European Commission

Thematic Report
Seniors



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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Summary

This report considers seniors as those aged 65 years and over. Health conditions that reduce mobility and increase crash risk can occur at any age, but do so more frequently from 50 years on. The highest risk is observed for road users over 75 years of age.

Seniors are most at risk in traffic as pedestrians or cyclists. Seniors form a high proportion of casualties as well as being at significantly greater risk per kilometre travelled. As drivers, seniors are a greater risk to themselves than to other road users.

Seniors' high crash risk is due to three factors: *Vulnerability*: crashes are more likely to have serious consequences. This is the most important reason for the overrepresentation of seniors in crash statistics. *Reduced driving*: Seniors typically drive fewer kilometres than younger drivers. Drivers with a low mileage have a higher risk per kilometre (regardless of age) because of the higher proportion of kilometres driven in urban areas and a lack of routine; and *Fitness to drive*: on average seniors have a greater crash risk because of age-related cognitive and physical limitations and health conditions that affect fitness to drive.

Crashes involving seniors typically occur at complex traffic situations. Senior drivers and riders are particularly involved in left-turn crashes (right-turn in case of left-hand traffic countries) and senior pedestrians while crossing at unsignalized locations.

With respect to *infrastructure*, seniors particularly benefit from a clear and predictable lay-out of intersections with ample time to react, as do other road users.

The *fitness* of older drivers should be monitored in a staged system of screening (self-test, advice from the primary care physician; reference to a specialist for a more thorough examination). A general age-based screening of all drivers is not deemed advisable.

Training may counter age-related problems in traffic and support seniors' compensation strategies. However, there is mixed evidence on the effectiveness of such training.

Passive safety measures such as smart seatbelts and bicycle helmets are important for seniors to compensate for their physical vulnerability. Advanced Driver Assistant Systems *(ADAS)* can help seniors by compensating for some age-related problems. Forward collision warning/mitigation, navigation systems, and parking assistants have been favourably evaluated.

1. What is the problem?

Society is continuously aging and the baby boomer generation, who is getting older, is healthier and more mobile than any other previous generation of seniors. The proportion of people aged 65 years or over in the total population of the European Union (EU-27) has been projected to increase from 21.1% in 2022 to 31.3% in 2100 (Eurostat, 2023). Similarly, the number of people aged 80 years or over is expected to grow from 6.1% in 2022 to 14.6% in 2060. With larger absolute numbers and greater participation in traffic, the number of senior road crash casualties is also rising.

Most statistics define seniors as people aged 65 and over. However, it is not possible to draw a firm line here, because this group is very heterogeneous (Bell et al., 2013). Some studies consider 50 or 55 year-olds as seniors already, while others only start with the age group of 70 (Krarup, 2012). This practice reflects the fact that seniors form a very heterogeneous group. Some struggle with health problems and functional loss as early as 50 to 60 years, whereas others are fit until high in their 80s (GOAL, 2013). This report considers seniors as those aged 65 years and over.

On average, the risk of being fatally injured increases from the age of 75 onward. Among those aged 65–74, the average risk is also increased, though to a lesser extent (CONSOL, 2014). It is important to make a distinction between the risk that older adults run themselves, and the risk that they pose to other road users. Evidence, albeit somewhat dated, indicates that older people are primarily at higher risk of being severely or fatally injured in crashes compared with middle-aged road users, while their likelihood of causing a crash that harms others appears less strongly elevated (e.g., Davidse, 2007). Older road users' greater physical vulnerability and the changes associated with ageing form a challenge for policymakers to make the infrastructure 'foolproof', ensure this groups' fitness to drive or cycle, and promote technical solutions that can compensate for certain age-related problems (e.g., Karthaus & Falkenstein, 2016).

2. How do seniors participate in traffic?

With increasing age, seniors reduce both the number and length of their trips. In particular, in between the age of 75 and 79 a drop in the number of trips is observed in many European countries (Bell et al., 2013). A more recent EU-wide survey reports a decline in mobility already from the age of 55 (Armoogum et al., 2022). Although the distribution of transport modes varies between countries, typically the proportion of trips as a car driver decreases while the share of walking and riding as a passenger is increased (Bell et al., 2013). In countries where cycling is common, there is a strong increase in the use of pedelecs (electrically assisted bicycles) by older cyclists. In Germany, for example, 11% of senior households have at least one pedelec, and half of the distances covered by pedelecs are by persons of 60 years and above (Nobis & Kuhnimhof, 2018). In the Netherlands, around 25% of total bicycle distance in the general population is covered by pedelec; among those 65–75 it is almost 50%, and among those 75+ it exceeds 60% (de Haas & Hamersma, 2020). Several European countries are in transition to encourage sustainable modes of transport, but 1. they have not yet completely modified their infrastructure to safely include cyclists and personal mobility devices as scooters, and 2. older users, whether motorists or cyclists, have not yet been able to adapt their behavior to these changes.

3. Seniors and road safety

The rising number of seniors in the population is reflected in the crash statistics. In 1992, in the European Union (EU27) 17% of the people who were killed in a road crash were 65 and older; whereas in 2023 this share had risen to 28%. Seniors make up a large proportion of the pedestrians (47%) and cyclists (47%) killed in road traffic crashes. Accordingly, almost half (49%) of the senior fatalities in Europe (2023) was either a pedestrian or cyclist. In contrast, among younger road users (0-64 years old), pedestrians and cyclists account for only 20% of the fatalities. For more details see Facts and Figures Seniors (European Commission, 2025).

3.1 Crash risk

Compared to middle-aged adults, seniors – especially from 75 years onward – have a greater risk of severe injury or even death in every mode of transport (Bell et al., 2013). For example, in 2013 -2022 in the Netherlands, older (70+) car drivers carried a risk of dying in a road crash 2.8 times higher than younger car drivers (60-) (SWOV, 2024). For older (70+) pedestrians the risk was 6.6 times higher and for older (70+) cyclists the risk was even higher; 12.4 times higher than for younger pedestrians. Whereas 60-69-year old pedestrians and car drivers have a comparable risk to younger pedestrians and car drivers, the risk of dying in a road crash for cyclists increases from the age of 60 years (SWOV, 2024).

