seat-belt lies properly across the chest, crossing e child's shoulder rather than the neck, and low across the pelvis. If too high across the stomach, in a crash serious internal injury could ild could submarine under the seat-belt. The booster seat has a back some protection in a side impact.

6–11 years (Group III)

Booster cushions without backs are designed for weights from 22 kg to 36 kg, but manufacturers are now producing booster cushions with backs that cover the full 15 kg to 36 kg range. Shield booster seats, which have a plastic shield in front of the child, offer less protection and should not be used. Booster seats for children aged 4–7 years have been shown to reduce injury risk by 59% compared to seat-belts alone (*13*).

Recent research suggests that children whose restraints are placed in the centre rear seating position incur less injuries than those placed on the outer seats, although this is in contrast to some earlier research that found that the centre seat was not a

tion (*14, 15*). It should also be noted that although children are best ecured in age-appropriate child restraints, if such restraints are not l better to use an adult seat-belt on the child than leave the child he back seat (*16, 17*).

estraint systems

Currently, most child restraint systems are designed to be installed using the vehicle's seat-belt. ISOFIX is a system that uses purpose-designed mounting points provided in the vehicle to attach the child restraint with a rigid mechanism, rather than using the seat-belt to secure the restraint (*18*). ISOFIX is increasingly used in Australia and in Europe, and similar systems have been adopted in the United States (LATCH) and in Canada (UAS).

1.4 Effectiveness of seat-belt and child restraint use in preventing death and reducing injury

1.4.1 Effectiveness of seat-belts

Since the 1960s studies conducted throughout the world have shown conclusively that seat-belts save lives, when worn and fitted correctly. A review of research on the effectiveness of seat-belts found that their use reduces the probability of being killed by 40–50% for drivers and front seat passengers and by about 25% for passengers in rear seats (Table 1.2) (*7*). The impact on serious injuries is almost as great, while the effect on slight injuries is smaller at 20–30%. More detailed analyses indicate that seat-belts are most effective in frontal impacts and in run-off-the-road crashes, where the probability of being ejected is high if seat-belts are not worn (*19*).

Table 1.2 Effect of seat-belts on the probability of personal injury in all types of collisions (individual effects)

Injury severity	Percentage change in number of injuries	
	Best estimate	95% confidence interval
Drivers of light vehicles (private cars and vans)		
Killed	–50	(–55; –45)
Serious injuries	–45	(–50; –40)
Minor injuries	–25	(–30; –20)
All personal injuries	–28	(–33; –23)
Front seat passengers in light vehicles (private cars and vans)		
Killed	–45	(–55; –25)
Serious injuries	–45	(–60; –30)
Minor injuries	–20	(–25; –15)
All personal injuries	–23	(–29; –17)
Back seat passengers in light vehicles (private cars)		
Killed	–25	(–35; –15)
Serious injuries	–25	(–40; –10)
Minor injuries	–20	(–35; –5)
All personal injuries	–21	(–36; –6)

Source: Adapted from Table 4.12.1 in reference 7.

The actions of rear seat passengers can affect both injuries that they themselves might incur and those that may be sustained by the driver or front seat passenger. An unrestrained rear seat passenger poses a serious threat to any restrained person seated directly ahead of them (*20*). Thus the use of seat-belts by rear seat passengers could not only reduce the likelihood and severity of injury to themselves, but also to drivers and front seat passengers.

NOTE

Seat-belts and crash fatality rates

Seat-belts are approximately 50% effective in preventing fatalities in crashes in which motorists would otherwise die. It is estimated that seat-belt use prevented about 15 200 deaths in the United States in 2004. If all passenger vehicle occupants over 4 years of age in the United States had used seat-belts in 2004, nearly 21 000 lives could have been saved (that is, an additional 5800 lives) (*21*).

NOTE

Cost savings through seat-belt use

Between 1975 and 2000, the United States saved US$ 588 billion in casualty costs due to seat-belt use. The annual savings have increased significantly as seat-belt wearing has increased among vehicle occupants. For example, the annual economic saving due to seat-belt use in 1975 was US$ 1.5 million. By 2000, that figure had risen to US$ 49.9 million. However, road death and injury from non-use of seat-belts still costs American society an estimated US$ 26 billion annually in medical care, lost productivity and other injury-related costs (*8*).

