CENTRUM DOPRAVNÍHO VÝZKUMU

Seniors in road traffic

Czech In-Depth Accident Study (CzIDAS)

Transport Research Centre (CDV)

Seniors in road traffic
Czech in-depth accident study

CDV: Transport Research Centre, Czech Republic

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Table of concents

Seniors in road traffic 2
Table of concents 3
1 Introduction 4
2 Czech in-depth study 4
3 Seniors in road traffic and specifics of their crashes 4
3.1 Crashes occurrence and contributory factors 6
3.1.1 Pedestrians 6
3.1.2 Cyclists 7
3.1.3 Drivers 8
3.2 Crash consequences 10
3.2.1 Pedestrians 10
3.2.2 Cyclists 13
3.2.3 Senior in the vehicle 16
4 Conclusion 18
Seniors in road traffic 20

1 Introduction

Human ageing is a complex and sindividualised process involving biological, psychological, sociological and behavioural changes. With advanced age, awareness and adaptability decrease, difficulties with adjustment to the new situation increase, adverse changes in the cognitive and intellectual sphere appear, perception process involutes, perceived sensations and information received is lowered, thinking processes change, and memory skills decrease.[1]

Mobility is an essential determinant of the quality of life influencing the ability to ensure crucial needs related to the social, psychological, and economic aspects of individuals' life. A number of previous studies concluded that traffic participation (including driving) is a substantial part of life quality. The presence of seniors in road traffic is also related to various safety issues. The elderly are a growing and vulnerable road user group.[2] [3]

The aim of the thematic report is to analyse selected safety issues related to the senior crashes. Seniors or elderly road traffic participants are defined as people aged 65 or older to match government statistics and road safety strategies. For the purpose of the analysis, aunique dataset of Czech in-depth Study Database will be used.

2 Czech in-depth study

Czech in-depth accident study (CzIDAS) is carried out by the Transport Research Centre (CDV) since 2011. Data from In-depth Accident Analysis provide a comprehensive view of all the factors related to a particular crash. The data serve to identify the characteristics leading to the accident causation and influencing its consequences.

The in-depth crash investigation teams document all relevant information at the scene immediately after the occurrence of a traffic crash. The crash analysis includes information about:

- **traffic environment,**
- **vehicles** and their deformation
- **human factors**
- crash mechanism, including the injury mechanism

Since CzIDAS project launch in 2011, more than 2000 traffic crashes have been analysed.[4] **Conducting of Czech in-depth accident analysis is supported by Czech Ministry of Transport.**

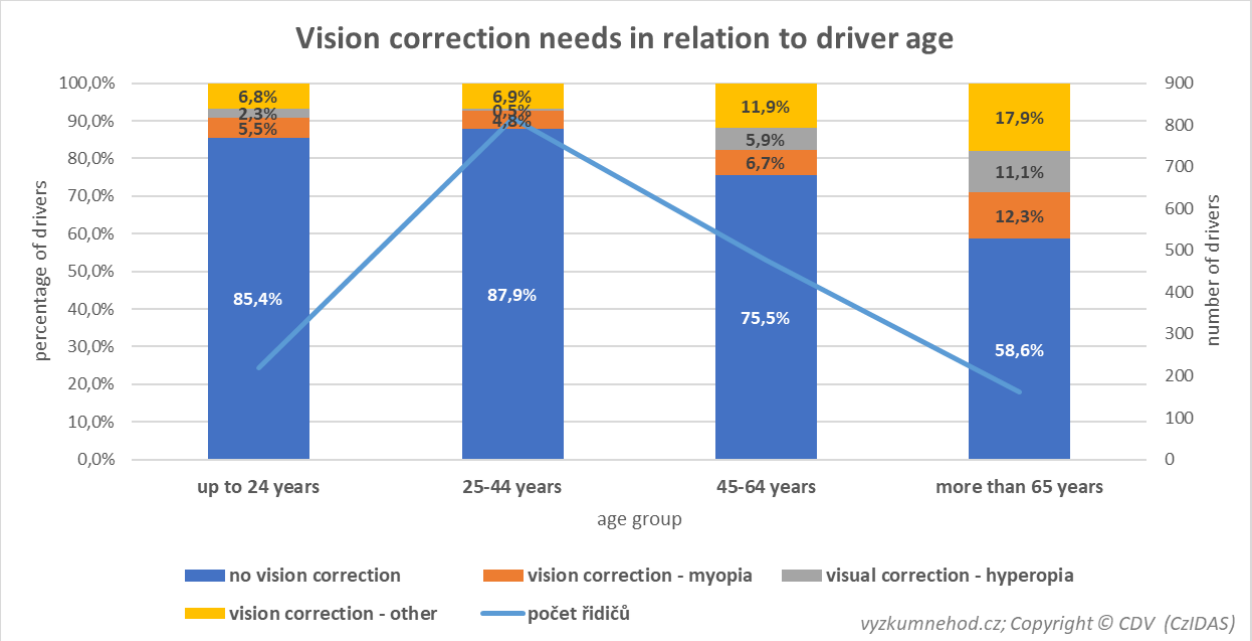
3 Seniors in road traffic and specifics of their crashes

Ageing is related to the deterioration of motoric and cognitive abilities and also vision, hearing, and sensation. The limited cognitive capabilities require a longer time to recognise hazards and respond, the orientation, decision-making, and judgment in a high-complex situation where it is necessary to

[1] Dziechciaz, M., & Filip, R. (2014). Biological psychological and social determinants of old age: Bio-psycho-social aspects of human aging. *Annals of Agricultural and Environmental Medicine*, *21*(4).
[2] Fildes, B. N., Corben, B., Kent, S. M., Oxley, J., Le, T. M., & Ryan, P. (1994). Older road user crashes.Monash University
[3] Rosenbloom, S. (1988). The mobility needs of the elderly. *Transportation in and Aging Society, Improving Mobility and Safety for Older Persons*, *2*, 21-71.
[4] Zůvala, R., Bucsuházy, K., Valentová, V., Frič, J. (2021). Representativeness of Czech In-Depth Accident Data. *Safety*, Vol. 7, No. 40. DOI: 10.3390/safety7020040

process information quickly are problematic. These factors could negatively influence the ability of safe movement in road traffic.

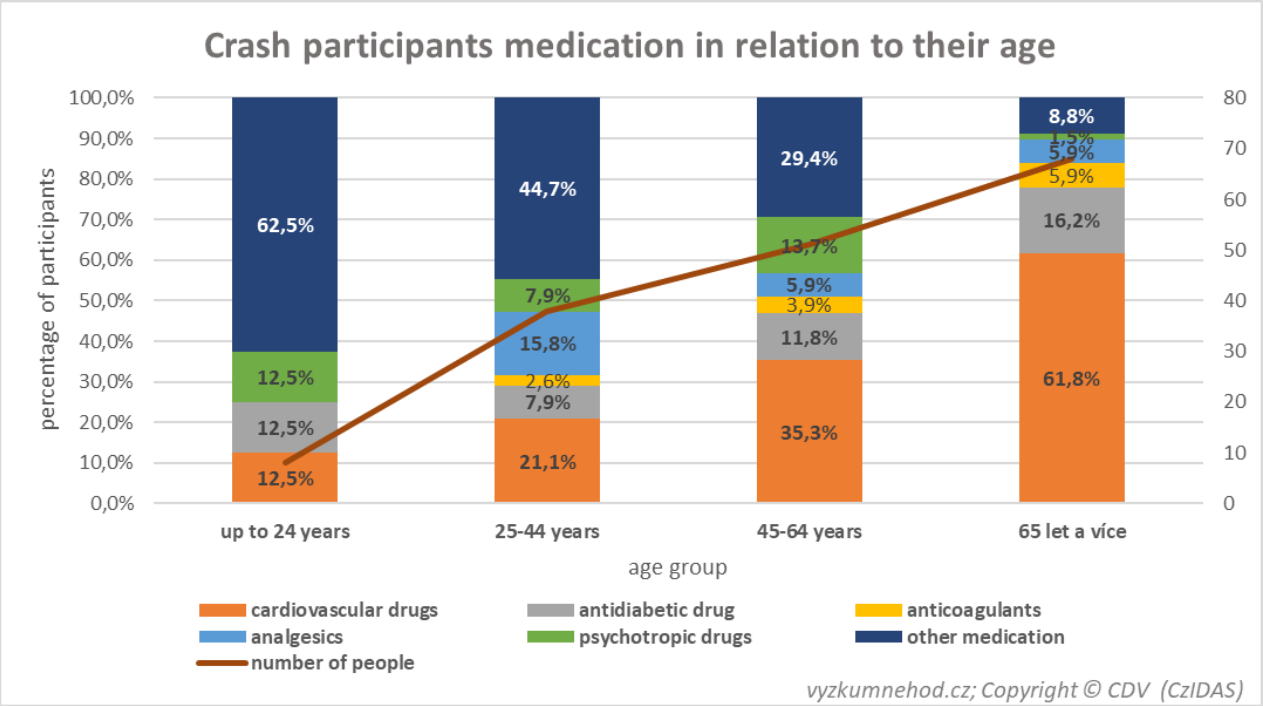
- The CzIDAS data confirmed a higher percentage of senior drivers who need visual correction. In the senior age, almost half of crash participants reported need of some vision correction for driving.