For motor-vehicle drivers, we can differentiate between two types of risk: sustaining injuries (or death) oneself due to a crash, or, being involved in a crash where someone else is injured (a passenger or another party). Older drivers are at especially increased risk of dying or being seriously injured due to a crash, but less so to be involved in a crash in which someone else is hurt (Davidse, 2007; Dellinger et al., 2004; Lafont et al., 2010; Tefft, 2008). Seniors are more at risk themselves than being a danger to others in traffic.

3.2 Causation factors

Increased risk for older road users can be ascribed to three factors:

- Frailty bias: older people are more vulnerable. A crash that would leave a younger person with relatively minor injuries can cause severe injuries in older persons. Moreover, seniors have an increased likelihood of complications and even with fatal consequences. Accordingly, older road users are overrepresented in all crash statistics, in particular regarding severe injury and fatality. See for more information Paragraph 3.3. Frailty)

- Reduced driving: older drivers travel less than younger people. Low mileage drivers have a higher risk per kilometre travelled (regardless of age) – particularly because of the type of road that is mostly used (more high-risk urban traffic, fewer low-risk motorways) (Zhu et al., 2025), but also because of the lack of routine (Charlton et al., 2019; Janke, 1991; Langford et al., 2006; Rolison & Moutari, 2018).

- Fitness to drive: on average seniors are at greater risk of being involved in a crash because of age-related cognitive and physical limitations and because of the higher occurrence of diseases that increase crash risk (Charlton et al., 2010; Falkenstein et al., 2020; Vaa, 2003).

3.3 Frailty

Older people’s bones break more easily, broken tissue takes longer to heal, and complications are more likely – in particular in conjunction with possible existing health conditions. For this reason, older road users are severely injured or even killed in crashes that would be less serious for younger people (Ang et al., 2017; Johannsen & Müller, 2013). The EC project SENIORS (Wisch et al., 2017) gives a good overview of injuries for senior road users:

- For *car occupants*, thorax injuries especially are more frequent and more severe in older occupants. For example, breaking three ribs or more is the most common injury type, with the risk being approximately 1.5 times greater for the 65+ age group compared with the 25-64 age group. These injuries are often caused by the seatbelt.

- For *cyclists*, most very severe injuries occur to head, thorax and lower extremities. Injuries to the upper extremity are common among injuries of moderate severity. Moreover, for users of pedelecs, the injury risk is greater for injuries to the head and the upper and lower extremities (Poos et al., 2017).

- In the case of *pedestrians*, the body regions most affected are similar to those for younger pedestrians, namely the lower extremities, the head, and the thorax. Also, senior pedestrians often suffer injuries to the upper extremities, although these are mostly of moderate severity.

3.4 Age-related changes

Older road users are less likely to exhibit risky behaviour. As drivers, they tend to drive more slowly, keep a greater following distance, and are less likely to execute dangerous manoeuvres (such as risky overtaking). A number of functions required to drive a vehicle can however deteriorate with increasing age: sight, in particular peripheral sight and night vision; balance; agility; reaction time. Such deterioration does not affect everybody to the same extent at the same age and does not necessarily lead to reduced fitness to participate in traffic. Often these limitations are compensated for by choosing the place and time where one drives or rides and by a careful driving/riding style. Apart from the "normal" age-related symptoms, chronic diseases such as heart and arterial problems, dementia or arthritis become more frequent at an older age. While limitations related to just one illness can often be compensated for, the risk of crashes increases clearly with multiple diseases. Medicine that is taken because of these conditions can moreover cause drowsiness and inattentiveness and therefore also impair driving (Ramaekers, 2017). (See, e.g., Karthaus and Falkenstein (2016) for more details).

3.5 Typical crashes

3.5.1 Pedestrians

When a pedestrian falls, this is not considered as a road crash if no vehicle is involved (UNECE, 2019). This is estimated to be the case with three out of four injured pedestrians treated in hospital. Consequently, these cases do not figure in any statistics on transport crashes. The cause of this type of crash is often found to be a poorly maintained road surface (Methorst et al., 2017).

In 2022, almost 1 in 2 pedestrian fatalities (47%) was a person aged 65 or older, and the share had increased since 2012 when 44% of the fatally injured pedestrians was over 65 (European Commission, 2024a). In pedestrian crashes with other road users, older pedestrians are overrepresented in crashes at intersections (e.g., O'Hern et al., 2015; Fiorentino et al., 2017). In a literature review (Oxley et al., 2004) it was shown that older adults – especially those with reduced mobility – are less likely to use crossing facilities if this involves more walking. On unsignalised crossings, older pedestrians fail more often than younger ones to take their (slower) walking speed into account, especially in complex traffic environments (Wilmut & Purcell, 2022). Moreover, they are more likely to look down to the ground to avoid falling (Zito et al., 2015) and therefore fail to see other road users. Other causal factors include incorrectly judging the speed of the oncoming vehicle or not expecting the vehicle's manoeuvre (e.g. vehicles reversing or turning). Finally, pedestrians' reduced visibility plays an important role in crashes of all age groups (Ewert, 2012; Oxley et al., 2004).

3.5.2 Cyclists

In 2022, 1 out of 2 cyclist fatalities were persons aged 65 years or older (European Commission, 2024b). The vast majority of the injury crashes of cyclists do not involve motor vehicles, but are falls or collisions with non-motorised vehicles. A study among cyclists who were treated in hospital or the emergency rooms in the Netherlands, Austria, and Switzerland, showed that approximately 90% had been involved in a crash without a motor vehicle (Methorst et al., 2016). This study concerned all age groups, but the share of non-motor vehicle crashes can be expected to be even higher for older cyclists, as they generally have more problems with balancing and getting on and off their bicycle (Methorst et al., 2016). It must be noted that bicycle crashes without motor vehicle involvement are severely underreported and hence much more frequent than crash statistics suggest.

Older cyclists who were involved in a crash *without* a motor vehicle were studied in the Netherlands. Three types of crashes were identified, each with an approximately equal share (Boele-Vos et al., 2017):

1) collided with another cyclist (mainly not so old cyclists, 50-70)
2) bumped into an obstacle (all ages 50+)
3) fell (e.g. due to a steering error or when stopping or turning) (mainly 70+).

