European Commission

Thematic Report

Pedestrians

Mobility and Transport

This document is part of a series of 20 thematic reports on road safety. The purpose is to give road safety practitioners and the general public an overview of the most important research questions and results on the topic in question. The level of detail is intermediate, with more detailed papers or reports suggested for further reading. Each report has a 1-page summary.

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Contents

Summary

Pedestrians are vulnerable road users and suffer the most severe consequences in collisions with other road users, because they are unprotected against the speed and mass of the crash opponent.

About 15 - 25% of all journeys are undertaken on foot. Some groups walk more than others. Age groups for which walking is particularly common are children and seniors. Half of all pedestrian fatalities in Europe are aged 65 or over. In particular, from 70 years on, the number of pedestrian fatalities increases significantly.

Pedestrians comprise just under 20% of all road deaths in the EU, a proportion that has declined slightly over the last decade. The number of pedestrians killed declined by around 30% between 2012 and 2022. Most pedestrian crashes occur in urban areas: pedestrians account for 38% of all road deaths in such areas. Cars account for over 70% of vehicles hitting pedestrians. Most crashes involving pedestrians occur while crossing the road and frequently at pedestrian crossings which are usually the location at which roads are most often crossed.

The factors identified as contributing to pedestrian crashes are: the road environment; lack or design of crossing facilities; speed of motorised vehicles; their weight and design; the unprotectedness of pedestrians; their (lack of) visibility; and finally the attitudes and behaviours (including intoxication) of all road users.

Countermeasures

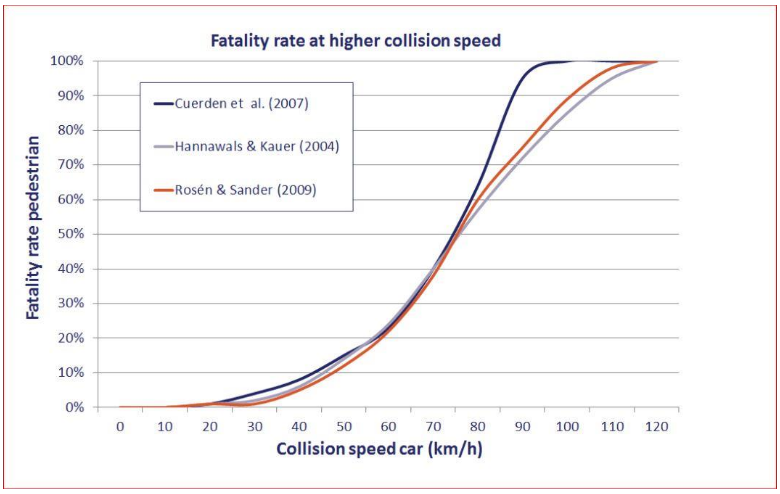
- Land-use planning, improving connectivity, assigning space for pedestrians and physically separating them from motor traffic.
- Good speed management and a default speed limit of 30 km/h in urban areas.
- Implementing safe walking routes, area-wide traffic calming, and improved crossing facilities.
- Good street lighting and the promotion of reflective devices for pedestrians to improve their visibility.
- Vehicle measures, including lowering car mass, a pedestrian-friendly car front, intelligent speed assistance to enforce low speeds, pedestrian detection linked to automatic emergency breaking, and improved viewing conditions for trucks and buses.
- Education and training for motorists as well as ample opportunities for children to safely practice their pedestrian skills.
- Legal framework and enforcement, to ensure safe behaviour by motorists and pedestrians.

1. What is the problem?

1.1 Safety issues for pedestrians

In the traffic and transport system, pedestrians play a specific role. Walking is the beginning and end of each journey (walking to a car or to public transport), and can be the sole transport mode for the journey. Despite the clearly important role of walking, little attention is paid to pedestrians and facilities for them. Moreover, pedestrians are particularly vulnerable in crashes with other road users. Walking is not safe in an environment with many motorised vehicles driving at high speeds (Figure 1). The higher the speed of the vehicle, the higher the percentage of pedestrians that are killed in case of a road crash. Young and older pedestrians particularly are prone to danger from traffic.

Figure 1. *Percentage of pedestrians killed in a collision with a motorised vehicle at different impact speeds (Source: Rosén et al., 2011)*



1.2 How do pedestrians participate in traffic?

1.2.1 The incidence of walking

The incidence of walking relative to other modes of transport is documented in travel surveys in various countries. These surveys do not always comprise all types of walking, so the distance walked is mostly underestimated. For a number of countries, the proportion of trips on foot varies between 8% and 27% (OECD, 2012).
The distance travelled on foot also varies between 36 and 777 kilometres per year (Table 1).

Table 1. *Average length of a walking trip in various OECD countries (Source: ITF, 2018)*

	Exposure
	km per person and year
Austria	84
Belgium	209
Finland	299
France	48
Germany	407
Ireland	239
Italy	36
Netherlands	251
Norway	550
Switzerland	777
United Kingdom	203

These differences in distance travelled reflect the way people travel in the countries mentioned in Table 1: in some countries, car use is high, in others bicycle use is high. This in turn reflects traditions, distances between origins and destinations, road networks, and the availability of public transport.
More information about walking as part of a trip is given by DG Move (EC, 2022).
Table 2 shows the frequency of walking trips for a number of European cities. This figure also shows differences between cities. The differences between these cities are smaller than in Table 1 above for countries.