Ageing is related with reduction of resilience to trauma and biomechanical tolerance.[5] The elderly are predisposed to a variety of diseases, especially chronic illnesses (e.g. peripheral arterial disease, osteoporosis, hypertension, diabetes etc.) [6] [7] [8]. Increased vulnerability in road traffic is connected with older people with multiple chronic morbidities and taking multiple medications. But it is also important to mention that there is a greater variance in health conditions among the elderly[9].

- The CzIDAS data illustrate an increasing trend of medication use by road users – crash participants, respectively - in connection with older age – especially cardiovascular drugs.

[5] Oxley, J., Corben, B., Fildes, B., O'Hare, M., & Rothengatter, T. (2004). Older vulnerable road users- measures to reduce crash and injury risk. *Monash University Accident Research Centre Reports*, *218*, 162.
[6] Zhao, C., Wong, L., Zhu, Q., & Yang, H. (2018). Prevalence and correlates of chronic diseases in an elderly population: A community-based survey in Haikou. *PloS one*, *13*(6), e0199006.
[7] Collins, T. C., Ewing, S. K., Diem, S. J., Taylor, B. C., Orwoll, E. S., Cummings, S. R., ... & Ensrud, K. E. (2009). Peripheral arterial disease is associated with higher rates of hip bone loss and increased fracture risk in older men. *Circulation*, *119*(17), 2305-2312.
[8] Schmucker, D. L. (2005). Age-related changes in liver structure and function: Implications for disease?. *Experimental gerontology*, *40*(8-9), 650-659.
[9] Kim, Joon-Ki, et al. A note on modeling pedestrian-injury severity in motor-vehicle crashes with the mixed logit model. Crash Analysis & Prevention, 2010, 42.6: 1751-1758.



The following chapters will introduce factors contributing to senior crash occurrence and essential characteristics related to seniors' vulnerability in road traffic in different roles – as pedestrians, cyclists, and drivers or vehicle passengers.

3.1 Crashes occurrence and contributory factors

3.1.1 Pedestrians

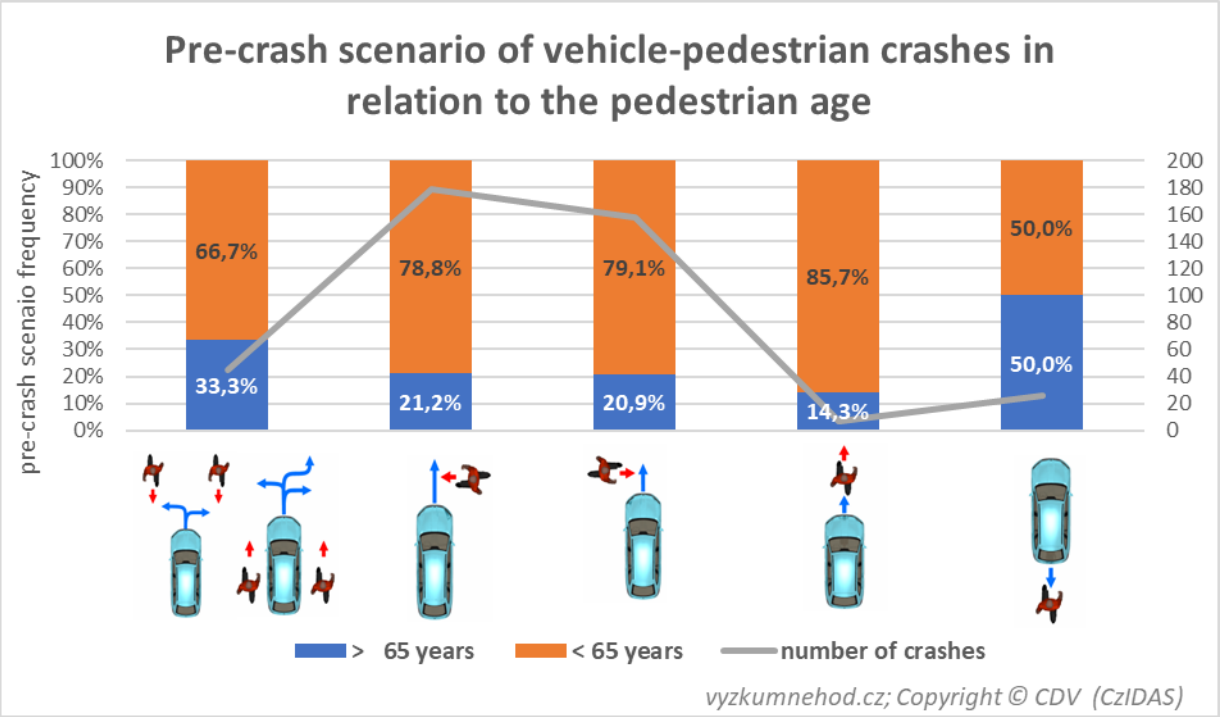
Generally, the most frequent vehicle – pedestrian crash scenario includes pedestrian crossing and vehicle driving straight. The analysis of crash mechanism in relation to the pedestrian age shows a higher proportion of elderly pedestrians in the following vehicle – pedestrian crash scenarios:

- Turning vehicle
- Backing vehicle

As highlighted by Kim[10], improved street crossing environments and intersections, due to older adults' higher involvement in crashes with turning vehicles, are critical to promote older pedestrian safety. It is also necessary to highlight risks related to ageing and resulting limits in the senior movement in road traffic – reduced physical capabilities results in less mobility, reduced ability to move out of the way of oncoming vehicles, reduction in sensory and cognitive capabilities results in different traffic judgement while crossing in comparison to younger people. [11]

[10] Kim, S., & Ulfarsson, G. F. (2019). Traffic safety in an aging society: Analysis of older pedestrian crashes. *Journal of transportation safety &* security, 11(3), 323-332.

[11] Oxley, J., Corben, B., Fildes, B., O'Hare, M., & Rothengatter, T. (2004). Older vulnerable road users- measures to reduce crash and injury risk. *Monash University Accident Research Centre Reports*, *218*, 162.



3.1.2 Cyclists

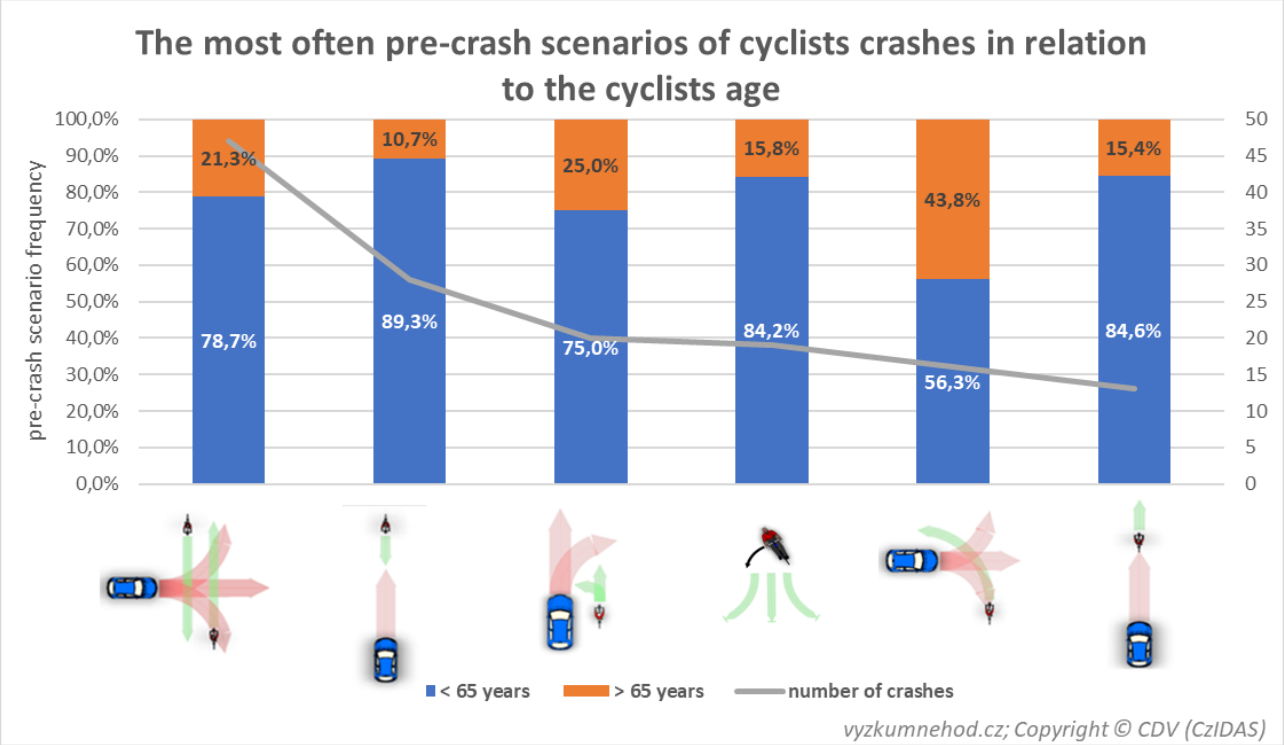
Generally, bicycle – vehicle collision often occurs at intersections (similar results were also described in [12] [13]).