Older cyclists colliding *with* a motor vehicle are often turning left (right in countries with left-hand traffic) (Goldenbeld, 1992; Oxley et al., 2004).

Pedelecs (electrically assisted bicycles) are a new, attractive means of transport for senior citizens. In a naturalistic cycling study, it was found that seniors ride their pedelecs more slowly than middle-aged cyclists but faster than their peers on conventional bikes (Schleinitz et al., 2017). The crash-involvement risk when using a pedelec is subject to scientific debate. For older women riding pedelecs poses greater injury risk as compared to riding conventional bicycles, but this effect is not clear for older men (Schepers et al., 2020). Important crash causation factors are problems with balance and unfamiliarity with the pedelec (Fyhri et al., 2019; Schepers et al., 2020).

3.5.3 Car drivers

Intersections are challenging for all drivers because they require simultaneous observation of multiple road users, estimation of their speeds, and rapid decision-making. Some of these skills can deteriorate with ageing, which makes these situations particularly difficult for seniors. Accordingly, senior drivers have a higher percentage of crashes at intersections, especially in left-turn conflicts (or right-turn in left-hand traffic countries). Senior drivers fail more often than middle-aged drivers to give priority to other road users and commit more driving errors such as crossing a red light or deviating from their lane (Fornells et al., 2017; Johannsen & Müller, 2013). In Denmark, an in-depth investigation of 32 crashes involving car drivers of 70 years or over found three types of crash, each taking up about one third of the sample (HVU, 2012):

1) The driver became ill and therefore incapacitated to drive. Denmark had at the time of the study a mandatory medical check-up for senior drivers and all drivers had passed the mandatory examination within the year preceding the crash. The investigator judged in two cases that there could have been doubts regarding the fitness to drive at the time of testing. For two other drivers, it was concluded that they should have realised before departure that their health condition was deteriorating.
2) The driver should have given priority or had crossed a red light. In all cases the senior driver missed some vital information. Contributing factors were stress or anxiety on the senior’s part, exaggerated speed by the other party, and complexity of the infrastructure.

3) The driver was innocently involved because of another road user's error. There was nothing the senior driver could have done to prevent the crash.

4. Countermeasures

4.1 Infrastructure

Infrastructure that is good for seniors is good for everyone. Seniors particularly benefit from clear and predictable layout at intersections, but younger road users also benefit. Important aspects include (Davidse, 2007):

- Pedestrian islands between wide crossover intersections where pedestrians and cyclists can safely wait. With fewer lanes to cross and only one direction to check, the complexity of crossing is reduced.
- Good maintenance of pavement and cycle paths, reducing the risk of falling and the need to look down.
- Good visibility in the approach to an intersection, giving drivers time to anticipate.
- Joining roads at an angle of 90° so that looking back over the shoulder to see oncoming traffic can be avoided.
- Conflict-free traffic lights and separate lanes for left-turning traffic (right turning in case of left hand traffic).
- Clear traffic signs, installed well in advance (right-of-way rules, warnings, indication of lanes).
- Traffic signs and road markings with high contrast and large font.
- Reduced speed.

For the benefit of walking and cycling seniors, road-crossings should have flattened curbs and all walking and cycling infrastructure should be well maintained to prevent potholes, slippery surfaces, protruding tiles, etc. that can cause falls or distract seniors from attending to other aspects of the traffic (Methorst et al., 2017).

4.2 Road users

4.2.1 Fitness-to-drive

Due to the increased numbers and mobility of older drivers in most industrialised countries, there has been a growing concern to ensure the fitness of older drivers. General screening from a certain age seems intuitively the most obvious solution. However, the evidence does not support it (Grabowski et al., 2004; Langford et al., 2008; Martensen, 2017; Siren & Haustein, 2015; Siren & Meng, 2012; Skyving et al., 2018; Vlakveld & Davidse, 2011). In practice, broad testing of all seniors (without any specific reason) has even proven to be counterproductive (Hakamies-Blomqvist et al. 1996; Mikkonen, 2014). One of the reasons is that people who do not drive very often voluntarily cease driving because of the medical examination. This could be a problem for road safety because older road users are typically more at risk when they walk or cycle instead of using the car (Hakamies-Blomqvist et al., 1996; Vlakveld & Davidse, 2011). Moreover, disqualification could mean for those affected a dramatic and unnecessary reduction in social integration (Marottoli et al., 2000). Furthermore, driving cessation is associated with depressive symptoms in older people (Carpenter et al., 2025)

Advising against age-based screening does not mean that it is not necessary to pay attention to the fitness of drivers. A staged system of screening, starting with a simple self-test and /or a visit to the primary care physician, is an alternative to mass screening. If primary care physicians doubt the patient's fitness to drive, they can refer patients to specialists for a more thorough examination, which should be focused on maintaining mobility, e.g. by issuing a limited licence (e.g. day-time only), adjusting medication, or possibly adapting the vehicle (Helman et al., 2017). Medical professionals need to be well informed about the potential risks posed by medical conditions (ETSC, 2021).

The fitness to drive of driving licence holders will in the future be more systematically checked across the EU. The new Directive (EU) 2025/2205 on driving licences[1], which entered into force in November 2025, contains several provisions that aim at ascertaining whether a driver is still (physically and mentally) fit to drive. As a minimum, drivers will be asked to fill in a self-assessment before a licence is issued to them and at each licence renewal or comply with other assessment systems designed at the national level.

4.2.2 Training

In general, no reductions in crash risk or improvements to driving performance have been demonstrated simply as a result of educational measures (e.g., awareness-raising with respect to age-related problems in driving; encouragement to minimise difficulties by avoiding certain situations like not driving at night or during rush-hours; refreshing the knowledge of traffic rules; Fausto et al., 2021). However, the combination of this type of educational measures and practical

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202502205

driving lessons has been shown to improve driving performance (Fausto et al., 2021; Poschadel et al., 2012).

One well-known type of training for older drivers are refresher courses. These courses are offered in many countries and usually consist of a theoretical and a practical part (Marin-Lamellet & Haustein, 2015). The practical part often consists of a feedback drive, where the participants take a ride with an instructor and get feedback afterwards on how to improve their driving.