Table 2. *Frequency of trips on foot in some European cities (Source: ISAAC, 2019)*

	Ghent	Liège	Tilburg	Groningen	Düsseldorf	Dortmund	Berlin	Bergen	Trondheim
How often do you walk on foot 10 minutes or more?									
Never	2.7	0.9	3.0	3.7	2.5	3.2	1.6	3.0	1.7
Once to few days a year	6.9	6.5	4.4	4.4	4.1	5.7	3.1	4.1	7.6
Once to few days a month	15.2	12.9	11.0	10.8	11.9	11.8	7.1	13.4	10.0
Once to few days a week	33.1	31.1	35.4	34.2	24.4	27.9	18.9	24.9	40.0
At least five days a week	42.0	48.7	46.2	46.9	57.1	51.3	69.3	54.7	40.8

1.2.2 Age and gender

Some groups of traffic participants walk more than others. These differences are also reflected in their involvement in crashes. Age groups among which walking is particularly common are children and seniors. Data from the Netherlands illustrate this: people aged 75 or over make one-third of their journeys on foot. They use the car slightly more often (38%), but considerably less often than younger adults aged 25 to 74, who drive for more than half of their journeys. Children aged 0 to 11 make 29% of their journeys on foot. The modal split for young adults (aged 18 to 24) is walking (20%), cycling (23%), and public transport (18%). For young people in secondary school (aged 12 to 17), the bicycle is by far the most important mode of transport: they use their bicycles for no less than 52% of all trips (SWOV, 2020).

Although few countries have as high a proportion of bicycle trips as the Netherlands, data from other (European) countries show generally the same pattern: children and older adults walk most, whereas teenagers cycle most (OECD, 2012).

Women tend to walk more than men. For instance, in Germany on an average day, 37% of the women walk while only 32% of the men do so. Women have access to a motor vehicle to a lesser extent than men and they make more use of public transport (which involves walking to and from the station). Among older people, where the share of kilometres travelled on foot is higher than for other age-groups, women constitute a larger part of the population because they live longer (Nobis & Kuhnimhof, 2018).

The pedestrian population is very heterogeneous regarding their walking needs, tasks and task abilities, and more than half of the population has one or more disadvantages, impairments or mobility restraints regarding walking. The heterogeneity is greater than for any other mode, because everyone is a (potential) pedestrian, walking is unavoidable, and walking is part of (almost) all trips (Methorst, 2021).

2. Pedestrians and road safety

2.1 Definition of a traffic-related crash

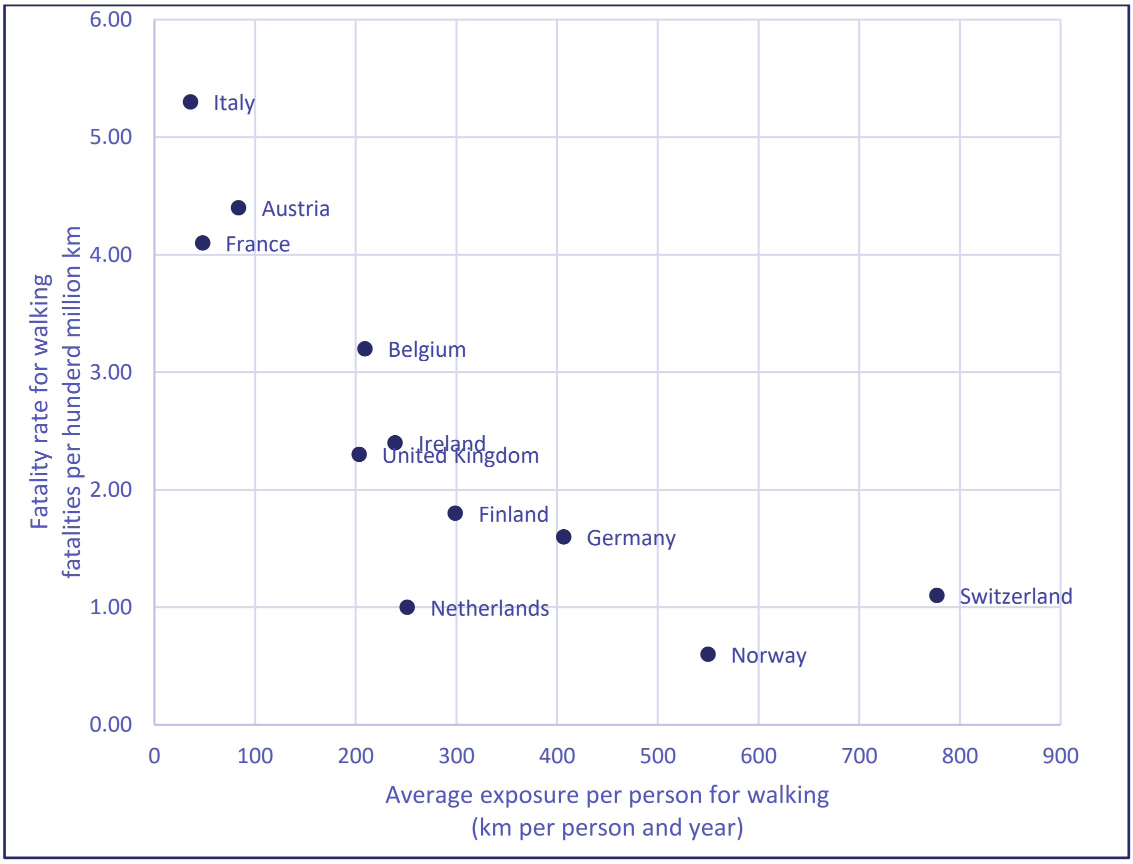
Not all incidents involving pedestrians are considered to be traffic-related. According to the UNECE definition, road crashes must include at least one moving vehicle (UNECE, Eurostat & ITF, 2019). Consequently, a pedestrian fall as a result, for example, of loose paving stones is not regarded as a road crash. The same applies when a pedestrian falls while boarding or alighting from a bus.

As a result of the above definition, incidents involving pedestrian falls are not included in crash statistics. The few available studies in OECD countries show that up to one third of overall pedestrian fatalities and three quarters of injuries are due to falls in public spaces (Methorst, 2021). Even pedestrian crashes with other vehicles – which do fall under the definition of a road crash - are disproportionally under-reported in police crash statistics compared to what hospital records and other studies show (WHO, 2023).