- The analysis of crash mechanism in relation to the cyclist age shows a higher proportion of elderly cyclists in crash scenarios at intersections, especially **seniors are significantly more often involved in pre-crash scenarios at intersection when bicyclists turn left.**

The analysis also shows higher proportion of elderly cyclists when cyclist change direction during riding or vehicle change direction during driving and crash with cyclist riding in the same direction.

The complex traffic situation such as intersections are especially for elderly cyclists difficult to negotiate.Older cyclist behavior could be more unpredictable due to physical difficulties they could also decide on particular maneuver at the last moment. [14]

12 Wang Y, Nihan N L. Estimating the risk of collisions between bicycles and motor vehicles at signalized intersections. Accident Analysis and Prevention. 2004;36:313–321.
13 Isaksson-Hellman, I. (2012, October). A study of bicycle and passenger car collisions based on insurance claims data. In Annals of Advances in Automotive Medicine/Annual Scientific Conference (Vol. 56, p. 3). Association for the Advancement of Automotive Medicine.
14 Oxley, J., Corben, B., Fildes, B., O'Hare, M., & Rothengatter, T. (2004). Older vulnerable road users- measures to reduce crash and injury risk. *Monash University Accident Research Centre Reports*, *218*, 162.

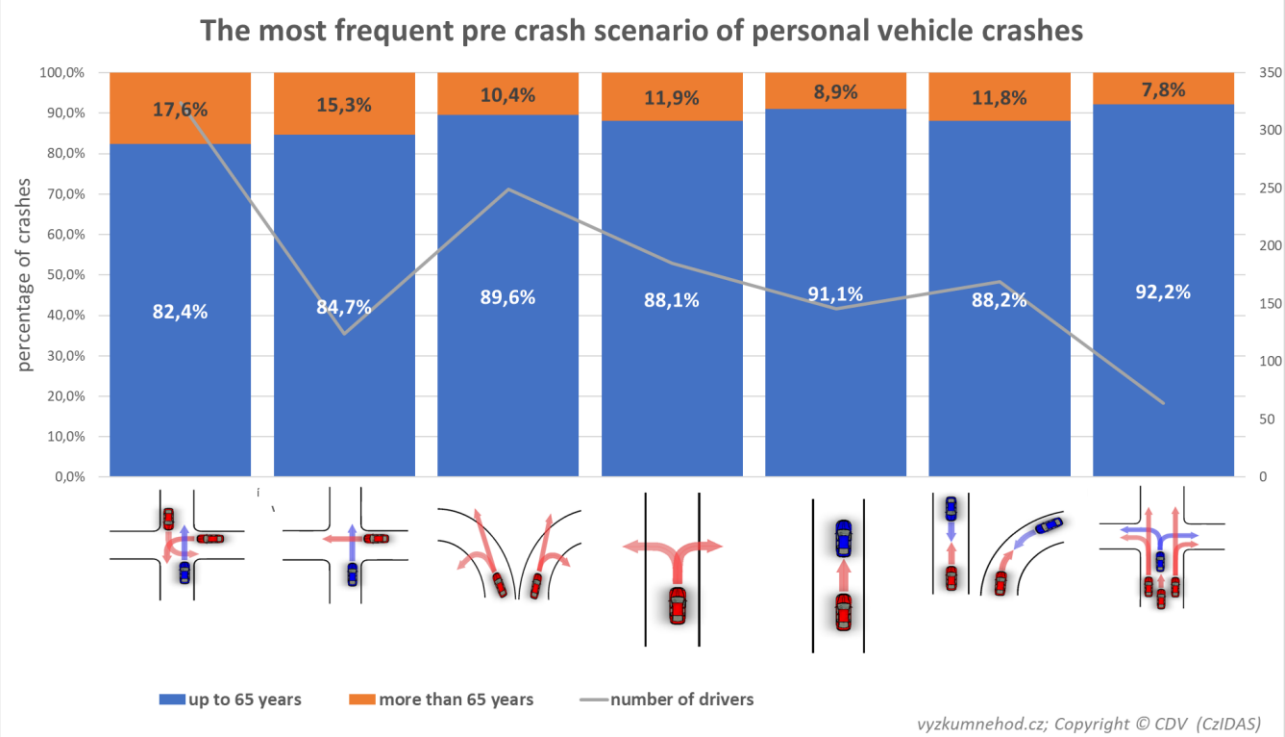


3.1.3 Drivers

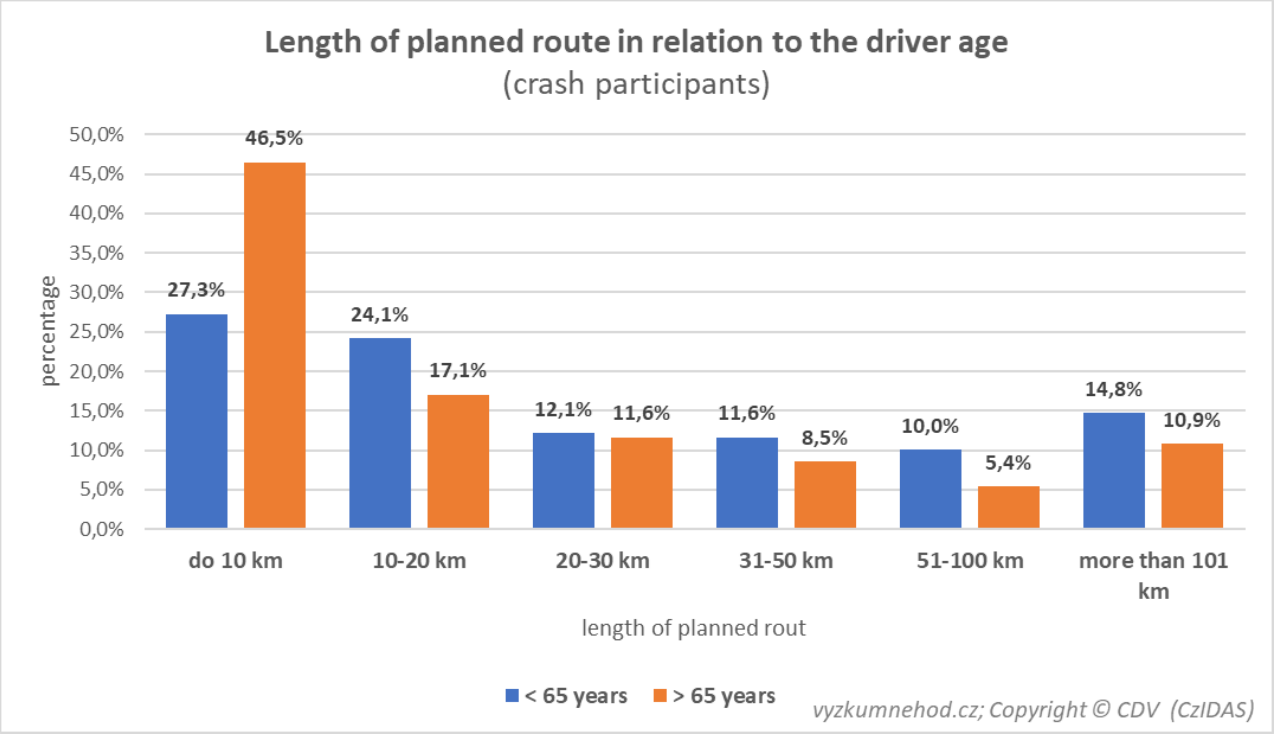
Concerning higher age, elderly crashes are more likely to be influenced by long-term factors of reduced capability to meet traffic contingencies such as reduction of cognitive and psychomotor function. [15] [16] Atwood et al. (2018) described that seniors and teenagers are more adversely impacted by secondary-task engagement than middle-aged drivers. [17]

- **Elderly driver crashes often occur at intersections. Specifically, critical movement, especially for elderly drivers, is left turning when it is necessary to give way to oncoming vehicles and sufficiently estimate gaps to perform the maneuver.** The proportion of seniors in left-turn scenarios is higher than the other most frequent pre-crash scenarios.