BOX 1.1: **Airbags, seat-belts and child restraints**

Airbags are a supplemental restraint system, designed to add additional protection to seat-belts in (primarily) frontal crashes over 13 kilometres per hour (km/h). While airbags have saved many lives, there have also been deaths attributed to airbags deploying in crashes that would not have been life threatening.

Analysis of deaths involving airbags in the United States showed that nearly all of the people who have died from airbag-related injuries were either unrestrained or improperly restrained (*22*). Most of the deaths have been to children and adults of small stature. Airbags are a passive restraint system, deploying automatically in some types of crashes. If an occupant is unrestrained, or the vehicle has an airbag installed but no seat-belt, it is possible that the occupant may come into contact with the airbag before it has fully inflated. This is also the case for people who need to sit closer to the steering wheel as a result of their size. Airbags deploy at approximately 300 km/h. Therefore, vehicle occupants should ensure that they are restrained regardless of whether or not a vehicle has an airbag installed.

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Manufacturers should be aware of the potentially dangerous implications of installing an airbag without also fitting a seat-belt, and parents should never position a child in an infant or child safety seat in front of an airbag. Some vehicles have been equipped with an airbag on/off switch requiring the driver to vigilantly monitor the airbag status to ensure maximum protection for passengers. More recently, manufacturers have designed "second-generation" or "smart" airbags that use sensors to detect when and at what speed to deploy, based on crash configurations and occupant characteristics. The safest way to ensure that children under 12 years of age are not injured by an airbag is to restrain them in a rear seat. Drivers should sit at least 25 cm from the steering wheel, and be properly restrained to minimize contact with the airbag if it deploys. The airbag must be reinstalled following each airbag deployment.

BOX 1.2: **The trauma care cost of not wearing a seat-belt**

Data from the North Carolina Trauma Registry were analysed to determine the effect of seat-belt usage on outcome in motor vehicle accidents. Of 6237 persons involved in motor vehicle accidents, data on seat-belt usage were available for 3396. Of these, 1480 were wearing seat-belts and 1916 were not. Comparison of hospital charges and outcomes for the belted and unbelted patients showed that seat-belts could have saved at least 74 lives and US$ 7.2 million. There were 135 deaths among the unbelted patients (7.0%) and 47 deaths among the belted patients (3.2%). Head injury was more common and more severe in unbelted drivers. This is important because head injury is a major factor in mortality. Seat-belt usage is associated with a significant decrease in mortality rate, hospital charges, length of stay, intensive care unit stay and ventilator requirements (*23*).

1.4.2 Effectiveness of child restraints

Like adult seat-belts, child restraints in cars are intended to keep a child firmly secured in their seat so that in the event of sudden braking or collision the child is not thrown against the car interior or ejected from the vehicle. The restraint must absorb kinetic energy (created by the motion of the child during the crash) without itself injuring the child and must be easy to use.

A review of the effectiveness of child restraints compared the risk of injury to children in different seating positions in cars (*7*). Children who sit in the rear without child restraints have around 25% lower risk of being injured than children who sit in the front without restraints. For children using restraints in both seating positions the risk in the rear is 15% lower than in the front (Table 1.3).

Table 1.3 Effects of child restraints in cars on child's risk of injury as a passenger

	Percentage change in risk of injury	
Type of restraint used	Best estimate	95% confidence interval
Restraining children aged 0–4 years in a forward-facing child restraint	–50	(–70; –30)
Restraining children aged 0–4 years in a rear-facing child restraint	–80	(–90; –70)
Restraining children aged 0–4 years with a seat-belt only	–32	(–35; –29)
Restraining children aged 5–9 years in appropriate child restraint with seat-belt	–52	(–69; –27)
Restraining children aged 5–9 years using seat-belt only	–19	(–29; –7)

Source: Adapted from Table 4.13.2 in reference 7.