2.2 Crash, injury risk and fatality rate

For a pedestrian, the risk of getting killed in a road crash is about the same as that for a car driver if it is calculated per minute spent travelling. However, because cars travel much further in the same amount of time, the risk per kilometre travelled is more than nine times higher for a pedestrian than for a car driver (Haddak, 2016).
Figure 2 shows the fatality rate for walking in a number of European countries related to the distance that pedestrians walk per year.
The differences between countries in both fatality rate and walking distance are in some cases quite large.

Figure 2. *Fatality rate vs. exposure for walking for different EU-countries (ITF, 2018)*



2.3 General trends in number of fatalities

Between 2012 and 2022 pedestrian fatalities in the EU fell by around 30%, while the *total number of fatalities* decreased by 21%. In almost all countries of the EU, the number of pedestrian fatalities has decreased over the past decade (EC, 2023). Although data on this are less reliable, it seems that the number of pedestrians who were *seriously injured* in road crashes has declined much less (by only 6%; ETSC, 2020).

It should be noted, however, that country-by-country reductions in the number of fatalities cannot be assessed without also looking at trends in mobility. The numbers of pedestrian fatalities are affected both by the number and age distribution of pedestrians and by the number of motorised vehicles with which crashes can occur.

2.3.1 Parties involved in crashes and their location

The fatalities in crashes involving pedestrians are in most cases the pedestrians themselves (98%). 66% of these crashes involved cars. Lorries, HGV's and busses are involved in 25%% of the crashes in which pedestrians were fatally injured (EC, 2023; CARE, 2020).

Most pedestrian injuries (regardless of severity) are sustained in urban areas. EU-wide, 73% of all pedestrian fatalities occur in urban areas where also most pedestrian mobility takes place. While pedestrians account for 20% of all road deaths, this rises to 38% in urban areas (EC, 2023). However, in rural areas, crash severity is higher (OECD, 2012). Higher vehicle speed in such areas is a key factor. Other contributing factors are the lack of adequate pedestrian footpaths or other pedestrian spaces as well as street lighting (ECMT, 2000).

2.3.2 Age and gender of pedestrian casualties

In the EU, the number of pedestrian fatalities increases with age, and very dramatically so from the age of 70 years on. Almost *half* of the pedestrians who died in a road crash in 2018 were *seniors* of 65 years or over (EC, 2023).

For most age-groups, only a relatively small share of road-crash fatalities were pedestrians. There are two exceptions to this (CARE 2020):

- Among *senior* fatalities, pedestrians form an ever-larger share: from just about one quarter of fatalities among the 60 to 64 year-olds to more than half the fatalities among the oldest seniors of 90 or over.

- Among *children* (aged 0-15), about one third of fatalities (35% in 2018) are pedestrians. Although the proportion is high, children nevertheless only account for a small share of pedestrian fatalities (4%).

The proportion of fatalities who are pedestrians is much higher for females (32%) compared to males (17%). Nevertheless men – who are more often involved in fatal crashes than women – account for 63% of the fatally injured pedestrians.

2.4 Crash factors

About two thirds of pedestrians in severe road crashes were crossing the road (e.g., Carpentier et al, 2014; Hesjesvol & Høye, 2019). Yue and colleagues (2020) identified the main scenarios in fatal pedestrian crashes in Florida (listed below with the most frequent contributing factors for each scenario):

- *Vehicle going straight and pedestrian crossing the road (51%).* Drivers distracted or did not expect pedestrian to suddenly turn into their lane. View obstructed by (parking) vehicle. Difficult viewing conditions: darkness or low sun.
- *Vehicle turning left and pedestrian crossing the road at the exit (17%) or the entry (3%) of the crossing*. Often at signalised intersection when left turn was not protected by the signal. Driver was distracted by oncoming traffic. Pedestrian was obstructed by other vehicles.
- *Vehicle turning right and pedestrian crossing the road at the exit (12%) or the entry (4%) of the crossing*. Often at non-signalized intersections. Drivers focussed on traffic coming from the left.
- *Vehicle going straight and pedestrian in (3%) or adjacent to (6%) the road*. Difficult lighting conditions. Unexpected manoeuvre of pedestrian. Driver fails to leave enough lateral space.

In two studies in Brussels, identifying the most frequent scenarios for pedestrian crossing crashes, the main contributing factors for signal-regulated crossings were non-compliance by the pedestrian (50%) and conflicting green-phases for pedestrians and turning motorists (25%) (Populer et al., 2018). For non-signalised crossings, the main factors were obstructions of view due to other traffic participants or parked vehicles. In another study, crashes took place more often in the *far lane* than in the lane closest to the pedestrians' point of departure (Dupriez & Houdmont, 2009).

Distraction is possibly a factor that is related to pedestrian crashes. A study by Yannis et al. (2020) indicates that 59% of pedestrians in

Europe declared that they read a text message/email or check social media while walking in the past month. These rates are significantly higher for pedestrians aged 18-24 (85%).

2.4.1 Crash factors with older pedestrians

Older pedestrians have a higher chance of being injured in a crash because of their greater physical vulnerability, but also because locomotive functions deteriorate with increasing age. As people age, functional limitations and disorders occur, such as reduced visual or auditory abilities, increased reaction times, difficulties with dividing attention, and dementia. The decline of motor functions in particular can increase the crash rate. In general terms, this decline consists of a slowing down of movement, a decline in muscle strength, a decline in fine motor skills, and a particularly strong decline in the ability to adapt to sudden changes in bodily position (SWOV, 2015).

An important cause of the high fatality rate among older female pedestrians is the physical vulnerability of elderly people. Since their bones are more brittle and their soft tissue less elastic, they run a higher risk of severe injury, compared with younger road users injured with the same crash force (Ang et al., 2017).