[15] Bucsuházy, K., Matuchová, E., Zůvala, R., Moravcová, P., Kostíková, M., & Mikulec, R. (2020). Human factors contributing to the road traffic accident occurrence. *Transportation research procedia*, *45*, 555-561.
[16] PETRIDOU, E., MOUSTAKI, M. (2000). Human factors in the causation of road traffic crashes. European Journal of Epidemiology, 16.9: 819- 826.
[17] Atwood, J., Guo, F., Fitch, G., & Dingus, T. A. (2018). The driver-level crash risk associated with daily cellphone use and cellphone use while driving. *Accident Analysis & Prevention*, *119*, 149-154.



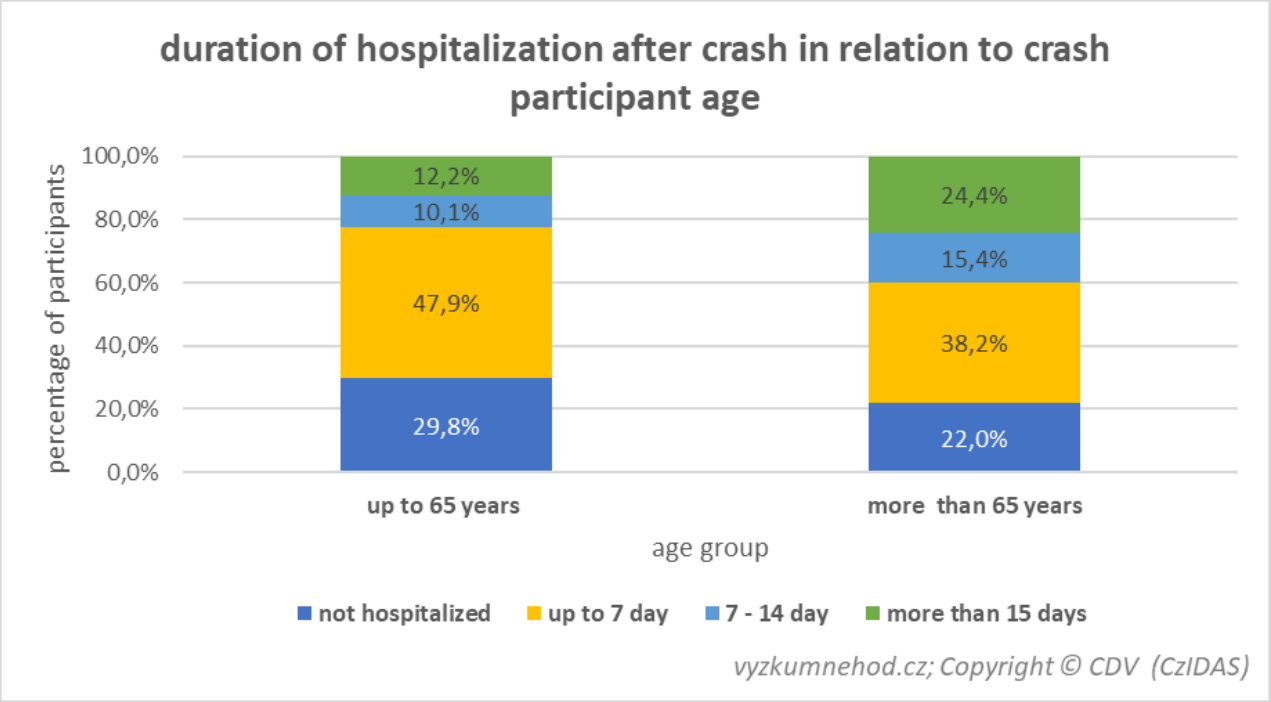
The context of senior drivers differs from younger ones, especially since senior drivers often drive for shorter distances. Comparing the length of the planned route with the driver's age, it is noticeable that approximately **half of the seniors' journeys are up to 10 km.** This proportion is almost doubled in comparison with the younger age group (the planned route length of younger drivers is up to 10 km in only approximately 27% of cases)



3.2 Crash consequences

Seniors are one of the most vulnerable groups in road traffic – they are predisposed to various diseases and take multiple medications, which is also reflected in the total treatment time or hospitalisation of the patient after a crash.

- CzIDAS data shows that a **hospitalisation period of 15 or more days is approximately twice as frequent among the elderly compared to the younger ones** - approximately 24% of injured crash participants spend 15 or more days in hospital after a crash.



3.2.1 Pedestrians

The character of pedestrian injuries involved in pedestrian – vehicle crashes is more severe than two-vehicle crashes. Unlike a vehicle occupant, pedestrians are unprotected. Elderly pedestrians are overrepresented in severe and fatal crashes[18].

Various factors could influence the severity of pedestrian injuries. The crash mechanism and injury severity is most significantly influenced by impact speed.[19] [20] [21]

[18] Vanlaar, W., Hing, M. M., Brown, S., McAteer, H., Crain, J., & McFaull, S. (2016). Fatal and serious injuries related to vulnerable road users in Canada. *Journal of safety research*, *58*, 67-77.

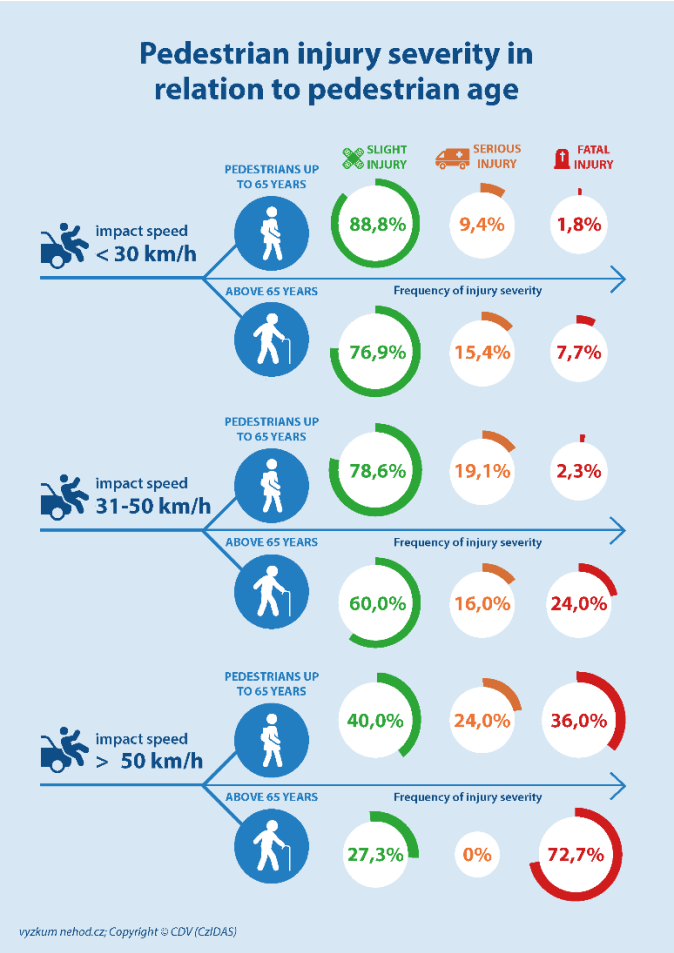
[19] Fildes, B., Gabler, H. C., Otte, D., Linder, A., & Sparke, L. (2004, September). Pedestrian impact priorities using real-world crash data and harm. In IRCOBI conference, Graz.

[20] Rosen, E., Stigson, H., & Sander, U. (2011). Literature review of pedestrian fatality risk as a function of car impact speed. Crash Analysis & Prevention, 43(1), 25-33.

[21] Teft, Brian C. Impact speed and a pedestrian's risk of severe injury or death. Crash Analysis and Prevention. 2013, (50), 871-878.

Seniors are higher-risk participants. As pedestrians became older, the probability of severe injuries increases (increasing age almost exponentially increases the risk of death)[22] [23].

