European Commission

Thematic Report
Cyclists

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

In this report cyclists are defined as users of a conventional bicycle or a pedelec/e-bike, i.e., an electric powered bicycle offering pedal assistance up to approximately 25 km/h.

Cyclists are vulnerable in traffic and constitute the only road user group in the EU where the number of fatalities has not significantly declined in the past decade. In 2023, around 1,950 cyclists died in traffic in the EU with many more seriously injured. In October 2023, the European Commission unveiled a proposal for a European Declaration on Cycling with a view to improving road safety and the quality and quantity of cycling infrastructure across the EU.

Fatal cyclist crashes mostly involve motor vehicles accounting for around 70% of the total. Reliable EU-wide data on serious injuries are lacking. It should be noted that non-fatal bicycle crashes are significantly underreported, in particular crashes without the involvement of motorised vehicles. As with other crashes, cyclist crashes are mostly caused by a combination of different crash factors. Infrastructural factors which contribute to the occurrence of bicycle crashes often include the general lay-out of the road or, in case of bicycle crashes involving motor vehicles, the absence of bicycle infrastructure. Furthermore, behavioural factors play an important role: unsafe behaviour of both cyclists and other road users (e.g. speeding, distraction, red light running, and alcohol) increase crash risk.

Cyclists can benefit from several infrastructure measures. To prevent crashes with motor vehicles, it is important to separate cyclists by means of dedicated, physically separated cycle tracks, also near intersections. When motor vehicles and cyclists can meet physically, e.g., at roads without separate cycle tracks and at intersections, the speed of motor vehicles must be very low. To prevent crashes which do not involve motor vehicles, recommended measures include: ensuring there are no obstacles on the cycle track, visual road alignment, sufficiently wide cycle tracks, and a road surface that is skid resistant and free of cracks and potholes.

With respect to the bicycle, adequate lighting is important for cyclists to be seen at night by other road users. Regarding protective measures, evidence shows that bike helmets protect against head and brain injuries in the event of a fall or crash. External car-mounted airbags can also reduce cyclist injuries in the case of a crash. Finally, technological developments such as intelligent speed assistance in cars should discourage car drivers from driving too fast in e.g. 30 km/h zones.

1. What is the problem?

In this report, cyclists are defined as users of a conventional bicycle or an e-bike, formally called pedelec. A conventional bike is solely human-powered while an e-bike is a bicycle that delivers power when the cyclist pushes the pedals up to a speed of 25 km/h. This report does not deal with users of speed pedelecs. Speed pedelecs offer pedal assistance up to 45 km/h and are therefore legally categorised as a moped.

Cyclists are vulnerable in traffic and constitute the only road user group where the number of fatalities increased in the past decade, by 2% since 2013 (European Commission, 2025) . In 2023, around 1,950 road deaths among cyclists in Europe were reported by the police. This means that one in ten recorded fatalities in traffic is a cyclist. Furthermore, the share of serious injuries in crashes involving a cyclist did not decline: their relative proportion increased from 7% in 2010 to 9% in 2019 (European Commission, 2021a). However, the volume of this share is probably much greater, due to under-reporting of these crashes (e.g. Shinar et al., 2018).

Almost 80% of fatal cyclist crashes involve motor vehicles.(European Commission, 2024). Reliable EU-wide data on serious injuries are lacking. It should be noted that bicycle crashes are significantly underreported, in particular crashes without the involvement of motorised vehicles. Hence, the actual share of bicycle-car crashes can be expected to be lower. For example, Dutch research (Odijk & Oude Mulders, 2025) shows that, in the Netherlands, the average share of single bicycle crashes between 2019 and 2023 amounts to around 32% for bicycle fatalities and around 82% for bicycle serious injuries. A recent review on single-bicycle crashes estimates that this share varies between 52% and 85% (Utriainen et al., 2022).

2. How cyclists participate in traffic

Cycling is popular and is promoted for health, wellbeing and the environment (Martino et al., 2010). For example, in October 2023, the European Commission unveiled a proposal for a European Declaration on Cycling with a view to improving road safety and the quality and quantity of cycling infrastructure across the EU. The draft Declaration recognises cycling as a sustainable, accessible, inclusive, affordable and healthy means of transport, with strong added value for the EU economy.