Older pedestrians are over-represented in crashes at intersections, particularly at those without traffic signals, and in crashes involving a turning vehicle. They have greater difficulties in estimating the speed and distance of oncoming vehicles and tend to overestimate their own walking speed. Like children, they have the tendency to look out for traffic only in the near lane and ignore possible traffic in the far lane (Tournier et al., 2016). Consequently, older pedestrians are also over-represented in crashes involving the crossing of midblock road sections, particularly on wide multi-lane roads in heavy bi-directional traffic (Oxley et al., 2004, 2016).

Although these are not road crashes according to the common definition (see Section 2.1), *pedestrian falls* also occur more frequently among older pedestrians (about eight times more than in collisions), e.g. when boarding or exiting public transport, falls on footpaths, when stepping off kerbs, and while crossing the road (without being struck by a vehicle). Although injuries resulting from pedestrian falls and other non-collision events are generally not as severe as those where a vehicle is involved, they nevertheless represent a significant cause of trauma for older pedestrians (Oxley et al., 2004, 2016). See also *Thematic Report Seniors, EC, 2023*.

2.4.2 Crash factors with young pedestrians

Variations between countries in the proportion of child fatalities that were travelling as pedestrians reflect the country's residential and traffic infrastructure and, not least, typical national habits such as children walking to school on their own or adults accompanying or driving children to school (OECD, 2012).

2.5 Safety attitudes

Torfs & Meesmann (2019) report about the attitudes of pedestrians regarding road safety. By way of questionnaires pedestrians (and other road users types) reported about their road crash involvement, safety feeling and unsafe traffic behaviour. It showed that pedestrians were more involved in crashes than car drivers. Pedestrians feel safer in road traffic than other 'vulnerable' road users (cyclists, mopes riders and motorcyclists). Gender, age and the support of policy measures are (statistically) related to the use of head-phones during walking.

3. Countermeasures

Long-term planning is needed to produce the fundamental changes that would improve the safety and mobility of vulnerable road users. Measures require a framework that takes the various needs of vulnerable road users into account, as set out in Sustainably Safe Traffic (SWOV, 2018), Safe Systems (ITF, 2016) or the EU Road Safety Policy Framework 2021-2030 (EC, 2019a). However, these frameworks are not specifically focused on pedestrians. Road traffic crashes are an inevitable side-effect of the road transport system. However, road fatalities and severe injuries can and should be avoided. Where crashes still occur, the circumstances which determine the severity of these crashes should be addressed so that in time the possibility of severe injury is virtually eliminated. In the framework of Sustainable Safety (SWOV, 2018) a safe system is characterized by:

- A road network structure that is adapted to the limitations of human capacity through proper design, and in which roads have a clearly appointed function, as a result of which improper use is prevented.
- Vehicles which are fitted with facilities to simplify the driver's tasks, and which are designed to protect the vulnerable human being as effectively as possible.
- Road users who are adequately trained, informed and, where necessary, guided and restricted.

3.1 Land use planning

In the 20th century, cities were designed and constructed to allow vehicular access and encourage mobility. Initially, this implied access and mobility involving horses and carts, then omnibuses, 'horseless carriages', and finally motor cars. In more recent times, however, there has been a shift back from motorised vehicles to vulnerable road users who are becoming a priority in the transport system. With the road network legacy, designed primarily for motor vehicles, it is not always easy to create room for pedestrians, but more and more cities are focussing on reducing motor traffic and increasing the active transport modes (e.g., Vean, 2018; London; Kievit, 2018; Kvashilava, 2018; ITF 2020).

The pedestrian safety measures which are most comprehensive and most closely associated with urban planning and policy philosophies include *area-wide speed reduction* or *traffic calming schemes*, and *integrated walking networks*.

3.1.1 Speed management (area-wide)

Speed is the key factor in serious and fatal crashes involving pedestrians. Speed also affects the available time to react on other road users as well as injury severity, particularly for vulnerable road users such as pedestrians. A pedestrian who is hit by a car travelling at 65km/h is four times more likely to be killed compared with a car travelling at 50km/h (cf. *Thematic Report Speed*, EC 2021). At collision speeds below 30 km/h, collisions between motorised vehicles and pedestrians are much less likely to happen, and if they do happen, they do not usually result in a fatality.

Physical measures such as speed humps can force speed reduction (GRSP, 2008), but may meet with opposition from bus and emergency vehicle drivers as well as from residents if extensive ground vibrations occur. Speed reduction can also be achieved (although to a lesser extent than by speed humps) by narrowing the carriageway or by a raised crossing.

More and more cities in Europe have implemented a 30km/h zone in the city centre (including Munich, Helsinki, Bilbao, Brussels, Madrid and Grenoble). There is a trend for cities to extend these zones, with a 30km/h limit envisaged for all urban roads (cf. *Thematic Report Speed*, EC 2021). The benefits are well proven: several systematic reviews have looked at the effects of traffic calming and found that it reduces traffic collisions, (Elvik et al., 2009), road injuries and fatalities (Quigley, 2017; Aarts & Dijkstra, 2018).

3.1.2 Safe walking routes

To encourage walking among *children*, many municipalities are acting to introduce safer schoolways e.g. Ireland (RSA, 2021), Slovenia (SIA, 2022), Spain (Pérez, 2023). In the Netherlands, many municipalities have implemented 'Kid routes', child-friendly routes with a playful layout and easily recognisable markings and signs guiding children to their destination (De Jager et al., 2005; Wassenberg & Milner, 2008).

3.2 Road design

Area-wide traffic calming, reduction of motor traffic, and lowering of speed are arguably the best measures which most increase pedestrian comfort and safety. The design of features such as footpaths and crossing facilities should be integrated in these measures.

3.2.1 Footpaths

Footpaths must be physically separated from both motor and bicycle traffic (AbouSenna, 2022). To ensure their useability, also to people with reduced walking abilities or vision, they must be well maintained without potholes and uneven paving stones to prevent falls and allow walkers to focus on the traffic rather than on the ground. In case of slopes and stairs/steps, pedestrians should be made aware of the situation. Crossing facilities should have levelled access to the street rather than a high kerb which can pose an important obstacle (Fournier et al., 2016).