- **As could be observed from CzIDAS data, not only does the probability of severe and fatal injuries increase with higher age, but even lower-speed crashes could, with higher probability, result in severe or fatal injuries.**



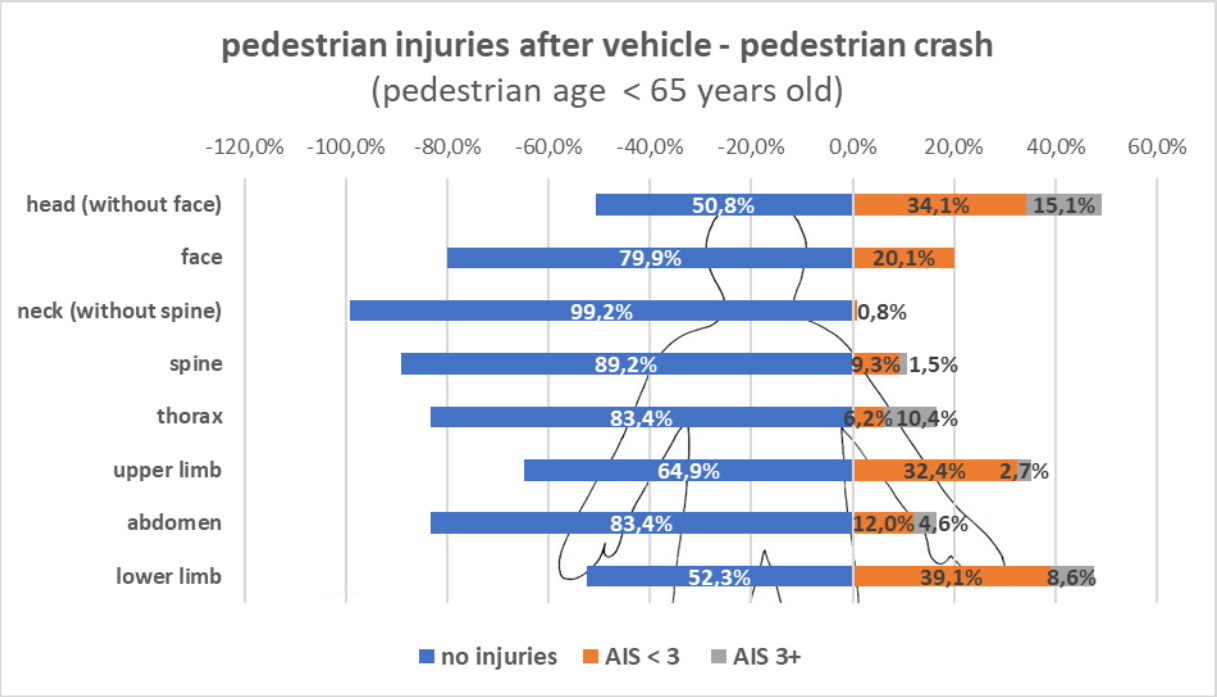
The **most frequently injured pedestrian body regions are the lower extremities, the head and the upper extremities**. [24] These locations of injuries are major regardless of age – senior and non-senior.

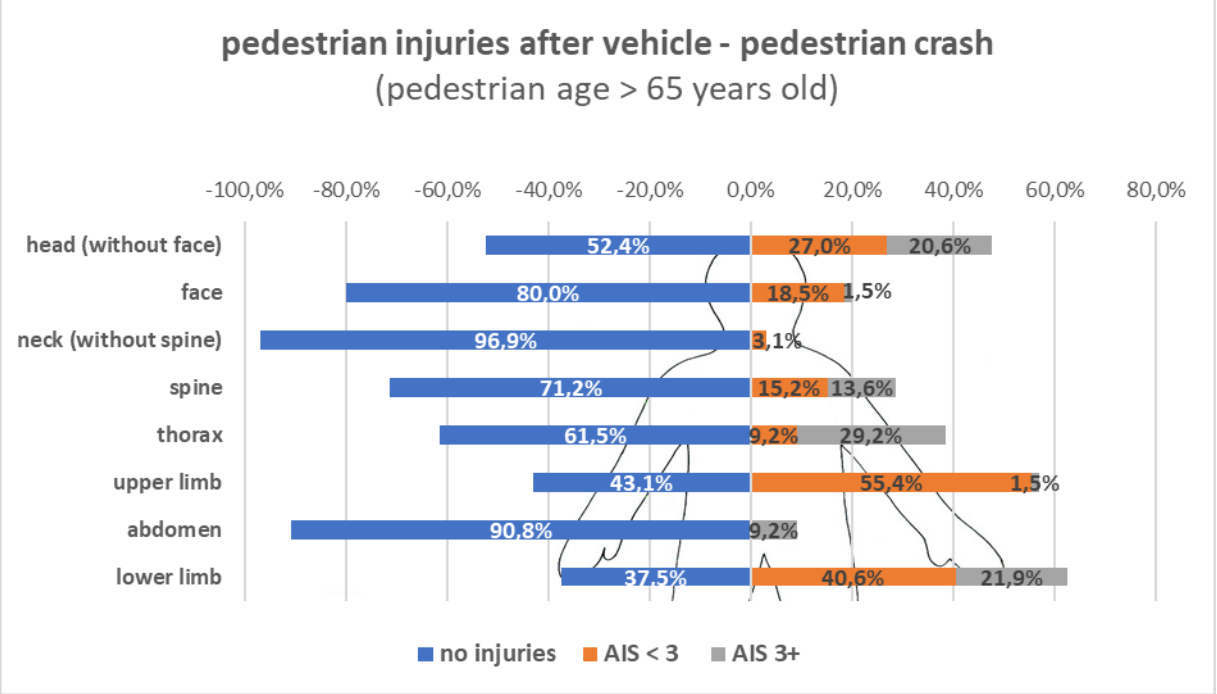
- **Older pedestrians more often received thoracic and spine injuries than younger ones.**

[22] Kim, Joon-Ki, et al. A note on modeling pedestrian-injury severity in motor-vehicle crashes with the mixed logit model. Crash Analysis & Prevention, 2010, 42.6: 1751-1758

[23] MARTINEZ-RUIZ, Virgina, Miriam VALENZUELA-MARTINEZ, Pablo LARDELLI-CLARET, Daniel MOLINA-SOBERANES a Elena MORENO-ROLDAN. Factors related to the risk of pedestrian fatality after a crash in Spain, 1993–2013. Journal of Transport & Health. ELSEVIER SCI LTD, 2019, 12, 279-289. DOI: 10.1016 / j.jth.2019.02.008.

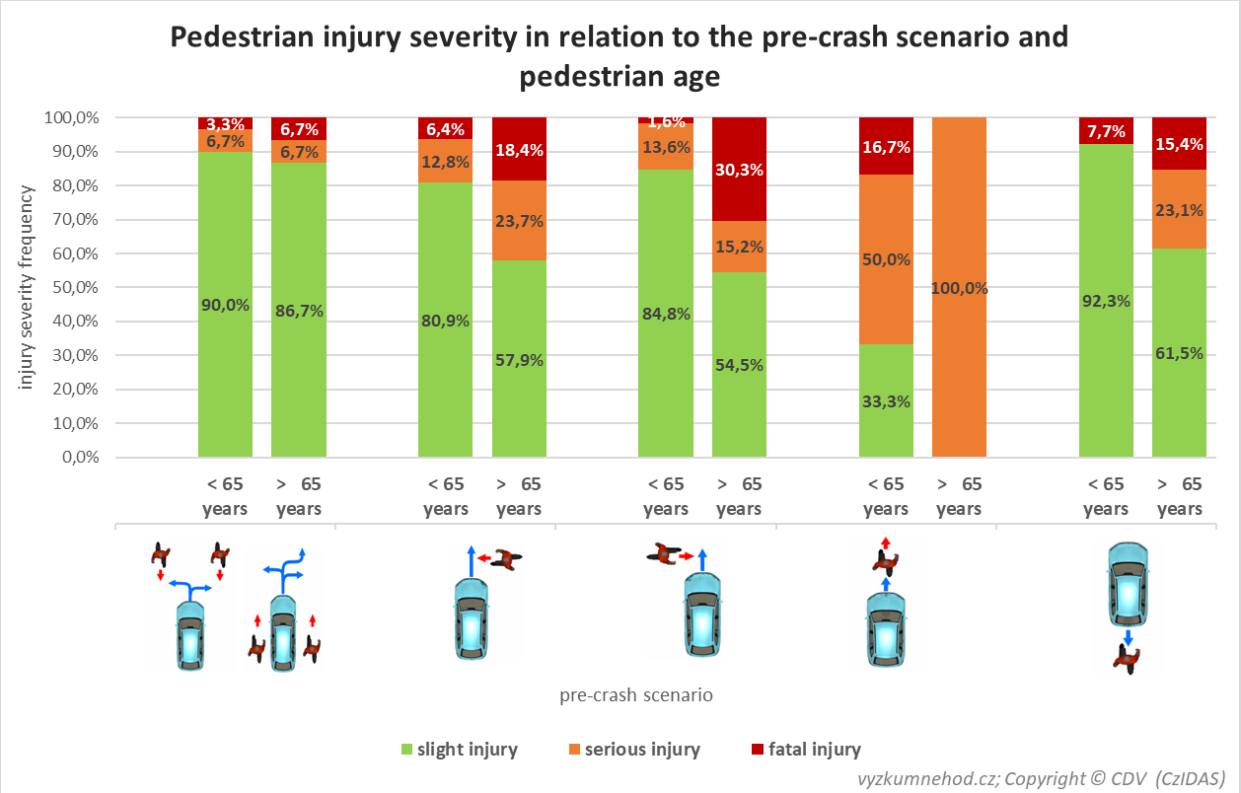
[24] Martin, J. L., Lardy, A., & Laumon, B. (2011, October). Pedestrian injury patterns according to car and casualty characteristics in France. In *Annals of advances in automotive medicine/annual scientific conference* (Vol. 55, p. 137). Association for the Advancement of Automotive Medicine.