The effect of child restraints varies depending on the type of restraint used. A child up to 4 years of age has a 50% lower risk of injury in a forward-facing child restraint and 80% lower in a rear-facing seat. This compares with injury reduction of only 32% when an adult seat-belt is worn (*7*).

For children aged 5–9 years, child restraints reduce injury by 52%, whereas for seat-belts alone the reduction is only 19%. For older children aged 10–14 years seat-belts reduce injury by 46%.

NOTE

Promoting booster seat use

A systematic review of interventions to promote booster seat use by children aged 4–8 years showed that combining financial incentives or distribution of free booster seats with education demonstrated marked beneficial outcomes for acquisition and use (*24*).

A review of various United States studies has shown that child safety seats that are correctly installed and used for children aged 0–4 years can reduce the need for hospitalization by 69% (*25*). The risk of death for infants is reduced by 70%, and that for children aged 1–4 years by 47–54%. Of children aged under 5 years, 485 lives could have been saved in the United States in 2002 if all the children had been in child safety seats (*26*).

It has been estimated in the United Kingdom that new rules on the use of child restraints rather than adult seat-belts for children up to 135 cm in height or aged 12 years and above will save over 2000 child injuries or deaths every year (*27*).

1.4.3 Seat-belt wearing rates

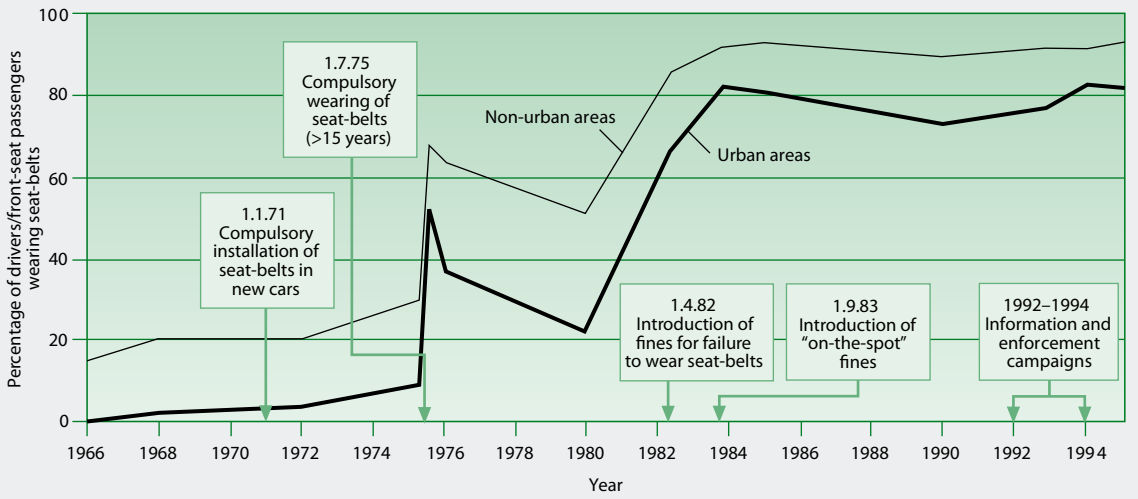
Rates of seat-belt use vary greatly between countries, governed to a large extent by the type of laws that require seat-belts to be fitted in vehicles and cars, and the laws requiring them to be worn. Rates are also dependent on the degree to which these laws are enforced (see Figure 1.2). In many low-income countries there is no requirement for belts to be fitted or used, and rates of use are therefore correspondingly low. In addition there may be cultural norms that negatively influence seat-belt wearing rates, particularly among young adult car occupants.

NOTE

Age and seat-belt use

Compared with older drivers, young drivers and front-seat passengers are less likely than older drivers and passengers to use seat-belts while in a moving vehicle (*28*).

Figure 1.2 Use of seat-belts by car drivers/front-seat passengers in urban and non-urban areas of Finland, 1966–1995



Source: Reference 1.

Table 1.4 shows the wearing rates for selected countries. There is considerable variation in wearing rates, despite legislation on mandatory use in all countries, and rates are generally lower in rear seats than in front seats. For many of these countries there is potential for improvement in wearing rates.