3.2.2 Crossing facilities

In principle, there are six types of provisions for pedestrian crossings:

- Locating the zebra crossing optimally on much used pedestrian routes,
- Lowering the speed of motor vehicles; e.g., raised junctions, speed humps, axis offsets and 30 km/h zones.
- Separating motor vehicles and pedestrians in time; i.e., different kinds of traffic light control: reduced waiting time or a longer green phase, green phases for pedestrians separated from left- or right-turning vehicles.
- Physically separating motor vehicles and pedestrians; e.g., bridges, tunnels, viaducts, pavements and centre islands.
- Increasing visibility and conspicuousness: lighting, markings, signage, and relocation of lay-bys, parking spaces, and bus stops and other sight obstructions.
- Crossing distance: should be as short as possible, preferably by centre islands.

Not all these provisions are equally effective. By and large, provisions that lower driving speeds or physically separate transport modes are most effective (Retting et al., 2003). Pedestrian bridges and underpasses (the most ideal solution in terms of road safety) are, however, not very popular (Manthirikul, 2022): for instance, English pedestrians would prefer walking an extra two and a half minutes to the next signalled crossing rather than use a pedestrian-bridge and more than 5 extra minutes to avoid using an underpass (Anciaes & Jones, 2018).

3.2.2.1 Non-signalled crossing facilities

In terms of the effectiveness of marked pedestrian crossings (zebra paths), studies do not all point in the same direction (Turner et al., 2006; Havard & Willis, 2012 and Gitelman et al., 2017). A *decrease* in crash risk has been established in particular for marked crossings on smaller roads with no more than two lanes, but for busy roads with more than two lanes risk has been found to *increase* after implementation of marked crossings (Hesjesvol & Høye, 2019). Studies looking into the severity of pedestrian crashes at marked crosswalks have, however, consistently found a significant *reduction in the severity* of pedestrian injuries (De Ceunynck & Focant, 2017). The following are the measures that improve the safety of marked crossings (Hesjesvol & Høye, 2019; Szagala, 2022):

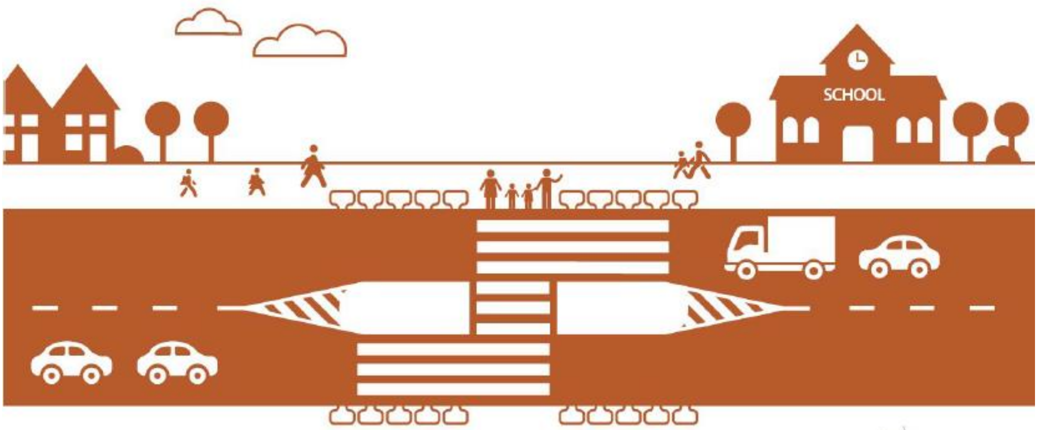
- *Elevated walkway (or speed bump), preferably with a zebra marking:* recommended where speed levels are too high and on roads with a speed limit of 40 km/h or more.
- A *centre island (refuge)* in the middle of the road can make it easier for pedestrians to cross. Shorter stretches that must be crossed one by one and where attention need only be directed to traffic from one direction at a time. At the same time, a refuge can make motorists more aware and mean a narrowing of the lane, thereby having a speed-reducing effect.
- *Extensions of footpaths* (bulb-outs) reduce the distance that pedestrians have to travel, prevent parking cars and thus improve visibility conditions, and can also function as a speed-reducing measure.
- *Illumination* of pedestrian crossings draws the attention of the motorists and makes it easier for them to detect pedestrians in the dark.
- *Automatic warning signs or intelligent traffic signals* that are activated when a pedestrian approaches has been shown to increase compliance by motorists.

- *Guide fences:* Fences that lead pedestrians to crossings are suggested by Hesjesvol & Høye (2019) because large numbers of pedestrians cross near but not at the street markings. In combination with moving the stopping line for motorists further away from where pedestrians cross, fences have been shown to reduce the number of serious conflicts (De Ceunynck et al., 2020, see Figure 3).

Studies focussing on risky crossings by pedestrians did not find any indication that pedestrians are less careful when the crossing facilities are better (De Langen, 2003; Fu et al., 2018; Pulugurtha et al.; 2012). Fu et al., however, did show that pedestrians cannot always take full account of the speed and the distance of oncoming vehicles.

At locations with many pedestrians, motorists pay more attention to them. This effect is called "*safety in numbers*": when more pedestrians cross the road the number of pedestrian crashes increases, but not proportionately to the number of pedestrians (Elvik, 2013; Kim et al., 2023). This is also true for other vulnerable road users: combining crossing facilities for pedestrians and cyclists can be effective in increasing protection in numbers (Ryley, Halliday & Emmerson, 1998). The advantage of a combined crossing is that it is more visible for fast-moving traffic travelling on the major road.