Elderly pedestrians are more vulnerable to injury, regardless of crash mechanism. The probability of severe injuries is higher for seniors in all crash scenarios.

- The riskiest scenario is striking a pedestrian from behind, but these crashes are not as frequent among seniors.
- High risk is also connected with crashes during pedestrian crossing the road.
- Serious consequences related to higher seniors vulnerability are also associated with crashes when a pedestrian is struck by a vehicle backing up - the driver usually does not register the impending danger and is not prepared to stop.

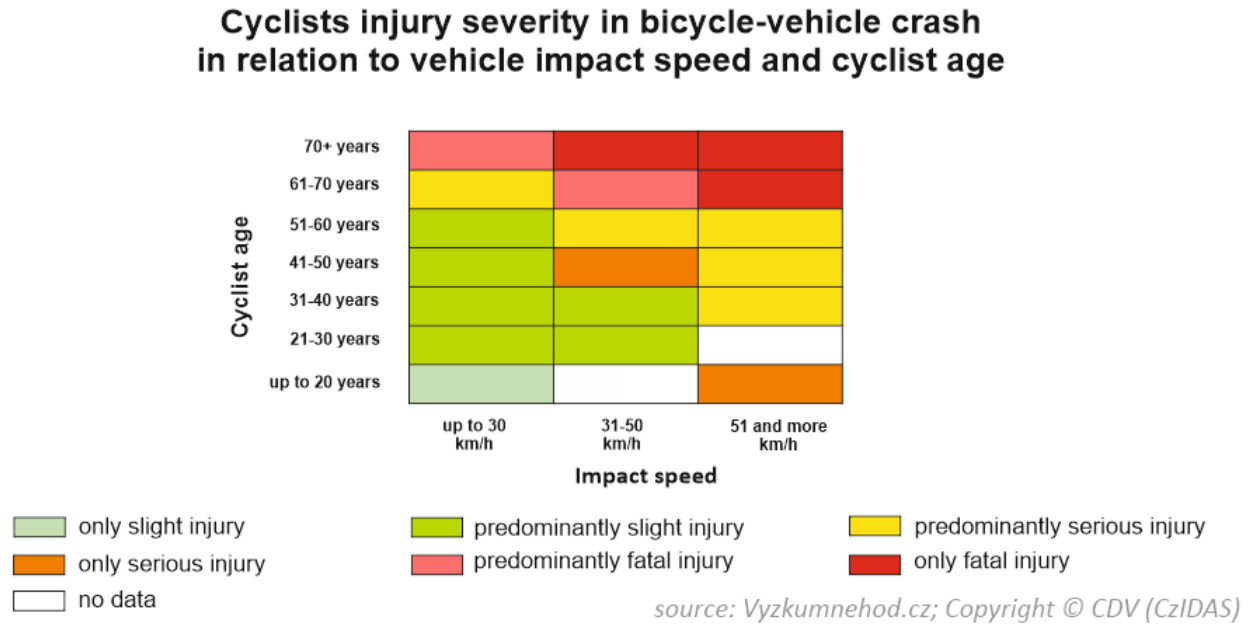


3.2.2 Cyclists

Increased probability of severe bicyclist injury is associated with older bicyclists and higher motor-vehicle speeds. [25]

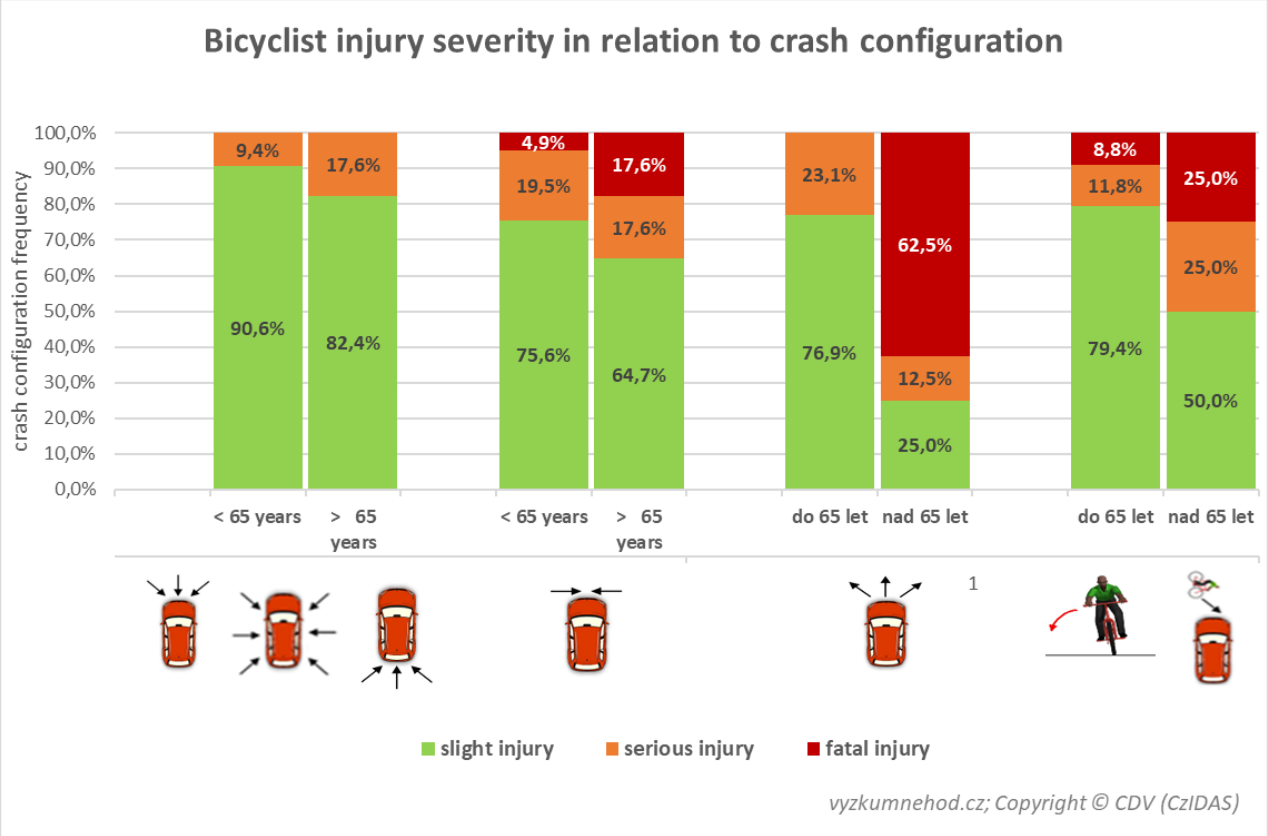
- **As could be observed from CzIDAS data, not only does the probability of cyclist severe and fatal injuries increase with higher age, but even lower-speed crashes could, with higher probability, result in severe injuries.**

[25] Wang, X., Liu, J., Khattak, A. J., & Clarke, D. (2016). Non-crossing rail-trespassing crashes in the past decade: A spatial approach to analyzing injury severity. *Safety science*, *82*, 44-55.



Elderly cyclists are more vulnerable to injury regardless of the crash mechanism.