Another type of training focusses on functionalities that are reduced specifically in older adults, such as useful field of view, information processing speed, or physical agility. This kind of training often takes place in much longer courses (typically 4 to 12 sessions) and has been shown to improve driving performance (Fausto et al., 2021).

Courses can also be aimed at encouraging walking, cycling, and the use of public transport. The drawback of this type of courses is that they usually attract persons who have already adopted the desired behaviours, and the courses are less successful in increasing acceptance of other transport modes by car-reliant users (Marin-Lamellet & Haustein, 2015).

For cyclists, in particular for new users of pedelecs, courses to improve safe cycling have also been suggested (Fyhri et al., 2019; Schepers et al., 2020) and been implemented, for example in the CycleOn programme in the Netherlands. However, effectiveness of these courses has not been investigated yet.

4.3 Vehicles

4.3.1 Passive protection systems

Seatbelts have an important protective function, but nevertheless they can also be the source of injuries (rib fractures) that can be very serious and even life-threatening for senior car occupants (Ekambaram, Frampton & Lenard, 2019). To improve their protection, it is necessary to test vehicles and restraint systems with crash test dummies that reflect the frailty of senior car occupants. Since injury probability for seniors starts increasing at lower speeds, crash tests should also include a moderate speed condition (e.g. 35 km/h) to optimize research into protective measures for this target group. New restraint system concepts can greatly reduce the risk of serious thorax injury to older car occupants in frontal impacts (see e.g. Ekambaram et al., 2015). While benefits will also accrue for occupants of other ages, it has been estimated that new restraint systems would potentially save 800 to

1,200 lives among the 65+ age group and avert 6,500 to 10,500 serious injuries over ten years if implemented in all new cars in Europe, resulting in an estimated economic benefit between 4.7-8.1 billion euro, over the period 2020-2030 (Thomas et al., 2018).

Bicycle helmets can reduce serious head injury by 48% (Høye, 2018), which would be important for senior cyclists who have a heightened risk of head injury – especially if they use a pedelec (Poos et al., 2017).

4.3.2 Assistance and information systems

A distinction can be made between advanced driver assistance systems (ADAS) and in-vehicle navigation systems (IVNS). In a general way, ADAS and IVNS are considered useful for older motorists if they (Davidse, 2006; Mitchell & Suen, 1997):

- draw the driver's attention to oncoming traffic;
- signal road users who are in the driver's blind spot;
- help the driver to focus his or her attention on the important aspects of traffic;
- provide advance information on the traffic situation.

In-vehicle navigation systems (IVNS)

Navigation systems are favourably evaluated, because they help drivers to focus on their driving rather than be distracted by searching for particular roads or streets (Eby et al., 2016; Young et al., 2017). They can however also be a source of distraction from driving (Emmerson et al., 2013). For senior drivers, the reference to landmarks (as icons or audio instructions) can improve the support in way finding (Edwards et al., 2016).

Possible extensions tailored to specific problems of senior drivers have been suggested: specially adapted route selection, e.g. avoid turning left – or right in case of left hand traffic (Schwarze et al., 2014); or displaying relevant information from the environment, e.g. signs or cyclists/pedestrians (Hoffmann et al., 2013). However, products "especially for the elderly" can be perceived as stigmatizing and might not therefore reach their intended user group (Braun et al., 2019).

Advanced Driving Assistance Systems (ADAS)

To evaluate the effects on traffic safety of advanced driving assistance systems, three questions need to be asked: (1) does it (if applied) prevent crashes? (2) is it used?, and (3) could drivers put too much trust in the system (overconfidence)?

Forward collision warning or mitigation can compensate for reduced vision and attention and slower execution of movements due to age. Since the systems work on the basis of radar (among other things) they can compensate for poor night vision. It is estimated that the number of crashes could be reduced by 20% if all vehicles (independent of driver age) were equipped with such a system. Forward collision warning systems are well received by seniors and do not cause overconfidence (Eby et al., 2016).

Intersection assistants can compensate for some seniors' problems by estimating speed and distance of oncoming vehicles and simultaneously monitoring different road users. However, the results of simulator studies are mixed. Some positive results were found, but other studies found no clear improvement in crossing behaviour, and even deterioration. There appeared to be overconfidence in the system in that participants did not check intersections as they did before using the assistant (Becic et al., 2018).

Behavioural adaptation can also be established for *blind-spot warnings*. Many seniors find it increasingly difficult to turn their head and check their blind-spot, which therefore makes a blind-spot warning system welcome to them. Users report increased awareness of the vehicles around them and are seen to check their mirrors more frequently. However, they also make less use of their indicator lights and take fewer looks over their shoulder, which could be seen as overconfidence in the system (Eby et al., 2016).

Parking assistants do not only increase comfort and reduce stress levels, but also reduce some actual dangers such as running into a passing vehicle or pedestrian when backing out of a parking space (Eby et al., 2016).

Use of ADAS and INVS: senior drivers have as many driving assistance systems in their car as the middle-aged generation and are more concerned about safety: and yet older drivers are less comfortable with using modern advanced technology, and less likely to use carry-in technology such as smartphones in their car. However, they tended to use in-vehicle technology such as navigation systems, collision warning systems, and backup cameras at the same rate as younger generations (Owens et al., 2015). Promoting the use of ADAS and INVS would increase the safety of this group. Driving simulators appear to be a safe way of introducing senior citizens to assistance systems. Such hands-on learning appears more effective in promoting the use of such systems than verbal explanation (Bellet et al., 2018).

4.3.3 Vehicle automation

While great hope is placed on ADAS and INVS systems, vehicle automation that takes over the driving task (almost) completely from the driver is seen as even more promising. However, the degree of automation that can realistically be achieved within the next few decades is that of Highly Automated Vehicles (Level 3, SAE/ISO, 2021), and this will not resolve the problem of fitness to drive. When a take-over request from the vehicle occurs, one has to switch from passenger to driver and the mental flexibility required at that moment could be subject to age-related decline. Most studies that have investigated takeover performance by senior drivers in a driving simulator conclude that their performance is poorer compared to younger adults (see the overview of Li et al., 2019 and review by Gasne et al., 2022). Their takeover times are longer, and they steered and braked a little too hard. Older drivers are more intensively engaged in their side activities and benefit more from earlier warning of taking over.