Table 1.4 **Seat-belt wearing rates for selected countries**

Country	Front seat driver %	Front seat passenger %	Rear seat %
Albania	52	27	27
Bulgaria	55	55	n/a
Canada	91	90	80
Costa Rica	82	76	48
Croatia	65	27	8
Czech Republic	61	n/a	13
Denmark	84	n/a	58
Egypt	70	45	n/a
Estonia	73	75	21
Finland	89	89	80
France	88	97	n/a
Germany	93	95	86
Israel	91	88	34
Luxembourg	74	78	60
Malta	99	93	25
Mauritius	94	84	n/a
Netherlands	90	91	69
Norway	85	90	92
Portugal	88	84	25
Slovenia	83	83	40
South Africa	81	50	8
Spain	87	89	52
Switzerland	81	n/a	56
United Kingdom	93	93	83

n/a = not available

Source: UNECE questionnaire and various other published articles (2004).

NOTE

Fatalities and seat-belt use in European Union

Analysis by the European Transport Safety Council estimates that within the European Union seat-belts currently reduce driver fatalities by 40%. Wearing rates in European countries vary widely from around 70% to over 95%. If all European Union countries were to achieve a 99% wearing rate for drivers, 2400 lives would be saved each year (29).

1.4.4 Child restraint use rates

In many high-income countries the use of child restraints is common – with usage rates up to 90% – but in other countries they are still rarely used. Choosing and installing the appropriate child restraint system is important. Even in countries where the use of child restraints is high, such as Sweden, the United Kingdom and the United States, restraints are frequently inappropriately used or misused. For instance, a child may be restrained in the wrong system for its age or weight, or the straps or harnesses may not be adequately secured or entirely left undone, thus placing the child at an increased risk of both fatal and non-fatal injuries (*25*).

Appropriate child restraint use may be limited by access and cost, or simply be impractical because of a large family size. In addition, a number of decisions about what seat to choose, where to place it and how to install it need to be made by parents. A lack of awareness about the benefits of appropriate and correctly used restraints can jeopardize their effectiveness. For instance, a study in Greece found that the majority of parents (88.4%) positioned their children on the back seat unrestrained, while 76.1% of those that did put their child into a restraint did not do this consistently (*30*).

1.5 Effectiveness of seat-belt and child restraint programmes at increasing wearing rates by vehicle occupants

The technical effectiveness of seat-belts and child restraints is well researched and proven. Properly designed and fitted restraints save lives. Once seat-belts have been installed in a vehicle, the next objective is to ensure that the vehicle occupants use them. There are a number of ways that this can be achieved. Laws making seat-belt use compulsory are essential in increasing the wearing of seat-belts in all countries, especially in low- and middle-income countries, where seat-belt wearing rates are low. To ensure that a much higher level of seat-belt wearing is achieved, a comprehensive programme is required (Box 1.3). To be successful, legislation should be preceded by public information campaigns to raise awareness of the benefits of wearing seat-belts and to provide information on the requirements of the law. Strong enforcement, especially in the period immediately after the law is implemented, and continuing publicity and enforcement campaigns are also required, both before enactment and during the initial enforcement period. Although legislation is essential, it will not achieve high wearing rates unless it is part of a comprehensive programme of legislation, enforcement, publicity, incentives and encouragement.

BOX 1.3: **Strategies to bring about increased seat-belt wearing rates**

Seat-belt legislation and enforcement. Introducing and enforcing a mandatory seat-belt law is needed if rates of seat-belt wearing are to be increased and maintained. This usually requires laws ensuring that all passenger vehicles are fitted with appropriate seat-belts, as well as laws requiring that they are worn. In the United States, for example, one of the strongest predictors of seat-belt use among young drivers is a state's seat-belt law. Between 2000 and 2004, rates of seat-belt use were higher and fatality rates lower, in every age group, in all states that enforced a seat-belt law compared to those that did not (*31*).

Ensuring that vehicles are fitted with appropriate seat-belts. Although rules that require all cars to be fitted with seat-belts are now in place in most countries, there is evidence that half or more of all vehicles in low-income countries may lack properly functioning seat-belts (*32*).