An EU-wide mobility survey (European Commission, 2022) showed that on average, cycling is not yet a very important mode of transport in the EU. Of the short-distance trips (here defined as less than 300 km), 8% is made by bicycle, as compared to 46% by car (as a driver) and 27% walking. The study reports substantial differences in bicycle use between countries. This is also reported by Adminaitė & Jost (2020): based on information from eight European countries, the distance cycled per inhabitant is highest for the Netherlands with 865 kilometres per year, and lowest for Great Britain with 80 kilometres per year (Adminaitė & Jost, 2020). Another study (Schepers et al., 2021) examined the amount of cycling in 14 European countries and showed that distances cycled ranged from 30 to 900 kilometres per person per year. This study also showed that, overall, these distances had remained fairly constant since 1990, but that cycling in the capitals of the 14 countries had increased in this period, probably related to the bicycle promotion policies in these cities. The finding that bicycle use is particularly increasing in urban areas is confirmed by recent French data (Vélo & Territoires, 2024): in 2023, compared to 2022, on average 5% more bicycles passages were observed, based on counts at different locations in France. However, increases were only observed in urban areas (+6%). In suburban and rural areas the number of observed passages had remained more or less stable.

In countries where cycling is popular, there is a strong increase in the use of pedelecs. In the Netherlands, for example, the total distance cycled by pedelec has increased across all age groups from 6% of the total distance in 2013 to 38% in 2023 (KiM, 2024). The pedelec is especially popular among cycling seniors, with nearly half of their cycling kilometres covered by pedelec in 2019 (KiM, 2020). A systematic review on pedelecs and travel behaviour change, however, showed that also younger age groups (39-58 years) use pedelecs when they have access to them (Chevance et al., 2025). Moreover, these pedelec trips mostly substitute car trips, reflecting in a 10% decrease in the use of the car (Chevance et al., 2025).

3. Cyclists and road safety

3.1 Crash risk

3.1.1 Reported fatalities

Between 2013 and 2023, the number of fatalities in cyclist crashes increased slightly (2%) whereas these numbers dropped substantially more for other modes of transport (22% on average (European

Commission, 2024; 2025)). In 2022, around 1,950 cyclists died in traffic with many more seriously injured.

The most recent analysis of cyclist fatalities covers the period until 2023 (European Commission, 2025). It shows that in relation to their share in the population, cycling seniors are over-represented in cyclist road fatalities: in 2023 50% of the cyclist fatalities were aged 65 or over. The percentage of cyclists in this age group increased from 45% in 2012 to 50% in 2023 (European Commission, 2024; 2025). The 0-24 year-olds are under-represented: 8% of the cyclist fatalities in 2023 and 26% in the population (European Commission, 2024; 2025). In general, the highest proportion of cycling fatalities can be observed in countries where cycling is popular (e.g. the Netherlands, Denmark, Belgium, Germany).

At EU level, the proportion of men in cyclist fatalities is high (80%). In countries where cycling is common (e.g. the Netherlands, Belgium, Germany, Denmark), the share of male fatalities is lower than the EU average, while their share is higher in Spain, Greece and Romania, where 9 out of 10 cyclist fatalities are male.

Most cyclist fatalities occur in crashes with motor vehicles. However, most cyclists are seriously injured in single bicycle crashes, i.e. crashes without involvement of other vehicles (European Commission, 2021). Fatal bicycle crashes typically occur during the day of the working week and have a seasonal peak during summertime. The number of fatal crashes is twice as high in June-August as in the winter months (December to February). This is most likely related to the fact that cycling is more frequent in summer than in winter.

3.1.2 Under-reporting of bicycle crashes

Bicycle crashes are largely under-reported compared with motor vehicle crashes. An international survey study of more than 7,000 cyclists showed that on average only 10% of all crashes were reported to the police (Shinar et al., 2018). Factors associated with reporting levels were the type of crash and the type of vehicle involved, and also injury severity (Shinar et al., 2018). A Danish in-depth study on hospital data showed similar results: only 11% of the bicycle crashes registered in hospital were registered by the police (Møller, Janstrup & Pilegaard, 2021). Underreporting of bicycle crashes is highest when no motor vehicle is involved in the crash, for example, when a cyclist collides with an obstacle or another cyclist (Schepers et al., 2015). Underreporting is higher for non-fatal crashes, although Dutch data indicate that even fatal bicycle crashes without involvement of motor vehicles are under-reported in police records (Schepers et al., 2017a). This background should be taken into account when evaluating the road safety of cyclists (Nieuwkamp & Schoeters, 2018). Moreover, a recent report on reducing serious injuries on European roads, recommended to national governments to improve the registration and recording of vulnerable road users and tackle underreporting (Carson, Jost & Meinero, 2025).