Figure 3. *Moving the stopping line upstream in combination with guiding fences has been shown to reduce the number of serious conflicts (Source: De Ceunynck et al., 2020)*



3.2.2.2 Signal-regulated crossing facilities

A study in Brussels showed that for signal-regulated crossing facilities, the two largest problems are pedestrians failing to obey the traffic lights (50%) and conflicting traffic light phases for turning vehicles and pedestrians at their exit approach (25%; Populer, et al., 2018). Smart signalisation, that can detect and count the numbers of pedestrians and cyclists crossing, can achieve a fairer distribution of waiting times for fast and slow traffic, and they often produce shorter waiting cycles, which increases compliance and ultimately safety (Ryley, Halliday & Emmerson, 1998). Increasing crossing times for pedestrian or increasing the phase lengths has been shown to reduce the crash risk for pedestrians (Chen et al., 2012, Retting et al., 2002).

The design of signalised pedestrian crossings should follow the following principles (Populer, 2018; SWOV, 2020):

- Setting traffic light intervals to accommodate the walking speed of older pedestrians;
- Setting traffic lights differently to avoid conflicts between turning cars and pedestrians, e.g., this is the case for example in Ireland and the United Kingdom
- Automated detection of pedestrians instead of using push buttons.

3.3 Visibility: lighting and reflecting devices

A study in Switzerland showed that 20% of crossing accidents happened in the dark (Ewert, 2012). While many actions are being taken to improve young people's visibility, this is not yet really the case with older people. The Swiss BFU recommends the use of reflective gear, especially applied to the legs, because this is where motor vehicle light beams are most concentrated and where reflective gear is most noticeable due to leg movement (Ewert, 2012).

3.4 Vehicle design of crash opponents

The new EU Regulation on type approval requirements for motor vehicles (EC, 2019b) makes Automatic Emergency Breaking (AEB) mandatory for cars and vans as from 2024. Chauvel and colleagues (2013) estimate that the number of pedestrians killed could be reduced by 15% and the number of pedestrian injuries by 38% if all passenger cars were equipped with *Automatic Emergency Breaking for Pedestrians* (AEBP).

Moreover, vulnerable road user detection and warnings on the front and side will be mandatory for busses and lorries, because these vehicles have large blind angles (EC 2019b). The problem with these systems is a relatively high rate of false alarms. Therefore, they must be combined with improved vision from the driver's position (EC, 2019b). This can be realized with lowered windows that allow the driver to check visually when there is a warning (e.g., Edwards et al., 2018 for busses) or with artificial intelligence that can predict pedestrian behaviour (e.g., Ruf et al., 2019 for lorries). The vehicle mass determines the outcome of a crash. However, the vehicle mass is not subject to any formal limit. (Methorst, 2021).

For active protection systems for pedestrians, like pop up bonnets and pedestrian airbags, it is expected that these can reduce severe pedestrian head injuries at speeds up to 60 km/h (Reed, 2017).

Intelligent Speed Assistance (ISA) can effectively contribute to the safety of pedestrians and cyclists by limiting drivers' speed, particularly in zones with 30 km/h speed limits.

3.5 Education and training

Car drivers and other drivers have to learn how they can safely interact with pedestrians, for example by incorporating hazard anticipation training with an emphasis on vulnerable road users in basic driver training and testing (Vlakveld, 2011).

Pedestrians need to learn by formal and informal education how to walk safely. Hoekstra & Meskens (2010) have suggested giving more information to parents and carers that emphasize the importance of walking in traffic together with children and setting a good example rather than only explaining what the correct behaviour should be.

The EC proposal in March 2023 for a revision of the Directive on Driving Licences also includes provisions to adapt driver training and testing to better prepare drivers for the presence of vulnerable users on the road.[1]

3.6 Legal framework and enforcement

Laws and – where necessary - penalties are important for influencing driver behaviour. They also indicate government commitment to road safety and show that the government is taking pains to balance road safety, mobility and freedom. Laws that are particularly relevant to the safety of pedestrians are those governing speeding, compliance at pedestrian crossings, and dangerous driving.

4. Further reading

Methorst (2021). Exploring the Pedestrians Realm; An overview of insights needed for developing a generative system approach to walkability. TRAIL Thesis Series no. T2021/6, the Netherlands Research School TRAIL. Delft University of Technology, The Netherlands.

OECD (2012). Pedestrian safety, urban space and health. Organisation for Economic Co-operation and Development OECD, Paris.

[1] https://transport.ec.europa.eu/document/download/964d4edc-5eea-49e1-ae08-2d1e38705713_en?filename=COM_2023_127.pdf

WHO (2023). Pedestrian safety; A road safety manual for decision-makers and practitioners. World Health Organization, Geneva, Switzerland.

5. References

Aarts, L. & Dijkstra, A. (2018). DV3 – Achtergronden en uitwerking van de verkeersveiligheidsvisie; De visie Duurzaam Veilig Wegverkeer voor de periode 2018-2030 onderbouwd. SWOV, Den Haag.

Ang, B. H., Chen, W. S., & Lee, S. W. H. (2017). Global burden of road traffic accidents in older adults: A systematic review and meta-regression analysis. Archives of Gerontology and Geriatrics, 72, 32–38.

Carole Miller Research (1998). The older child pedestrian casualty. Central research unit, Edinburgh.

CARE (2020). Community database on Accidents on the Roads in Europe. Data extracted 27 December 2020. https://ec.europa.eu/transport/road_safety/specialist/statistics_en#

Chauvel, C., Page, Y., Fildes, B., & Lahause, J. (2013). Automatic emergency braking for pedestrians effective target population and expected safety benefits. 1–9.

Chen, L., C. Chen, R. Ewing, C. McKnight, R. Srinivasan, and M. Roe (2012). Safety Countermeasures and Crash Reduction in New York City—Experience and Lessons Learned. Accident Analysis and Prevention, 50, Pages 312-322.

De Ceunynck, T., Focant, N. (2017), Implementation of marked crosswalks, European Road Safety Decision Support System, developed by the H2020 project SafetyCube.