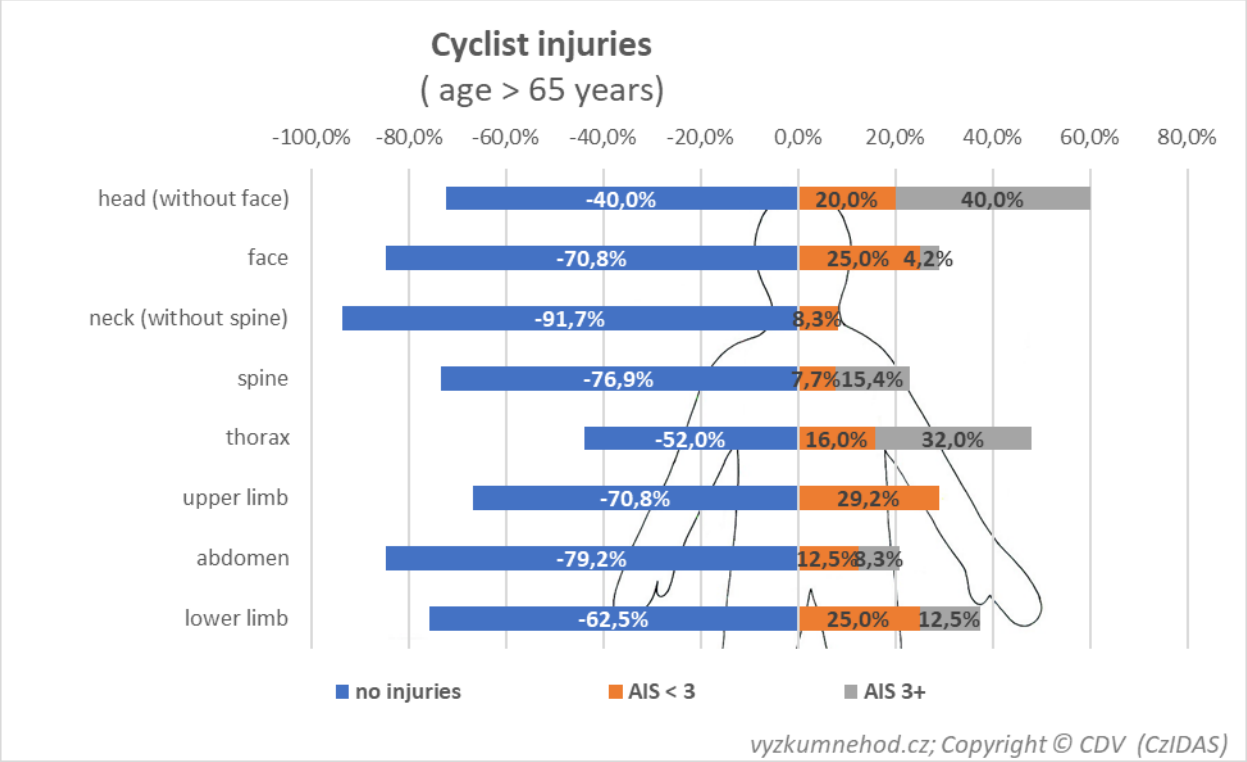
- The riskiest scenario is rear-ended vehicle collision with a cyclist and also the fall off the bike, especially when including subsequent collision with a vehicle or road infrastructure.



The **most frequently injured cyclist body regions are the lower extremities, the head and the upper extremities**. [26] These locations of injuries are major regardless of age – senior and also non-senior.

- **Older cyclists most often suffered fatal thorax and head injuries.**

Older cyclists (aged 55+) were identified as the main risk group for traumatic brain injuries, which is themain cause of mortality and severe morbidity among cyclist crashes [27] [28] [29] More frequent severe head injuries of elderly cyclists are also related to the less share of helmet use among seniors**.**

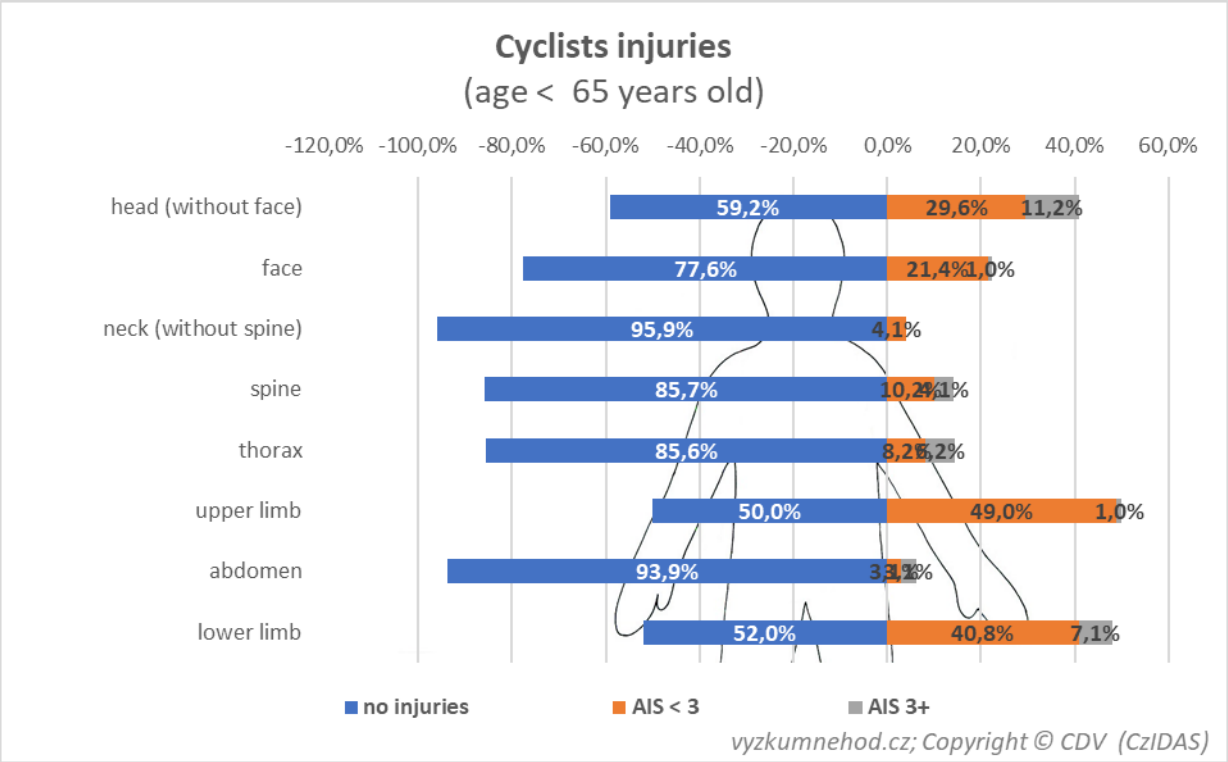


[26] Martin, J. L., Lardy, A., & Laumon, B. (2011, October). Pedestrian injury patterns according to car and casualty characteristics in France. In *Annals of advances in automotive medicine/annual scientific conference* (Vol. 55, p. 137). Association for the Advancement of Automotive Medicine.

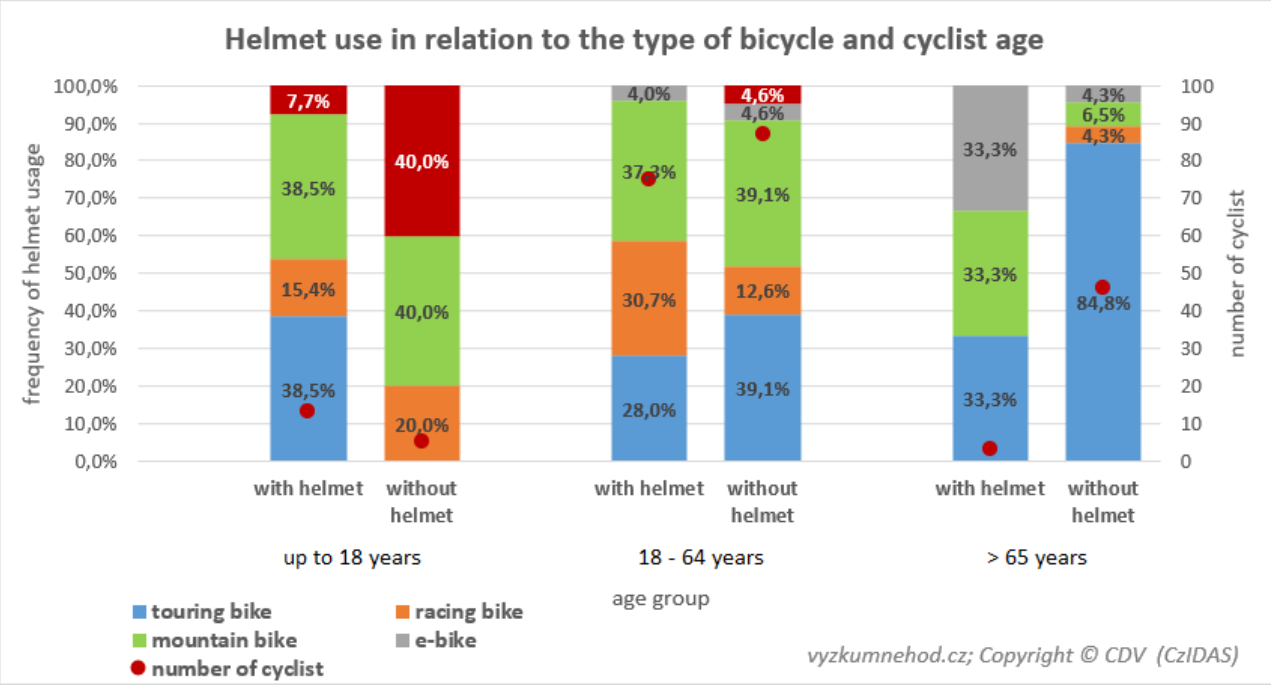
[27] W.S. Chen, R.Y. Dunn, A.J. Chen, J.G. Linakis Epidemiology of nonfatal bicycle injuries presenting to United States emergency departments, 2001–2008. Acad. Emerg. Med., 20 (6) (2013), pp. 570-575