These findings do not address the effect of certain health conditions on the ability to take over the wheel again. To conclude, there are health requirements that must be met for driving an automated vehicle, although they may not be the same as for conventional vehicles. Guidelines will therefore be needed in the foreseeable future for the fitness to drive highly automated vehicles which still require human involvement.

4.3.4 Bicycles for seniors

Older cyclists can benefit from a few simple bicycle modifications like anti-slip pedals, a rearview mirror on the handlebars or a more powerful headlight to see obstacles or suchlike well ahead of time (Schepers, et al., 2020). In order to improve balance and improve safety when gaining speed or slowing down, modified bicycles are being developed. A tricycle can provide stability even at standstill (Schepers et al., 2020); an electric tilting tricycle can provide extra stability while cornering (Stelling, Hettema & Boele, 2024). Another example is a bicycle with a low saddle height - to enable the riders to put their feet on the ground - and an active handlebar support - to keep the bicycle stable at lower speeds (Dubbeldam et al., 2017).

5. Further reading

Davidse, R. J. (2007). *Assisting the older driver: intersection design and in-car devices to improve the safety of the older driver*. Dissertation Groningen University. SWOV, Leidschendam. www.swov.nl/sites/default/files/publicaties/dissertatie/ragnhild_davidse.pdf

Karthaus, M., & Falkenstein, M. (2016). Functional changes and driving performance in older drivers: Assessment and interventions. *Geriatrics* 1(2). https://doi.org/10.3390/geriatrics1020012

Eby, D. W., Molnar, L. J., Zhang, L., St. Louis, R. M., Zanier, N., Kostyniuk, L. P., & Stanciu, S. (2016). Use, perceptions, and benefits of automotive technologies among aging drivers. *Injury Epidemiology*, 3(1). https://doi.org/10.1186/s40621-016-0093-4

Li, S., Blythe, P., Guo, W., & Namdeo, A. (2019). Investigation of older drivers' requirements of the human-machine interaction in highly automated vehicles. *Transportation Research Part F: Traffic Psychology and Behaviour*, 62, 546–563. https://doi.org/10.1016/j.trf.2019.02.009.

6. References

Achermann Stürmer, Y., Berbatovci, H., & Butler, I. (2020). *Cyclists*. ESRA2 Thematic report Nr. 11. ESRA project (E-Survey of Road users' Attitudes). Swiss Council for Accident Prevention. esranet.eu/storage/minisites/esra2018thematicreportno11cyclists.pdf

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. https://doi.org/10.1016/j.archger.2017.05.004

Armoogum J., Garcia C., Gopal Y., Borgato S., Fiorello D., Maffii S., Mars K-J., Popovska T., Schlemmer L., Vincent V., Bogaert M., Gayda S. (2022) *Study on new mobility patterns in European cities. Task A: EU-Wide Passenger Mobility Survey*. Brussels, European Commission.

Becic, E., Edwards, C. J., Manser, M. P., & Donath, M. (2018). Aging and the use of an in-vehicle intersection crossing assist system: An on-road study. *Transportation Research Part F: Traffic Psychology and Behaviour*, 56, 113–122. https://doi.org/10.1016/j.trf.2018.03.032

Bell, D., Pokriefke, E., Risser, R., Biler, S., Šenk, P., Parkes, A., Stannard, J., Armoogum, J., Marin Lamellet, C., Gabaude, C., Loupe Madre, J., Alauzet, A., Monterde i Bort, H., & Henriksson, P. (2013). *Mobility Patterns in the Ageing Populations*. Deliverable WP2 of the EC FP7 Project CONSOL.

Bellet, T., Paris, J. C., & Marin-Lamellet, C. (2018). Difficulties experienced by older drivers during their regular driving and their expectations towards Advanced Driving Aid Systems and vehicle automation. *Transportation Research Part F: Traffic Psychology and Behaviour*, 52, 138–163. https://doi.org/10.1016/j.trf.2017.11.014

Boele-Vos, M. J., Van Duijvenvoorde, K., Doumen, M. J. A., Duivenvoorden, C. W. A. E., Louwerse, W. J. R., & Davidse, R. J. (2017). Crashes involving cyclists aged 50 and over in the Netherlands: An in-depth study. *Accident Analysis and Prevention*, 105, 4–10. https://doi.org/10.1016/j.aap.2016.07.016

Braun, H., Gärtner, M., Trösterer, S., Akkermans, L. E. M., Seinen, M., Meschtscherjakov, A., & Tscheligi, M. (2019). *Advanced driver assistance systems for aging drivers*. Proceedings - 11th International ACM Conference on Automotive User Interfaces and Interactive Vehicular Applications, AutomotiveUI 2019, 123–133. https://doi.org/10.1145/3342197.3344517

Carpenter, J., Koppel, S., & Bennett, J. M. (2025). Understanding the relationship between driving cessation and depressive symptomology in older adults: A systematic review.

Transportation Research Part F: Traffic Psychology and Behaviour, 114, 535–549. https://doi.org/https://doi.org/10.1016/j.trf.2025.05.035

Charlton, J. L., Koppel, S., Odelll, M., Devlin, A., & Langford, J. (2010). *Influence of chronic illness on crash involvement of motor vehicle drivers*. Monash University Accident Research Centre, Melbourne.

Charlton, J.L., Koppel, S., D'Elia, A., Hua, P., et al. (2019). *Changes in driving patterns of older Australians: Findings from the Candrive/Ozcandrive cohort study.* Safety Science, 119, 219-226.

CONSOL (2014). *CONcerns & SOLutions - Road Safety in the Ageing Societies. Synthesis & Recommendations*. Deliverable 6 of the EC FP6 project CONSOL. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/projects_sources/consol_synthesis_recommendations.pdf

Davidse, R.J. (2006). Older drivers and ADAS; Which systems improve road safety? *IATSS Research*, 30(1), 6-20.

Davidse, R. J. (2007). *Assisting the older driver : intersection design and in-car devices to improve the safety of the older driver*. Dissertation Groningen University. SWOV, Leidschendam. www.swov.nl/sites/default/files/publicaties/dissertatie/ragnhild_davidse.pdf

De Haas, M., & Hamersma, M. (2020) *Cycling facts new insights*. The Hague, Netherlands Institute for Transport Policy Analysis – KiM.