Seat-belt public awareness campaigns. Laws mandating seat-belt use should be backed up by public education campaigns. Such campaigns may focus on young people, and can be used both to increase awareness and to help make wearing seat-belts a social norm.

Community-based projects. Community projects can employ parents and peers to encourage young people to wear seat-belts.

It is important to note that most studies that examine the impact of seat-belt laws have been conducted in high-income countries, where legislation when introduced is heavily enforced, and is usually preceded by extensive publicity campaigns. Although it seems very likely that the introduction of seat-belt wearing legislation in low- or middle-income countries will decrease fatality rates among motor vehicle occupants, there are several unknown factors. Availability of suitable seat-belts and child restraints is variable across such countries, and the likely level of enforcement is also a factor that must be considered. Legislation is most likely to work where seat-belts are widely fitted as standard, where enforcement is comprehensive and where there is widespread community education on the benefits of seat-belt use. In low- and middle-income countries where police resources are constrained and community attitudes to seat-belt wearing are not supportive of legislation, effective enforcement requires widespread government support.

NOTE

Enforcement of seat-belt law in Argentina

In Argentina a seat-belt law was introduced in Buenos Aires in 1992 that raised wearing rates for drivers from 6% to 32% but, due to lack of enforcement, rates subsequently declined to 13% by 1995. New laws and campaigns raised the rate to 22% by 2004, but the major gain was made through an enforcement effort that raised the rate to 77% by February 2005. If that wearing rate could be achieved and maintained across Argentina, 1000 lives could be saved each year (*33*).

Programmes that have introduced manufacturing or wearing legislation and delivered a sustained enforcement effort, while using publicity and education to raise awareness and increase compliance, have proven to be successful in raising wearing rates. Table 1.5 highlights the achievements of selected countries.

Table 1.5 Increases in front seat-belt wearing rates in selected countries after the implementation of legislation and campaigns

Country	Wearing rates (%) prior to legislation and campaigns	Wearing rates (%) after legislation and campaigns
Australia	25	95*
Austria	30	70
Costa Rica	24	82
Croatia	50	80
Czech Republic	30	60
Denmark	5	94
Finland	40	93
India	0.5	50*
Japan	37	84
Netherlands	15	86
Norway	10	94
South Africa	33	81*
Spain	25	86
Sweden	20	90
United Kingdom	25	91

* Differs between states.

Mandatory child restraint laws and their enforcement also lead to an increase in the use of child restraints and have been shown to be effective at reducing deaths and injuries among children (*25*). As with seat-belt programmes, successfully increasing child restraint use requires appropriate legislation and enforcement, as well as community-wide information campaigns. As child restraints are not installed within vehicles like seat-belts but must be purchased and fitted by parents it is more challenging to achieve high usage rates, especially in low- and middle-income countries. Module 3 provides more detail on measures to increase child restraint use.

BOX 1.4: **International support for seat-belt wearing**

International recommendations provide strong support for countries to implement programmes that legislate for mandatory seat-belt use. Some countries may use the international policy environment and international law as a means of providing the necessary impetus for developing national policies on seat-belt use. International agreements can also be used by civil societies to advocate seat-belt law reform in their own countries.

The *World report on road traffic injury prevention* recommends that all countries, regardless of their level of income, follow several good practices, including "setting and enforcing laws requiring seat-belts and child restraints for all motor vehicle occupants" (*1*).

In 2004, the World Health Assembly (WHA) adopted resolution WHA57.10, which recommends Member States, "especially developing countries, to make mandatory both provision of seat-belts by automobile manufacturers and wearing of seat-belts by drivers" (*34*).

The WHA resolution is an international agreement that can be used by those wishing to influence policy on seat-belt use as a basis for obtaining political support for this measure. In particular, such a resolution has direct relevance for ministries of health, who, by adopting WHA resolutions, undertake to support the principles enshrined in them.

United Nations General Assembly resolution A/60/5 (2005) "Invites Member States to implement the recommendations of the *World report on road traffic injury prevention* including those related to the five main risk factors, namely the non-use of safety belts and child restraints, the non-use of helmets, drinking and driving, inappropriate and excessive speed, as well as the lack of appropriate infrastructure" (*35*).