3.2 Typical crash circumstances

3.2.1 Crashes with motor vehicles

Crashes between cyclists and motor vehicles typically occur in locations where they meet, e.g. at road stretches without separate cycling facilities, at intersections, and at crossing locations (Schepers et al., 2020). EU-wide, around two-thirds of cyclist fatalities occur on road stretches, around one fifth at an intersection or roundabout. Compared with all road fatalities, the proportion of cyclist fatalities is lower on road stretches and considerably higher at intersections (European Commission, 2021a).

A European in-depth study into crashes involving two-wheelers investigated - amongst other things - crashes in which a cyclist had collided with a motor vehicle (Morris et al., 2018). Fatal bicycle crashes or crashes involving seriously injured road users typically (in 45% of the cases) occurred in two types of crash scenario: so-called crossing scenarios where the bicycle and the motor vehicle came from perpendicular directions; and a turning scenario, where the cyclists turned left (in UK right) in front of the motor vehicle (Morris et al., 2018).

A German naturalistic cycling study showed that there are no differences in crash involvement of pedelecs and conventional bicycles, except at intersections. At intersections, the crash involvement of pedelecs was twice as high compared to the conventional bicycle; car drivers did not give priority to the pedelec (Petzoldt et al., 2017a). Furthermore, according to the police in a German longitudinal study, pedelec crashes were more often caused by inappropriate speed than conventional bicycle accidents (Schleinitz & Petzoldt, 2023).

3.2.2 Crashes without motor vehicles

International review studies have shown that among injured cyclists, single-bicycle crashes constitute a significant number of all injuries. (Schepers et al., 2015; Utriainen et al., 2022). These are crashes where no other vehicles are involved or crashes where the cyclist collides with stationary obstacles (e.g. kerb, bollards). A recent longitudinal analysis of German pedelec and bicycle crash data between 2013 and 2021 showed that each year pedelec riders had a significantly higher percentage of single vehicle crashes than conventional cyclists (Schleinitz & Petzoldt, 2023). However, this percentage has increased over the years for both bicycle types.

An in-depth analysis of single bicycle crashes in Denmark showed that the majority of contributory factors in self-reported single-bicycle crashes were skidding on water or ice (60%), road design (24.9%, e.g. kerbstones, obstacles close to the road, maintenance of the road), and to a much lesser extent the condition of the cyclist (e.g. alcohol, 1.4%; speed, 4.6%; distraction, 4.6%) (Olesen et al., 2021).

Similar findings were found in a Finnish study that investigated the characteristics of commuters' single bicycle crashes: more than 60% were related to infrastructure, e.g. slippery road surface (Utriainen, 2020).

An in-depth study involving 50+ cyclists in crashes without motor vehicles was carried out in the Netherlands (Boele-Vos et al., 2017). Three main types of crashes were identified:
- Fall from a bicycle
- Colliding with an object
- Colliding with another cyclist or road user travelling at low speed.

3.3 Contributing crash factors

Usually, a combination of several crash factors leads to a road crash. The next section discusses the contributing factors that lead to bicycle crashes.

3.3.1 Infrastructure

The quality of the road and the general road lay-out play a role in the occurrence and outcome of bicycle crashes. Poor quality and uneven road surfaces (e.g. potholes) are often a contributing factor in crashes without motor vehicles or single bicycle crashes. Typical causes are (e.g. Algurén & Rizzi, 2022; Boele-Vos et al., 2017; Davidse et al., 2014; Møller et al., 2021; Schepers & Klein Wolt, 2012; Utriainen, 2020):
- Poorly visible obstacles
- Lack of markings alongside the road
- Bicycle track and/or road that are too narrow
- Slippery roads due to rain, ice, snow, wet leaves.

One very important factor is the availability of dedicated cycling infrastructure. The absence of dedicated cycleways increases the risk of bicycle crashes with motor vehicles. A recent study showed that controlling for kilometres travelled by bicycle and by motor vehicle, 50-

60% fewer bicycle crashes occur on roads with separated bicycle tracks compared to those with marked or painted bicycle lanes (van Petegem et al., 2021). Also, two-way bicycle tracks have a higher risk of crashes with motor vehicles at unsignalized intersections as compared with one-way bicycle tracks (as discussed in Prati et al., 2018).