Dellinger, A. M., Kresnow, M. J., White, D. D., & Sehgal, M. (2004). Risk to self versus risk to others: How do older drivers compare to others on the road? *American Journal of Preventive Medicine*, 26(3), 217–221. https://doi.org/10.1016/j.amepre.2003.10.021

Dubbeldam, R., Baten, C., Buurke, J. H., & Rietman, J. S. (2017). SOFIE, a bicycle that supports older cyclists? *Accident Analysis and Prevention*, 105, 117–123. https://doi.org/10.1016/j.aap.2016.09.006

Eby, D. W., Molnar, L. J., Zhang, L., St. Louis, R. M., Zanier, N., Kostyniuk, L. P., & Stanciu, S. (2016). Use, perceptions, and benefits of automotive technologies among aging drivers. *Injury Epidemiology*, 3(1). https://doi.org/10.1186/s40621-016-0093-4

Edwards, S. J., Emmerson, C., Namdeo, A., Blythe, P. T., & Guo, W. (2016). Optimising landmark-based route guidance for older drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*, 43, 225–237. https://doi.org/10.1016/j.trf.2016.10.017

Ekambaram, K., Frampton, R., & Bartlett, L. (2015). Improving the Chest Protection of Elderly Occupants in Frontal Crashes Using SMART Load Limiters. *Traffic injury prevention*, 16(Suppl 2), S77–S86. https://doi.org/10.1080/15389588.2015.1064528

Ekambaram, K., Frampton, R. & Lenard, J. (2019). Factors associated with chest injuries to front seat occupants in frontal impacts. *Traffic Injury Prevention, 20 (sup2),* S37–S42.

Emmerson, C., Guo, W., Blythe, P., Namdeo, A., & Edwards, S. (2013). Fork in the road: In-vehicle navigation systems and older drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*, 21, 173–180. https://doi.org/10.1016/j.trf.2013.09.013

Engbers, C., Dubbeldam, R., Brusse-Keizer, M. G. J., Buurke, J. H., de Waard, D., & Rietman, J. S. (2018). Characteristics of older cyclists (65+) and factors associated with self-reported cycling accidents in the Netherlands. *Transportation Research Part F: Traffic Psychology and Behaviour*, 56, 522–530. https://doi.org/10.1016/j.trf.2018.05.020

ETSC (2021). *Are medical fitness to drive procedures fit for purpose?* PIN Flash Report 40. European Traffic Safety Council. Brussels. https://etsc.eu/are-medical-fitness-to-drive-procedures-fit-for-purpose-pin-flash-40/

European Commission (2024b). *Facts and Figures - Cyclists*. European Road Safety Observatory. Brussels, European Commission, Directorate General for Transport.

European Commission (2024a). *Facts and Figures - Pedestrians*. European Road Safety Observatory. Brussels, European Commission, Directorate General for Transport.

European Commission (2025). *Facts and Figures - Seniors.* European Road Safety Observatory. European Commission, Directorate General for Transport, Brussels.

European Commission (2023b) *Facts and Figures Cyclists*. European Road Safety Observatory. Brussels, European Commission, Directorate General for Transport.

Ewert, U. (2012). *Senioren als Fussgänger*. Bfu-Faktenblatt Nr.08. Bfu – Beratungsstelle für Unfallverhütung, Bern.

Falkenstein, M., Karthaus, M. & Brüne-Cohrs, U. (2020). *Age-Related diseases and driving safety*. Geriatrics, 5 (4), 80. https://doi.org/10.3390/geriatrics5040080.

Fastenmeier, W., Gstalter, H., Rompe, K., & Risser, R. (2015). *Selektion oder Befähigung: Wie kann die Mobilität älterer Fahrer aufrechterhalten werden?* Stellungnahme des Vorstandes der Deutschen Gesellschaft für Verkehrspsychologie e.V. Zeitschrift Für Verkehrssicherheit, 61(1), 33–42.

Fausto, B. A., Adorno Maldonado, P. F., Ross, L. A., Lavallière, M., & Edwards, J. D. (2021). A systematic review and meta-analysis of older driver interventions. *Accident Analysis and Prevention*, 149. https://doi.org/10.1016/j.aap.2020.105852

Fiorentino, A., Fornells, A., Schubert, K. & Medina, K.F. (2017). *Behavioural aspects of elderly as road traffic participants and modal split*. SENIORS Deliverable 1.1. European Commission Eight Framework Programme Horizon 2020, Brussels.

Fornells, A., Parera, N., Ferrer, A., & Fiorentino, A. (2017). *Senior Drivers, Bicyclists and Pedestrian Behavior Related with Traffic Accidents and Injuries*. SAE Technical Papers, 2017-March(March). https://doi.org/10.4271/2017-01-1397

Fyhri, A., Johansson, O., & Bjørnskau, T. (2019). Gender differences in accident risk with e-bikes—Survey data from Norway. *Accident Analysis and Prevention*, 132(March), 105248. https://doi.org/10.1016/j.aap.2019.07.024

Gasne, C., Paire-Ficout, L., Bordel, S., Lafont, S., & Ranchet, M. (2022). Takeover performance of older drivers in automated driving: a review. *Transportation Research Part F: Traffic Psychology and Behaviour*, 87, 347-364. https://doi.org/10.1016/j.trf.2022.04.015

GOAL. (2013). *GOAL Transport Needs for an Ageing Society*. *Action Plan.* https://trimis.ec.europa.eu/sites/default/files/project/documents/20140115_095617_32515_Action_Plan Transport_Needs_of_an_Aging_Society.pdf

Goldenbeld, C. (1992). *Ongevallen van oudere fietsers in 1991*. R-92-71. SWOV, Leidschendam.

Grabowski, D. C., Campbell, C. M., & Morrisey, M. A. (2004). Elderly Licensure Laws and Motor Vehicle Fatalities. *Journal of the American Medical Association*, 291 (23), 2840-2846. https://jamanetwork.com/journals/jama/fullarticle/198945

Hakamies-Blomqvist, L., Johansson, K., & Lundberg, C. (1996). Medical screening of older drivers as a traffic safety measure - A comparative Finnish-Swedish evaluation study.