United Nations General Assembly resolution A/62/L.43 (2008) repeated the 2005 resolution call for implementation of the *World report on road traffic injury prevention* recommendations.

Summary

The seat-belt is an effective safety tool that not only saves lives, but also significantly reduces the severity of injury that a vehicle occupant may have sustained if they were not wearing the device. Around half of all deaths of front seat occupants could be prevented through the correct use of seat-belts.

Motor vehicle users make up a high proportion of overall traffic injuries and deaths in high-income countries, and in low- and middle-income countries the proportion is growing as motor vehicle ownership is increasing. It is therefore vital that seat-belt use is increased in these countries to prevent a rapid growth in death and injury among vehicle occupants.

Children should use restraints that are suitable for their size. Use of the appropriate type of restraint for a child's age, height, weight and physical limitations reduces deaths of children by between 50% and 75%.

Programmes that set and enforce mandatory seat-belt legislation, combined with public education campaigns, are effective at increasing seat-belt wearing rates and thus reducing injuries and fatalities. Seat-belt laws that are implemented through primary enforcement are more effective in increasing wearing rates than laws implemented through secondary enforcement.

There is strong international support for seat-belt wearing programmes.

References

1. Peden M et al., eds. *World report on road traffic injury prevention*. Geneva, World Health Organization, 2004.
2. *International road traffic and accident database*. Organisation for Economic Co-operation and Development (http://cemt.org/IRTAD/, accessed 5 November 2008).
3. *Turning the tide: injuries and violence prevention in China*. Beijing, China, World Health Organization, 2006 (http://www.wpro.who.int/NR/rdonlyres/05F04193–96CB-4A11–873A-A99CACBB45D3/0/injurychina.pdf, accessed 5 November 2008).
4. Mackay M. The use of seat-belts: some behavioural considerations. *Proceedings of the risk-taking behaviour and traffic safety symposium, 19–22 October 1997*. Washington, DC, National Highway Traffic Safety Administration, 1997:1–14.
5. Hobbs CA, ed. *Priorities for motor vehicle safety design*. Brussels, European Transport Safety Council, 2001.
6. *Restraints for adults and children in the back seat of private cars: an estimation of the effect of alternative regulations*. Report 37A. Nordisk Trafiksikkerhedsrad, 1984.
7. Elvik R, Vaa T, eds. *The handbook of road safety measures.* Elsevier, 2004.
8. *Seat-belts*. Texas, United States, American College of Emergency Physicians (ACEP), 2002 (http://www.acep.org/patients.aspx?LinkIdentifier=id&id=26106&fid=1348&Mo=No&acepTitle=Seat%20Belt%20Fact%20Sheet, accessed 5 November 2008).
9. *The critical need for active ongoing seat-belt use programs in rural areas*. National Highway Traffic Safety Administration, 2006 (http://www.nhtsa.dot.gov/people/injury/airbags/RuralCrashes/pages/CriticalNeed.htm, accessed 5 November 2008).
10. Tingvall C. Children in cars: some aspects of the safety of children as car passengers in road traffic accidents. *Acta Paediatrica Scandanavica,* 1987, Suppl. 339:1–35.
11. Agran PF, Dunkle DE, Winn DG. Motor vehicle childhood injuries caused by noncrash falls and ejections. *Journal of the American Medical Association*, 1985, 253:2530–2533.
12. *Child passenger safety program*. United States Department of Transportation, National Highway Traffic Safety Administration (NHTSA) (http://www.nhtsa.gov/portal/site/nhtsa/menuitem.9f8c7d6359e0e9bbbf3081106000 8a0c/, accessed 5 November 2008).
13. Durbin DR, Elliott MR, Winston FK. Belt-positioning booster seats and reduction in risk of injury among children in vehicle crashes. *Journal of the American Medical Association*, 2003, 289(14):2835–2840.
14. Kallan MJ, Durbin DR, Arbogast KB. Seating patterns and corresponding risk of injury among 0- to 3-year-old children in child safety seats. *Pediatrics*, 2008, 121(5):e1342–e1347.
15. Lund UJ. The effect of seating location on the injury of properly restrained children in child safety seats. *Accident Analysis and Prevention*, 2005, 37(3):435–439.
16. Hertz E. *Revised estimates of child restraint effectiveness.* Research Note. Washington DC, National Highway Traffic Safety Administration, 1996.
17. Johnston C, Rivara FP, Soderberg R. Children in car crashes: analysis of data for injury and use of restraints. *Pediatrics*, 1994:6:960–965.
18. *ISOFIX and passenger safety systems in road vehicles*. International Organization for Standardization (http://www.iso.org/iso/support/faqs/faqs_widely_used_standards/widely_used_standards_other/isofix_and_passenger_safety_systems_in_road_vehicles.htm, accessed 5 November 2008).