3.3.2 The bicycle

The extent to which the bicycle itself plays a role in the occurrence of crashes is difficult to establish and is also not systematically recorded. However, some studies on hospital data of bicycle crashes showed that bicycle defects can contribute to the crash (Krul et al., 2022; Møller, Janstrup & Pilegaard, 2021). Bicycles are vehicles that require balance and at low speeds they are unstable (Schwab & Meijaard, 2013) and may increase the risk of falls (Boele-Vos et al., 2017; Kovácsová et al., 2016). To reduce falls while (dis)mounting the bicycle, (older) cyclists could benefit from lower saddle heights (Boele- Vos et al., 2017).

Furthermore, pedelecs are heavier than bicycles without pedal support. This affects the riding characteristics of the pedelec, especially when (dis)mounting the pedelec and keeping balance at low speeds (Twisk et al., 2017). Loss of balance with pedelecs has been identified as a crash causation factor in surveys (Haustein & Møller, 2016; Hertach et al., 2018).

In a Swiss survey (Hertach et al., 2018) among both pedelec and speed pedelec[1] riders, one third of the respondents (34%) indicated that inability to maintain balance during, for example, an evasive manoeuvre had contributed to the occurrence of the single vehicle crash. According to most respondents (82%), this would also have happened if they had been riding a conventional bicycle. The 18% who reported bicycle characteristics as a crash factor often mentioned weight and balance. In a Danish survey on the crash involvement of pedelec riders (amongst other things), one in ten respondents (10.2%) mentioned the weight of the bicycle and/or balance as factors contributing to safety- critical incidents (Haustein & Møller, 2016).

3.3.3 Behaviour

Most studies, that discuss cyclist behaviour, come from the typical cycling countries and in particular from the Netherlands. Extrapolating the results to countries with substantially lower bicycle traffic and fewer bicycle facilities may be difficult.

[1] Speed pedelecs are categorized as mopeds by EU legislation

Unsafe traffic behaviour by other road users (e.g. speeding, distraction, red light running, and impaired driving) increases the risk of bicycle crashes. Cycling crashes can also be caused by (conscious or unconscious) unsafe cycling behaviour, although this seems to play a lesser role in the occurrence of bicycle crashes than, for example, infrastructural factors, such as slipperiness and obstacles (Olesen et al., 2021). A recent Danish in-depth study analysed bicycle-car crashes on intersections and concluded that in 8 of 27 crashes the cyclist behaviour contributed to the occurrence of the crash. In 7 crashes the cyclist failed to give way. For example, some cycled into a signal-controlled intersection after the light had turned yellow or red or thought they had been seen by the car driver (HVU (Danish Accident Investigation Board), 2024).

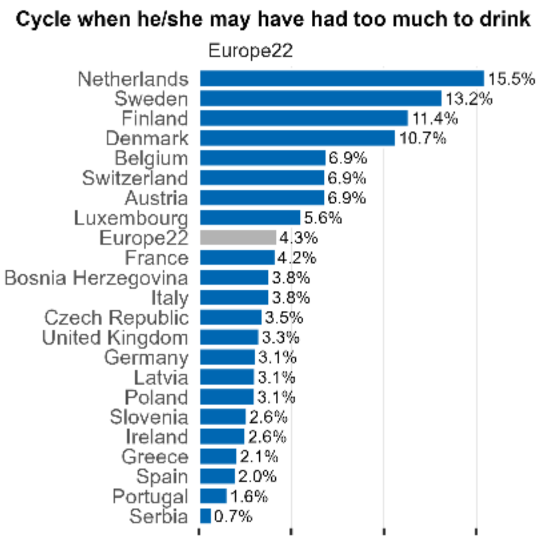
Cycling under the influence of alcohol

Alcohol is an important factor in the occurrence of bicycle crashes, in particular for single bicycle crashes (Møller et al., 2021). There are no recent studies that quantify the risk of cycling under the influence of alcohol. The most recent study dates from the nineties and showed that crash risk for cyclists increases as the blood alcohol content (BAC) increases: the risk of being injured while cycling with a BAC of 1.0 g/l is at least ten times higher than for a sober cyclist (Olkkonen & Honkanen, 1990).