Journal of the American Geriatrics Society, 44(6), 650–653. https://doi.org/10.1111/j.1532-5415.1996.tb01826.x

Helman, S., Vlakveld, W., Fildes, B., Oxley, J., Fernández-medina, K., & Weekley, J. (2017). *Study on driver training, testing and medical fitness*. European Commission, DG MOVE.

Hoffmann, H., Wipking, C., Blanke, L., & Falkenstein, M. (2013). *Experimentelle Untersuchung zur Unterstützung der Entwicklung von Fahrerassistenzsystemen für ältere Kraftfahrer*. Bundesanstalt für Straßenwesen (BASt), Bergisch Gladbach.

Holte, H. (2018). *Seniorinnen und Senioren im Straßenverkehr - Bedarfsanalysen im Kontext von Lebenslagen, Lebensstilen und verkehrssicherheitsrelevanten Erwartungen*. Bundesanstalt für Straßenwesen (BASt), Bergisch Gladbach.

Hoye, A. (2018). Bicycle helmets – To wear or not to wear? A meta-analyses of the effects of bicycle helmets on injuries. *Accident Analysis and Prevention*, 117(December 2017), 85–97. https://doi.org/10.1016/j.aap.2018.03.026

HVU (2012). *Ulykker med aeldre bilister*. Temarapport 9. HVU, Havarikommissionen for Vejtrafikulykker, Copenhagen.

Janke, M.K. (1991). Accidents, mileage, and the exaggeration of risk. *Accident Analysis & Prevention*, 23(2–3), 183-188. https://doi.org/10.1016/0001-4575(91)90048-A

Johannsen, H., & Müller, G. (2013). *Accident and injury risks of elderly car occupants*. Paper presented at the 23rd International Technical Conference on the Enhanced Safety of Vehicles (ESV), 27-30 May 2013, Seoul, South Korea.

Karthaus, M., & Falkenstein, M. (2016). Functional changes and driving performance in older drivers: Assessment and interventions. *Geriatrics*, 1(2), 12. https://doi.org/10.3390/geriatrics1020012

Lafont S, Gabaude C, Paire-Ficout L. et al., (2010) Older drivers less dangerous for the others: results of A study including all injury crashes in France between 1996 and 2005», Le travail humain, 2010/1 (Vol. 73), p. 75-92. https://doi.org/10.3917/th.731.0075.

Langford, J., Bohensky, M., Koppel, S., & Newstead, S. (2008). Do age-based mandatory assessments reduce older drivers' risk to other road users? *Accident Analysis and Prevention*, 40(6), 1913–1918. https://doi.org/10.1016/j.aap.2008.08.010

Langford, J., Methorst, R., & Hakamies-Blomqvist, L. (2006). Older drivers do not have a high crash risk - A replication of low mileage bias. *Accident Analysis and Prevention*, 38(3), 574–578. https://doi.org/10.1016/j.aap.2005.12.002

Li, S., Blythe, P., Guo, W., & Namdeo, A. (2019). Investigation of older drivers' requirements of the human-machine interaction in highly automated vehicles. *Transportation Research Part F: Traffic Psychology and Behaviour*, 62, 546–563. https://doi.org/10.1016/j.trf.2019.02.009

Marin-Lamellet, C., & Haustein, S. (2015). Managing the safe mobility of older road users: How to cope with their diversity? *Journal of Transport and Health*, 2(1), 22–31. https://doi.org/10.1016/j.jth.2014.07.006

Marottoli, R. A., de Leon, C. F. M., Glass, T. A., Williams, C. S., Cooney, L. M., & Berkman, L. F. (2000). Consequences of Driving Cessation: Decreased Out-of-Home Activity Levels. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 55(6), S334–S340. https://doi.org/10.1093/geronb/55.6.s334

Martensen, H (2017), *Age-based screening of elderly drivers*, European Road Safety Decision Support System, developed by the H2020 project SafetyCube. Retrieved from www.roadsafety-dss.eu on 24-9-2023.

Methorst, R., Eenink, R., Cardoso, J., MacHata, K., & Malasek, J. (2016). Single Unprotected Road User Crashes: Europe we have a Problem! *Transportation Research Procedia*, 14, 2297–2305. https://doi.org/10.1016/j.trpro.2016.05.246

Methorst, R., Schepers, P., Christie, N., Dijst, M., Risser, R., Sauter, D., & van Wee, B. (2017). 'Pedestrian falls' as necessary addition to the current definition of traffic crashes for improved public health policies. *Journal of Transport and Health*, 6, 10–12. https://doi.org/10.1016/j.jth.2017.02.005

Mikkonen, V. (2014). *Ajokortin uusintaan liittyvien ikäkausitarkastusten vaikutus liikennemenestykseen*. Trafi Research Report 02/2014. Finnish Transport Safety Agency Trafi, Helsinki. https://www.lvk.fi/document/81935/2BBA82BC430D9938529A102CD53F1D51C8BA859B158699D634BB082BB5BD74DF

Mitchell, C.G.B. & Suen, S.L. (1997). *ITS impact on elderly drivers*. Paper presented at the 13th International Road Federation IRF World Meeting, Toronto, Ontario, Canada, June 16 to 20, 1997.

Nobis, C., & Kuhnimhof, T. (2018). *Mobilität in Deutschland – MiD Ergebnisbericht*. Studie von infas, DLR, IVT und infas 306 im Auftrag des Bundesministers für Verkehr und digitale Infrastruktur (FE-Nr. 70.904/15). www.mobilitaet-in-deutschland.de

O'Hern, S., Oxley, J., & Logan, D. (2015) Older adults at increased risk as pedestrians in Victoria, Australia: An examination of crash characteristics and injury outcomes. *Traffic Injury Prevention*, 16, S161-S167. https://doi.org/10.1080/15389588.2015.1061662.

Oxley, J., Corben, B., Fildes, B., O'HARE, M., & Rothengatter, T. (2004). *Older Vulnerable Road Users: Measures To Reduce Crash and Injury Risk*. Report No. 218. Report. Monash University Accident Research Centre, Melbourne.

Owens, J.M., Antin, J.F., Doerzaph, Z. & Willis, S. (2015). Cross-generational acceptance of and interest in advanced vehicle technologies: A nationwide survey. *Transportation Research Part F: Traffic Psychology and Behaviour, 35,* 139–151.