Dupriez, B., & Houdmont, A. (2009). Gedetailleerde analyse van ongevallen in het Brussels Hoofdstedelijk Gewest (2000-2005). Brussels Mobility D/2009/0779/87.

ECMT (2000). Safety in traffic for vulnerable users. European conference of ministers of transport.

EC (2019a) EU Road Safety Policy Framework 2021-2030 - Next steps towards "Vision Zero". Commission staff working document, European Commission, Brussels, Belgium. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/move-2019-01178-01-00-en-tra-00_3.pdf

EC (2019b). Regulation (EU) 2019/2144 of the European Parliament and of the Council. https://eur-lex.europa.eu/eli/reg/2019/2144/oj

EC (2022). Study on New Mobility Patterns in European Cities. Task A: EU Wide passenger mobility survey. Final report. Directorate General Move, Brussels.

EC (2023) Facts and Figures Pedestrians. European Road Safety Observatory. Brussels, European Commission, Directorate General for Transport.

Edwards, A.; Barrow, A; O'Connell, S; Krishnamurthy, V.; Khatry, R.; Hylands, N.; Mc Carthy, M.; Helman, S. & Knight, I. (2018). Analysis of bus collisions and identification of countermeasures. Published project report PPR819. Transport Research Laboratories, Berks. http://content.tfl.gov.uk/analysis-of-bus-collisions-and-identification-of-countermeasures.pdf

Elvik, R. Høye, A. Vaa, T. & Sorensen, M. (2009). The handbook of road safety measures. Second edition. Emerald Group Publishing Ltd, Bingley, UK.

Elvik, R. (2013). Safety-in-numbers: Estimates based on a sample of pedestrian crossings in Norway. Accident Analysis & Prevention, 91, 175-182.

ETSC (2020). How safe is walking and cycling in Europe? Pin Flash Report 38. European Transport Safety Council ETSC, Brussels.

Ewert, U. (2012). Senioren als Fussgänger bfu-Faktenblatt Nr 8. Beratungsstelle für Unfallverhütung, Bern.

Fu, T., Miranda-Moreno, L. & Saunier, N. (2018). A novel framework to evaluate pedestrian safety at non-signalized locations. Accident Analysis & Prevention, 111, 23-33.

Gitelman V., Carmel R., Pesahov F., Hakkert S. An examination of the influence of crosswalk marking removal on pedestrian safety as reflected in road user behaviours. Transportation Research Part F 46 (2017), 342-355.

GRSP (2008). Speed management: a road safety manual for decision-makers and practitioners. Global Road Safety Partnership, Geneva.

Haddak, M.M. (2016). Exposure-based road traffic fatality rates by mode of travel in France. In: Transportation Research Procedia, 14, pp. 2025 – 2034.

Havard, C., & Willis, A. (2012). Effects of installing a marked crosswalk on road crossing behaviour and perceptions of the environment. Transportation Research Part F, 15, 249–260.

Hesjesvol, I. & Høye, A. (2019) Pedestrian crossing options. Chapter 3.14 of the Handbook of Road Safety Measures. Downloaded 15/02/2021 from: https://translate.google.com/translate?sl=auto&tl=en&u=https://www.tshandbok.no/del-2/3-trafikkregulering/doc663/.

Hoekstra, A.T.G. & Mesken, J. (2010). De rol van ouders bij informele verkeerseducatie; Vragenlijststudie naar kennis, behoeften en motieven van ouders. R-2010-31. SWOV, Leidschendam.

ITF (2016), Zero Road Deaths and Serious Injuries: Leading a Paradigm Shift to a Safe System, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789282108055-en

ITF (2018), Exposure-adjusted road fatality rates for cycling and walking in European countries. Roundtable 168. International Transport Forum, Paris.

ITF (2020), Best Practice for Urban Road Safety. https://www.itf-oecd.org/best-practice-urban-road-safety.

ISAAC (2019). Determinants and barriers of walking, cycling and using Personal e-Transporters: a survey in nine European cities. ISAAC project, Brussels.

Jager, D. de, Torenstra, J., Haas, J. de & Spapé, I. (2006). Veilige kindcorridor in steden; Kindlint zet dit jaar eerste stapjes in Amsterdam en Delft. Verkeerskunde, 57(4), 34-39.

Kim, S.; Jang, K.; Park, S. (2023). Safety in numbers for walkers; Effects of pedestrian volume on per-pedestrian crash rate and severe injury probability. In: Sustainability, 15, 10027.

Kvashilava, G. (2018), Walkable and Bike-Friendly Tbilisi. Presentation at ITF Safer City Streets, 28 November, 2018. https://www.itf-oecd.org/walkable-and-bike-friendly-tbilisi.

Kievit, E. de; (2018) Walkability in Amsterdam: More space for the mother of all modes of transport. Presentation at ITF Safer City Streets, 28 November, 2018. https://www.itf-oecd.org/walkability-amsterdam-more-space-mother-all-modes-transport.

Langen, de, A.C.B. (2003). Veiligheid van enkele typen oversteekvoorzieningen in stedelijke gebieden. Analyse van ongevallengegevens en gedragswaarnemingen. R-2003-23. SWOV, Leidschendam.

Manthirikul, S.; Jain, U. & Amshala, V. (2022). A critical review of grade-separated pedestrian crossing facilities. In: Journal of Transportation Engineering, Part A: Systems, Volume 148, Issue 10, October 2022.

Methorst (2021). Exploring the Pedestrians Realm; An overview of insights needed for developing a generative system approach to walkability. TRAIL Thesis Series no. T2021/6, the Netherlands Research School TRAIL. Delft University of Technology, The Netherlands.

OECD (2012). Pedestrian safety, urban space and health. Organisation for Economic Co-operation and Development OECD, Paris.