Alcohol measurements in nightlife situations in two Dutch cities showed that 62% of cyclists were under the influence of alcohol and 42% above the legal limit (BAC > 0.5 g/l; De Waard et al., 2016). A retrospective survey of cyclists treated in Dutch emergency departments in the period from July 2020 to June 2021 showed that the proportion of injured cyclists under the influence of alcohol is highest for 18-24- year-olds (26%) and lowest for injured cyclists aged 12-17 (7%) and 55 and over (3-5%) (Krul et al., 2022).

Self-reports from European cyclists (22 countries) also indicate that cycling under the influence of alcohol is a fairly common problem, in particular for men: 5,5% of male cyclists and 3,1% of female cyclists reported that they had cycled when they thought they might have had too much to drink at least once in the last month ((Møller & Jensen, 2024). Figure 1 shows the average results for individual European countries.

Figure 1. *Self-declared cycling under the influence of alcohol in European countries: % of cyclists at least once in the past 30 days (Source: (Møller & Jensen, 2024)).*



Red light running by cyclists

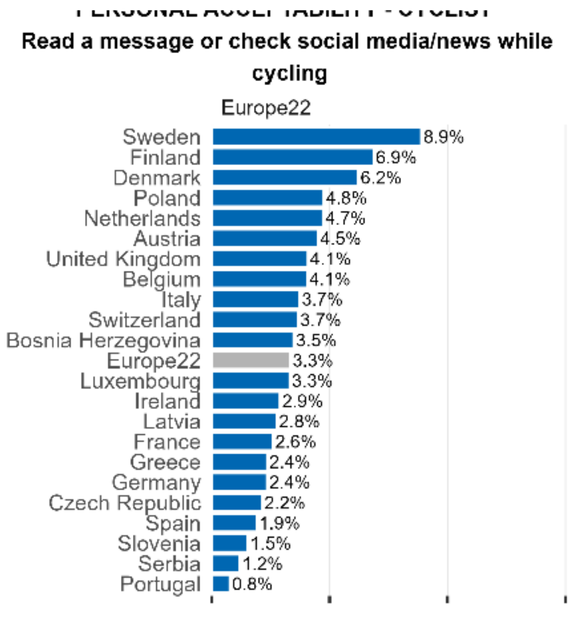
There is some evidence to show that red light running by cyclists is fairly common. A Dutch observation study has given some insight into red light running for three different age groups. Young cyclists (<20 years) and adult cyclists (20-64 years) ran the red light in 35% and 24% of times respectively, whereas older adults (>65 years) ran the red light in 22% of cases (Van der Meel, 2013). A German naturalistic cycling study with 90 participants riding their own bicycles showed that they experienced nearly 8,000 red light situations. In 16.2% of situations, they ran the red light; men violated the red light more often (17.2%) than women (14.9%) and older cyclists had a reduced violation rate (12.8%) compared to other age groups (17.8%) (Schleinitz et al., 2019). It is likely that crash risk increases when cyclists run a red light, because of the increase in the number of possible conflicts with other road users. However, the extent to which risk increases is (still) unknown.

Mobile phone use while cycling

Recent surveys and observational studies show that many cyclists engage in potentially distracting activities. In one Dutch survey, more than half the cyclists (56%) between the ages of 12 and 80 reported sometimes using their phones while cycling (Van der Kint & Mons, 2019). In this study on all mobile phone activity, young people (aged 12-17) were shown to use their phones while cycling more often than adults. Both adult and young cyclists reported using their phones most often to read messages (38% and 55.5% respectively) or send messages (33% and 54% respectively), to set navigation (33% and 36% respectively), or to take pictures or record videos (33% and 43% respectively). Listening to music also proves to be very popular among cyclists, in particular young people. Over 70% of 16-18-year-old cyclists reported sometimes listening to music while cycling (Stelling-Konczak et al., 2017).

EU-wide, self-reports from adult cyclists showed that, on average, almost 4% of them had read text messages or emails or checked social media at their phone while cycling in the past 30 days ((Møller & Jensen, 2024)– Figure 2).