19. Evans L. Safety belt effectiveness: the influence of crash severity and selective recruitment. *Accident Analysis and Prevention*, 1996, 28:423–433.

20. Broughton J. *The threat posed by unrestrained rear seat car passengers*. TRL Report 563. Crowthorne, United Kingdom, TRL Ltd, 2003.

21. *The national initiative for increasing safety belt use: Buckle Up America campaign.* Eighth Report to Congress. National Highway Traffic Safety Administration, 2005 (http://www.nhtsa.dot.gov/people/injury/airbags/8thBUAReport/index.htm, accessed 5 November 2008).

22. *Air bags*. Texas, United States, American College of Emergency Physicians (ACEP), 2002 (http://www.acep.org/practres.aspx?LinkIdentifier=id&id=26100&fid=1348&Mo=No&acepTitle=Air%20Bag%20Safety, accessed 5 November 2008).

23. Rutledge R et al. The cost of not wearing seat-belts. *Annals of Surgery*, 1993, 217(2):122–127.

24. Ehiri JE et al. *Interventions for promoting booster seat use in four to eight year olds traveling in motor vehicles*. Cochrane Database of Systematic Reviews, Issue 4, 2007.

25. Zaza S, Sleet DA, Thompson R. Review of evidence regarding interventions to increase the use of child safety seats. *American Journal of Preventive Medicine*, 2001, 21(Suppl. 4):31–34.

26. *Traffic safety facts 2002: occupant protection*. DOT HS 809 610. National Highway Traffic Safety Administration, 2003 (http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/TSF2002/2002occfacts.pdf, accessed 5 November 2008).

27. *Amendment to the seat-belt wearing regulations*. United Kingdom Department for Transport, 2006 (http://www.dft.gov.uk/consultations/aboutria/ria/amendmenttotheseatbeltwearin5501?page=2#a1024, accessed 5 November 2008).

28. Williams AF et al. Seat belt use of high school drivers and their passengers. *Journal of Traffic Medicine*, 1997, 25:21–25.

29. *Road safety performance Index Flash 4: increasing seat-belt use.* European Transport Safety Council, 2007 (http://www.etsc.be/documents/PIN%20Flash%204.pdf, accessed 5 November 2008).

30. Tsoumakas K et al. Parents knowledge and attitudes about preventing injuries in motor vehicle accidents in children in Greece. *Traffic Injury Prevention*, 2008, 9(2):129–134.

31. Liu C et al. *States with primary enforcement laws have lower fatality rates*. Traffic Safety Facts Research Note, DOT HS 810 557. Washington, DC, National Highway Traffic Safety Administration, 2006.

32. Forjuoh S. Traffic-related injury prevention interventions for low-income countries. *Injury Control and Safety Promotion*, 2003, 10:109–118.

33. Silveira AJ. *Seat-belt use in Buenos Aires, Argentina: a 14-year-old struggle.* Luchemos por la Vida. Paper presented at the International Conference on Traffic Safety on Four Continents, Warsaw, October 2005.

34. *Road safety and health*. Resolution WHA57.10 of the World Health Assembly, 57th session, 22 May 2004 (http://www.who.int/violence_injury_prevention/publications/road_traffic/en/index.html, accessed 5 November 2008).

35. *Improving global road safety*. Resolution A/60/5 of the United Nations General Assembly, 60th session, 1 December 2005 (http://www.who.int/violence_injury_prevention/publications/road_traffic/en/index.html, accessed 5 November 2008).