Pelssers, B. (2020). *Hoe verplaatsen we ons het veiligst? – Onderzoek naar de wijze waarop we ons verplaatsen en verkeersveiligheid*. Vias institute – Kenniscentrum Verkeersveiligheid, Brussels.

Poos, H. P. A. M. J., Lefarth, T. L., Harbers, J. S., Wendt, K. W., El Moumni, M., & Reininga, I. H. F. (2017). E-bikers raken vaker ernstig gewond na fietsongeval: Resultaten uit de Groningse fietsongevallendatabase. *Nederlands Tijdschrift Voor Geneeskunde*, 161(20), 1–17.

Poschadel, S., Boenke, D., Blöbaum, A., & Rabczinski, S. (2012). *Ältere Autofahrer: Erhalt, Verbesserung und Verlängerung der Fahrkompetenz durch Training*. Mobilität im Alter, Band 06. TÜV Rheinland.

Ramaekers, J. G. (2017). Drugs and Driving Research in Medicinal Drug Development. *Trends in Pharmacological Sciences*, 38(4), 319–321. https://doi.org/10.1016/j.tips.2017.01.006

Rolison, J.J., & Moutari, S.S. (2018). Risk-Exposure Density and Mileage Bias in Crash Risk for Older Drivers. *American Journal of Epidemiology*, 187 (1), 53–59. https://doi.org/10.1093/aje/kwx220.

SAE/ISO. (2021). J3016TM Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles. J3016_202104. SAE International/ISO.

Schepers, P., de Geus, B., van Cauwenberg, J., Ampe, T., & Engbers, C. (2020a). The perception of bicycle crashes with and without motor vehicles: Which crash types do older and middle-aged cyclists fear most? *Transportation Research Part F: Traffic Psychology and Behaviour*, 71, 157–167. https://doi.org/10.1016/j.trf.2020.03.021

Schepers, P., Klein Wolt, K., Helbich, M., & Fishman, E. (2020b). Safety of e-bikes compared to conventional bicycles: What role does cyclists' health condition play? *Journal of Transport and Health*, 19(December 2019), 100961. https://doi.org/10.1016/j.jth.2020.100961

Schleinitz, K., Petzoldt, T., Franke-Bartholdt, L., Krems, J., & Gehlert, T. (2017). The German Naturalistic Cycling Study – Comparing cycling speed of riders of different e-bikes and conventional bicycles. *Safety Science*, 92, 290–297. https://doi.org/10.1016/j.ssci.2015.07.027

Schwarze, A., Ehrenpfordt, I., & Eggert, F. (2014). Workload of younger and elderly drivers in different infrastructural situations. *Transportation Research Part F: Traffic Psychology and Behaviour*, 26(PART A), 102–115. https://doi.org/10.1016/j.trf.2014.06.017

Siren, A., & Haustein, S. (2015). Driving licences and medical screening in old age: Review of literature and European licensing policies. *Journal of Transport and Health*, 2(1), 68–78. https://doi.org/10.1016/j.jth.2014.09.003

Siren, A., & Meng, A. (2012). Cognitive screening of older drivers does not produce safety benefits. *Accident Analysis and Prevention*, 45, 634–638. https://doi.org/10.1016/j.aap.2011.09.032

Skyving, M., Forsman, A., & Dukic, T. (2018). *Samband mellan sjukdomar och äldre bilförares inblandning i trafikolyckor*. TSV 2018-4875. Transportstyrelsen, Stockholm.

Stelling, A., Hettema, Z.J.A. & Boele, M.J. (2024). *Ervaringen met een elektrische kanteldriewieler; Praktijktest in de provincie Fryslân*. SWOV, The Hague.

SWOV (2024). *Ouderen in het verkeer*. SWOV-factsheet, August 2024. SWOV, The Hague.

Tefft, B. C. (2008). Risks older drivers pose to themselves and to other road users. *Journal of Safety Research*, 39(6), 577–582. https://doi.org/10.1016/j.jsr.2008.10.002

Thomas, A., Hynd, D., Kent, J., Appleby, J., & Zander, O. (2018). *Benefit analysis SENIORS project*. Deliverable 4.3 of the EC H2020 project SENIORS.

UNECE. (2019). *Glossary for Transport Statistics 2019*, 5th edition. UNECE, Geneva. https://doi.org/10.1787/505b670b-en

Vaa, T. (2003). *Impairments, diseases, age and their relative risks of accident involvement: results from meta-analysis*. Deliverable R1.1 of the EU-project IMMORTAL. https://www.toi.no/getfile.php?mmfileid=5780

Vlakveld, W., & Davidse, R. (2011). *Effect van de verhoging van de keuringsleeftijd op de verkeersveiligheid*. R-2011-6. SWOV, Leidschendam.

Wilmut, K., & Purcell, C. (2022). Why Are Older Adults More at Risk as Pedestrians? A Systematic Review. *Human Factors, 64(8),* 1269–1291. https://doi.org/10.1177/0018720821989511

Wisch, M., Vukovic, E., Schäfer, R., Hynd, D., Barrow, A., Khatry, R., Fiorentino, A., Fornells, A., Pradeep, P., & Lübbe, N. (2017). *Road traffic accidents involving the elderly and obese people in Europe incl. investigation of the risk of injury and disabilities*. Deliverable 1.2 of EC H2020 project SENIORS.

Young, K. L., Koppel, S., & Charlton, J. L. (2017). Toward best practice in Human Machine Interface design for older drivers: A review of current design guidelines. *Accident Analysis and Prevention*, 106, 460–467. https://doi.org/10.1016/j.aap.2016.06.010

Zhu, Y., Jiang, M., & Yamamoto, T. (2025). Personality, functional performance, and travel patterns related to older drivers' risky driving behavior: A naturalistic driving study. *Accident Analysis & Prevention, 209,* 107833. https://doi.org/https://doi.org/10.1016/j.aap.2024.107833

Zito, G.A., Cazzoli, D., Scheffler, L., Jäger, M., et al. (2015). Street crossing behavior in younger and older pedestrians: an eye- and head-tracking study. *BMC Geriatrics, 15 (1),* 176.

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