***Figure 2**. Self-declared mobile phone use while cycling in European countries: % of cyclists at least once in the past 30 days (Source: (Møller & Jensen, 2024)., 2020).*



A survey study among Danish and Dutch cyclists (mean age 46 years) - at the time when handheld use of phones was forbidden in Denmark but still legal in the Netherlands - established that believing there were no rules on handheld phone use increased the likelihood of using the handheld phone while cycling (Brandt et al., 2022).

Whether smartphone use by cyclists increases crash risk is still unknown. An in-depth analysis of self-reported single bicycle crashes in Denmark (Olesen et al., 2021) showed that distraction is a contributory factor in only a small number of cases. Furthermore, the results of a bicycle simulator study on handsfree distractions (e.g. listening to (and remembering) a podcast) suggest that these do not impact a relatively simple cycling task (Møller, Luise Berghoefer &

Vollrath, 2024). However, an experimental on-road cycling study using eye-tracking demonstrated that mobile phone use while cycling negatively impacted cyclists' safety, as making calls reduced cycling speed and impaired overall cycling performance. In particular, texting while cycling had the most detrimental effect, as cyclists' attention was increasingly directed towards their phones, thereby decreasing their awareness of the surrounding environment (Jiang et al., 2021).

Speed choice

Naturalistic cycling studies show that cycling speeds on pedelecs is on average 1.7 to 3.6 km/h higher than on conventional bicycles (Dozza et al., 2016; Schleinitz et al., 2017; Twisk et al., 2021; Vlakveld et al., 2015). Speed is an important factor in the occurrence and outcome of road crashes in general: the higher the speed, the more crashes and the more serious the injuries. In theory, this also applies to cyclists, however, so far there is no objective empirical data to verify this. An in-depth analysis of self-reported single bicycle crashes in Denmark (Olesen et al., 2021) showed that speeding contributed to only a small number of cases. However, a recent German longitudinal study showed that pedelec crashes were caused by inappropriate speed for the situation more often than crashes with conventional bicycles (Schleinitz & Petzoldt, 2023).

4. Countermeasures

4.1 Infrastructure

4.1.1 Preventing crashes with motor vehicles

Cycling infrastructure can be improved by constructing bicycle routes and separate bicycle tracks. An important aspect of this is the separation of heavy traffic and bicycles and safer design of 30- and 50 km/h roads (SWOV, 2020).

For instance, in the Netherlands speed-reducing measures at unsignalized intersections (e.g. speed humps) have prevented around 2.5% of the total number of cyclist fatalities (Prati et al., 2018; Schepers et al., 2017b). Furthermore, the overall safety effect of one-way bicycle tracks on busy roads is positive. Research shows that the likelihood of bicycle-motor vehicle crashes at intersections is lower with physically separated bicycle tracks that are 2-5 metres away from the intersection area compared to intersections with bicycle lanes that are not separated from the carriageway[2] or without any bicycle facility. Physical separation of bicycle facilities along road sections reduces even further these type of crashes (Schepers et al., 2011; Schepers et al., 2017b).

Furthermore, international studies show that reducing speed limits from 50km/h to 30 km/h on urban roads contributes to road safety, especially for vulnerable road users such as cyclists. A systematic review by Yannis and Michelaraki (Yannis & Michelaraki, 2024; 2025) analysed the effects of urban 30 km/h measures in 40 European cities, with the following average results:

- 37% fewer traffic fatalities
- 38% fewer serious injuries
- 23% fewer accidents in total

Another, recent, infrastructural development are bicycle streets, a street where bicycles are prioritized and motorized vehicles are restricted in volume and speed. However, the impact on road safety for cyclists is not clear yet (Uijtdewilligen, Wijlhuizen & Nabavi Niaki, 2024).

4.1.2 Preventing crashes without motor vehicles

Recommendations for preventing bicycle crashes without the involvement of motor vehicles by infrastructure measures are derived from knowledge of the causes of these bicycle crashes (see *Section 3.3.1*). Recommendations for a safe infrastructure of dedicated bicycle tracks can be summarized as follows (CROW, 2016):

- No obstacles on or alongside the bicycle track
- Road alignment is visually guided with edge and centre line markings
- Bicycle tracks are sufficiently wide
- Road surface is even, skid-resistant, free of cracks, and clean
- Kerbs and road shoulders are forgiving.

Research is needed to evaluate the effectiveness of these recommendations.

4.2 Bicycle-related measures

Adequate lighting on the bicycle prevents bicycle-motor vehicle crashes because cyclists are more visible (Schepers et al., 2019).