Oxley, J., Corben, B., Fildes, B., O'Hare, M. & Rothengatter, T. (2004). Older vulnerable road users: measures to reduce crash and injury risk. MUARC Report No. 218. Accident Research Centre MUARC, Monash University, Clayton, Victoria.

Oxley, J., O'Hern, S., Burtt, D., Rossiter, B. (2016). Fall-Related Injuries While Walking in Victoria, Victoria Walks, Melbourne.

Pérez, K., Santamariña-Rubio, E., Ferrando, J., López, M.J., Badiella, L. (2023). Effectiveness of a Road Traffic Injury Prevention Intervention in Reducing Pedestrian Injuries, Barcelona, Spain, 2002-2019. In: Am. J. Public Health, pp.495-499.

Populer, M.; Chalanton, I. & Focant, N. (2018). Ongevallen met voetgangers op of in de buurt van lichtengeregelde voetgangersoversteekplaatsen. VIAS Institute, Brussels.

Pulugurtha, S.S., Vasudevan, V., Nambisan, S.S. & Dangeti, M.R. (2012). Evaluating effectiveness of infrastructure-based countermeasures for pedestrian safety. In: Transportation Research Record, Vol. 2299, Nr. 1, 100-109.

Reed, S. (2017), Active Technology for Pedestrian Protection, European Road Safety Decision Support System, developed by the H2020 project SafetyCube. Retrieved from www.roadsafety-dss.eu on 05/22/2020

Retting, RA, Chapline, JF, & Williams, AF (2002). Changes in crash risk following re-timing of traffic signal change intervals. Accident Analysis & Prevention, 34 (2), 215-220.

Retting, R.A., Ferguson, S.A. & Hakkert, A.S. (2003). Effects of red light cameras on violations and crashes: a review of the international literature. Traffic Injury Prevention, 4 (1), 17-23.

RSA (2021). Guidelines for improving Road Safety around your school. Road Safety Authority, Ballina, Ireland.

Ruf, M.; Neumann, C.; Lützner, J.; Eilers, C. (2019). Digital Guardian Angels - Right-turn Assistants for Commercial Vehicles. ATZ worldwide, 121(1), 16–21.

Quigley, C (2017), Implementation of 30-Zones, European Road Safety Decision Support System, developed by the H2020 project SafetyCube.

Rosén, E., Stigson, H. & Sander, U. (2011). Literature review of pedestrian fatality risk as a function of car impact speed. Accident Analysis and Prevention, 43, 25-33.

Ryley, T., Halliday, M. & Emmerson, P. (1998). Toucan crossings; Trials of nearside equipment. TRL Report No. 331. Transport Research Laboratory TRL, Crowthorne, Berk

Sentinella, J., & Keigan, M. (2005). Young adolescent pedestrians' and cyclists' road deaths: analysis of police accident files. Prepared for the Department for Transport, Road Safety Division. TRL Report; No. 620 Transport Research Laboratory TRL, Crowthorne, Berkshire.

SIA (2022). Safer to school guidelines for installing urban equipment and architectural design of traffic areas to improve road safety for school children. Ministry of Infrastructure, Slovenian Infrastructure Agency, Ljubljana, Slovenia.

SWOV (2015). The elderly in traffic. SWOV Fact sheet. SWOV Institute for Road Safety Research, The Hague.

SWOV (2018). Sustainable Safety 3rd edition – The advanced vision for 2018-2030; Principles for design and organization of a casualty-free road traffic system. SWOV, The Hague

SWOV (2020). Pedestrians. SWOV Fact sheet. SWOV Institute for Road Safety Research, The Hague.

Szagala, P.; Brzezinski, A.; Kiec, M.; Budzynski, M.;Wachnicka, J.; Pazdan, S. (2022) Pedestrian safety at midblock crossings on dual carriageway Roads in Polish cities. In: Sustainability, 14, 5703.Tight, M.R., Carsten, O.M.J., Kirby, H.R., Southwell, M.T. & Leake, G.R. (1996). A review of road safety research on children as pedestrians: How far can we go towards improving their safety? IATSS Research, 20(2), pp. 69 74.

Torfs, K. & Meesmann, U (2019). How do vulnerable road users look at road safety? International comparison bases on ESRA data from 25 countries. Transportation Research Part F. pp. 144 - 152.

Tournier, I.; Dommes, A. & Cavallo, V. (2016). Review of safety and mobility issues among Z

Turner, S., Fitzpatrick, K., Brewer, M., Park, E.S., 2006. Motorist yielding to pedestrians at unsignalized intersections: findings from a national study on improving pedestrian safety. Transportation Research Record 1982, pp. 1–12.

UNECE, Eurostat & ITF (2019). Glossary for transport statistics. European Union, United Nations, ITF and OECD. Publications office of the European Union, Luxembourg.

Vlakveld, W.P. (2011). Hazard anticipation of young novice drivers; Assessing and enhancing the capabilities of young novice drivers to anticipate latent hazards in road and traffic situations. PhD Thesis, University of Groningen. SWOV dissertation series. Leidschendam, the Netherlands: SWOV Institute for Road Safety Research.

Wassenberg, F. & Milder, J. (2008). Evaluatie van het project Kindlint in Amsterdam. Onderzoeksinstituut OTB, Delft.

WHO (2023). Pedestrian safety; A road safety manual for decision-makers and practitioners. World Health Organization, Geneva, Switzerland.

Yannis, G., Nikolaou, D., Laiou, A., Stürmer, Y. A., Buttler, I., & Jankowska-Karpa, D. (2020). Vulnerable road users: Cross-cultural perspectives on performance and attitudes. IATSS research, 44(3), 220-229.

Yue, L.; Abdel-Aty, M.; Wu, Y.; Zheng, O.; Yuan, J. (2020). In-depth approach for identifying crash causation patterns and its implications for pedestrian crash prevention. Journal of Safety Research, 73(), 119–132. doi:10.1016/j.jsr.2020.02.020

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