[2] See for the formal definitions of bicycle facilities the UNECE publication *Agreed definitions for types of cycling:* https://unece.org/sites/default/files/2023-10/ECE-TRANS-WP5-GE5-2023-02r1e.pdf

To prevent crashes while (dis)mounting the bicycle it is important that the bicycle fits the cyclists, i.e. allowing (older) cyclists to put both feet on the ground when stopping and dismounting.

One problem that still seems to be in evidence is the fact that other road users underestimate the speed of a pedelec and therefore make wrong and dangerous (crossing) decisions (Petzoldt et al., 2017b). Improving the recognizability of the pedelec, possibly in combination with information about the characteristics of pedelecs, could help improve the expectations of other road users. How recognizability can be improved will have to be further investigated.

Motor skills decline with age. This means, among other things, that looking over the shoulder while maintaining balance becomes increasingly difficult. This problem could be solved with a rear-view mirror on the bicycle, but it could also help younger cyclists gain a better view of the traffic situation behind them. A recently developed rear-view assistant could also warn the cyclist when other vehicles are about to overtake the cyclist and prevent startling the cyclist (Engbers et al., 2018). Bicycles can, like motorized vehicles, also be equipped with warning technologies that deliver direct, real-time alerts to cyclists about surrounding traffic, potential obstacles, and safety-related riding behavior (Jannah et al., 2025). Most technological solutions employ sensors mounted directly on the bicycle or integrated within the on-bike warning mechanism (e.g. radar, lidar, GPS). Although these warning technologies and systems are developed to improve cyclist safety, this systematic review of studies showed that only a few have investigated the effect on crash risk for cyclists (Jannah et al., 2025).

4.3 Protective measures

4.3.1 Bicycle helmets

Evidence has shown that bicycle helmets protect cyclists from head and brain injuries (European Commission 2021b). In the case of a fall or crash, the use of a bicycle helmet has been found to reduce fatal head/brain injury by 71% on average (Høye, 2018). More recent research in France shows that cyclists wearing a helmet can reduce the risk of neurological injuries by up to 90% and the risk of skull fracture by more than 50% in some cases[3].

Bicycle helmets have to undergo several tests and fulfil specific criteria to be approved. An EU approved helmet is provided with a CE marking

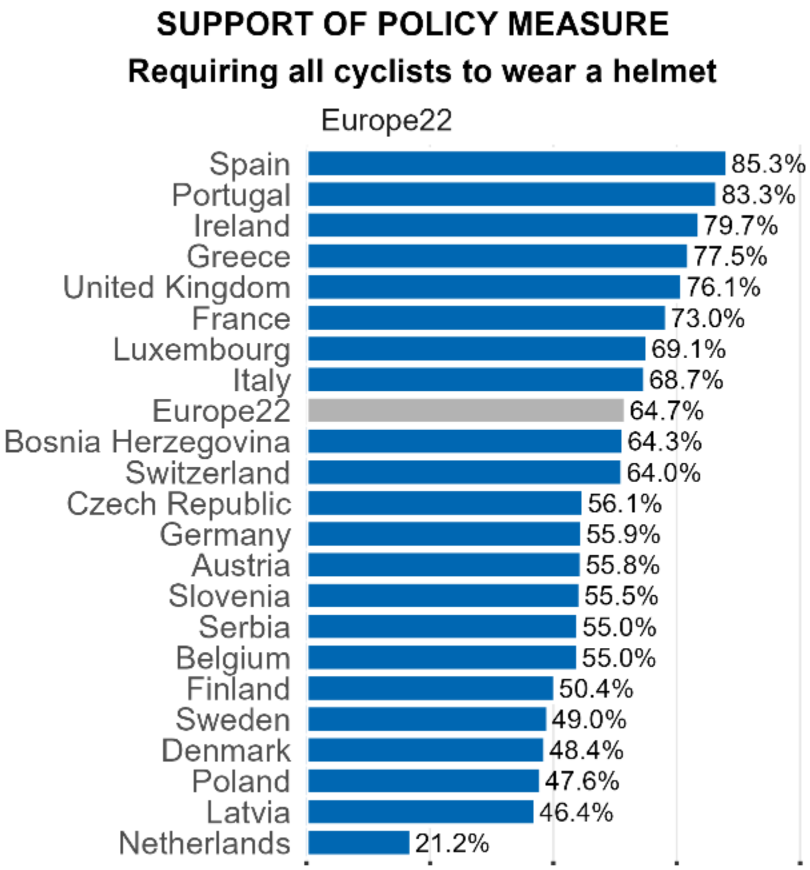
[3] https://www.cerema.fr/fr/system/files?file=documents/2024/05/7._meyer-webinairemobilitecerema-04042024.pdf

plus the number of the European standard: EN-1078 for adults and EN-1080 for children’s helmets. The European standard prescribes a test in which the helmet impacts a flat surface (‘flat anvil’) at a speed of approximately 20 km/hour and a ‘curb’ surface (‘curb anvil’) at a speed of approximately 17 km/hour. Many researchers call for expanding the testing procedures in order to better reflect real life crash conditions, thereby providing stronger evidence on the preventive effect of helmet wearing (e.g., Bland et al., 2018; Deck et al., 2019; Wang et al., 2022).

In many European countries bicycle helmets are not obligatory or only obligatory for children (Adminaitė & Jost, 2020). Denmark is one of the countries where bicycle helmets are not compulsory, but it has been successful in promoting bicycle helmet use through awareness campaigns. Bicycle helmet use in city traffic has increased from 33% in 2015 to 47% in 2020 (Olsson, 2021).

The majority of European road users say they are in favour of making bicycle helmets mandatory with the Dutch being a clear exception ((Stelling, Schmidt & Van der Kint, 2024) – Figure 3). The survey did not single out the views of cyclists alone.

***Figure 3.** Support for requiring all cyclists to wear a helmet among all road users for European countries: % of support (Source: (Stelling, Schmidt & Van der Kint, 2024)).*



4.3.2 Vehicle design

In 2019 the General Safety Regulation[4] was adopted and mandates a range of safety features on new motor vehicles. These systems can contribute to the safety of cyclists. For example:

- Vulnerable road user detection and warnings on the front and side of vehicles (trucks and buses) especially when making turns
- Vulnerable road user improved direct vision from the driver's position (in the case of trucks and buses)
- Intelligent Speed Assistance (ISA) which will often dissuade drivers from driving above the indicated speed limit (cars, vans, trucks, buses)
- Head impact zone enlargement for pedestrians and cyclists - safety glass in case of crash (cars and vans)

[4] https://ec.europa.eu/growth/sectors/automotive-industry/safety-automotive-sector_en

4.3.3 Airbags

Traditionally, airbags are associated with the protection of car occupants. However, airbag technology can also be applied to protect cyclists. First of all, there has been research work into vehicle mounted external airbags. These airbags aim to protect pedestrians and cyclists from impact with the bonnet and windscreen of a car or with the side of a car in case of a collision. Studies have shown substantial injury reducing potential of these airbags, both for cyclists and for pedestrians (Rodarius et al., 2008; Frederiksson et al., 2014; Condrea et al., 2019; Carroll et al., 2022).

There are also airbags that are integrated in the bicycle helmet. It is worn like a collar around the neck and will deploy when a crash is taking place. Airbag helmets are found to reduce head injuries much better than conventional helmets (Stigson et al., 2017; Tse & Holder, 2021).

4.4 Enforcement

Enforcement can be targeted at unsafe traffic behaviour that contributes to bicycle crashes. Enforcement can focus both on motor vehicles (to prevent behaviour that endangers cyclists such as speeding, distraction, close passing, etc.) as well as cyclists (to prevent unsafe cycling behaviour such as insufficient lighting, red light running and handheld phone use).

4.5 Traffic education

There are various traffic education programmes for different groups of cyclists (primary school pupils, secondary education, elderly). These programmes often focus on improving knowledge and skills. Little research has been carried out on the impact of traffic education on the behaviour and crash rate of cyclists. The studies that have been conducted concern mainly younger cyclists and/or suggest that the effects are minor. It also seems relevant to focus on higher order skills, e.g. hazard perception. Hazard perception training courses for cyclists have, for example, being developed in Finland and Belgium (Lehtonen et al., 2016; Zeuwts et al., 2017).

5. Further reading

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SWOV fact sheets on cyclists, pedelecs and speed-pedelecs, bicycle helmets, infrastructure for pedestrians and cyclists: https://swov.nl/en/fact-sheet/cyclists

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