[28] Scholten, A. C., Polinder, S., Panneman, M. J., Van Beeck, E. F., & Haagsma, J. A. (2015). Incidence and costs of bicycle-related traumatic brain injuries in the Netherlands. *Accident Analysis & Prevention*, *81*, 51-60.

[29] Dagher, J. H., Costa, C., Lamoureux, J., De Guise, E., & Feyz, M. (2016). Comparative outcomes of traumatic brain injury from biking accidents with or without helmet use. *Canadian journal of neurological sciences*, *43*(1), 56-64.



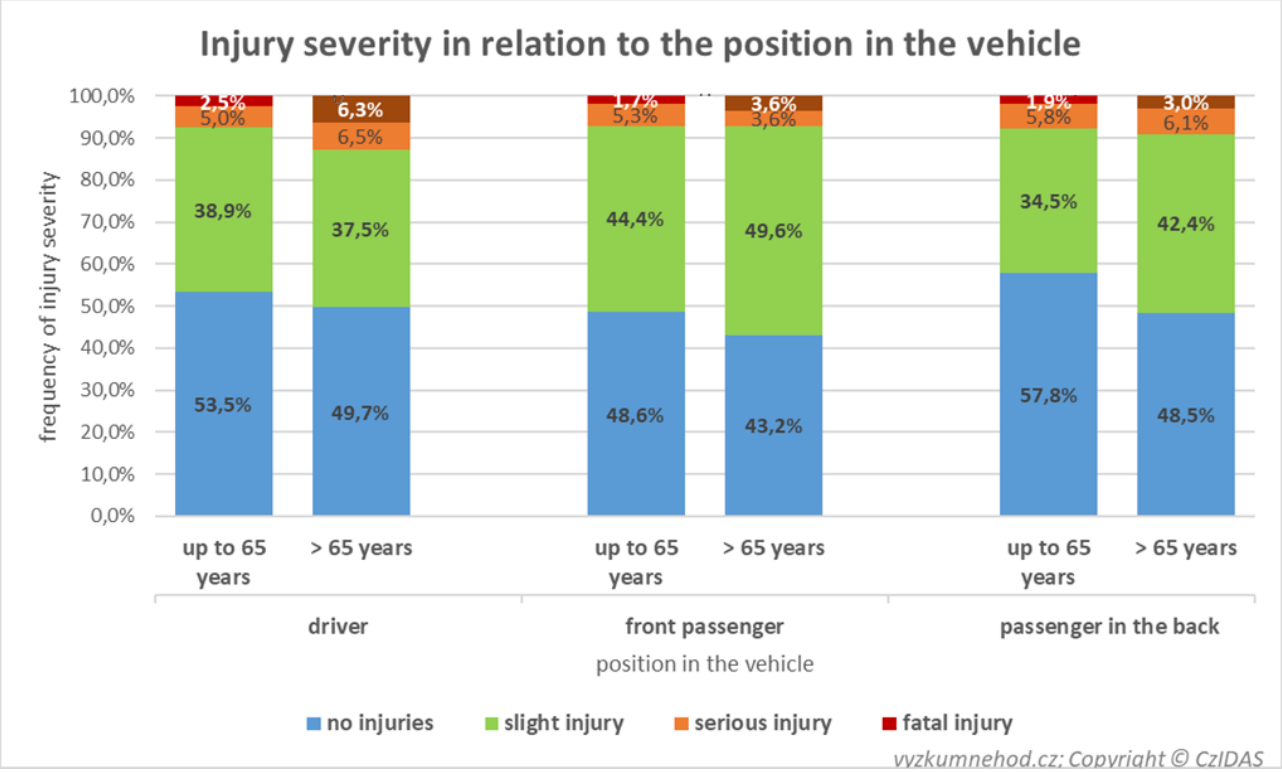
Older cyclists are a risk group regarding head injuries and related helmet usage – only a minority of senior cyclists (including e-bike cyclists) used helmets during crashes. In Czechia, it is mandatory to wear a cyclist helmet until the age of 18 years.



3.2.3 Senior in the vehicle

Seniors' vulnerability in the vehicle is also confirmed by CzIDAS data – regardless of vehicle position. Typical circumstances surrounding senior involvement in crash include manoeuvring difficulties,

fast-moving traffic, and colliding while driving an old vehicle.[30]. The high vehicle age is also one of the factors negatively affecting the crash consequences. [31] [32]



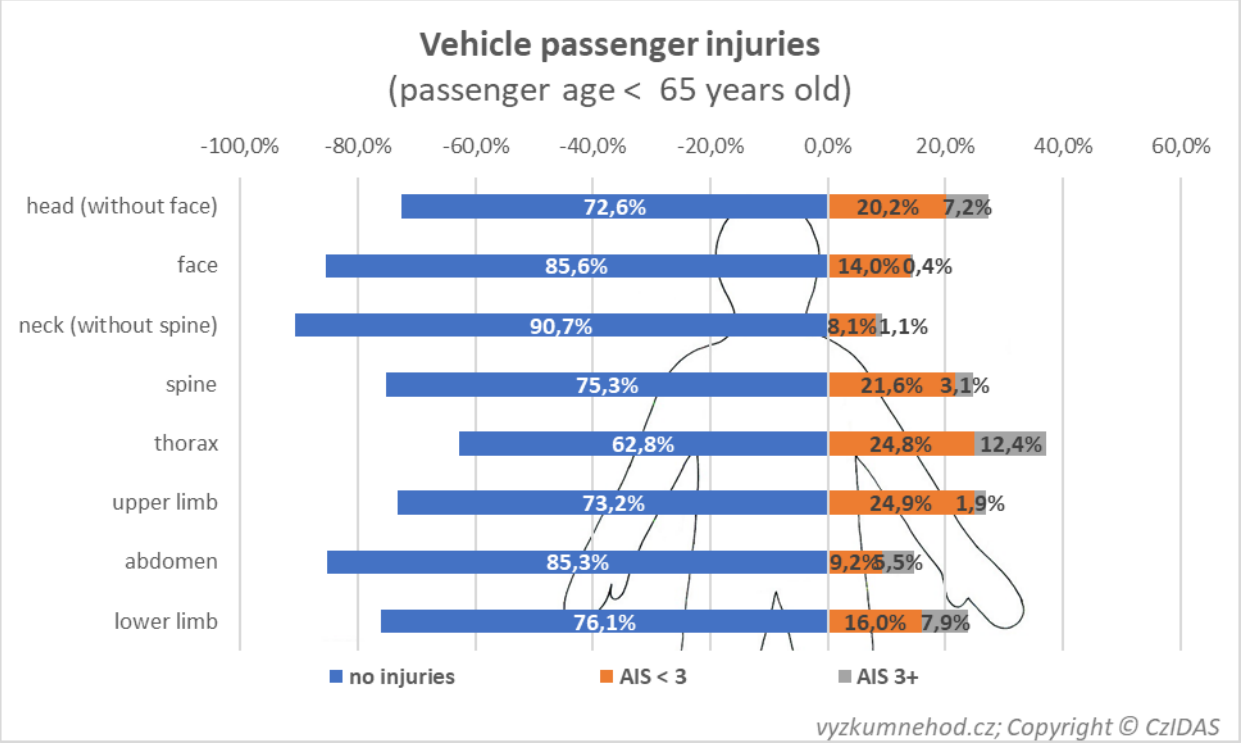
As could be seen from CzIDAS data, among vehicle occupants, injuries of head and thorax are the most severe. The distribution of injured body regions is similar in group of elderly vehicle occupants in comparison to younger ones, but older occupants more often received fatal thoracic injuries (which also confirmed Wisch[33])

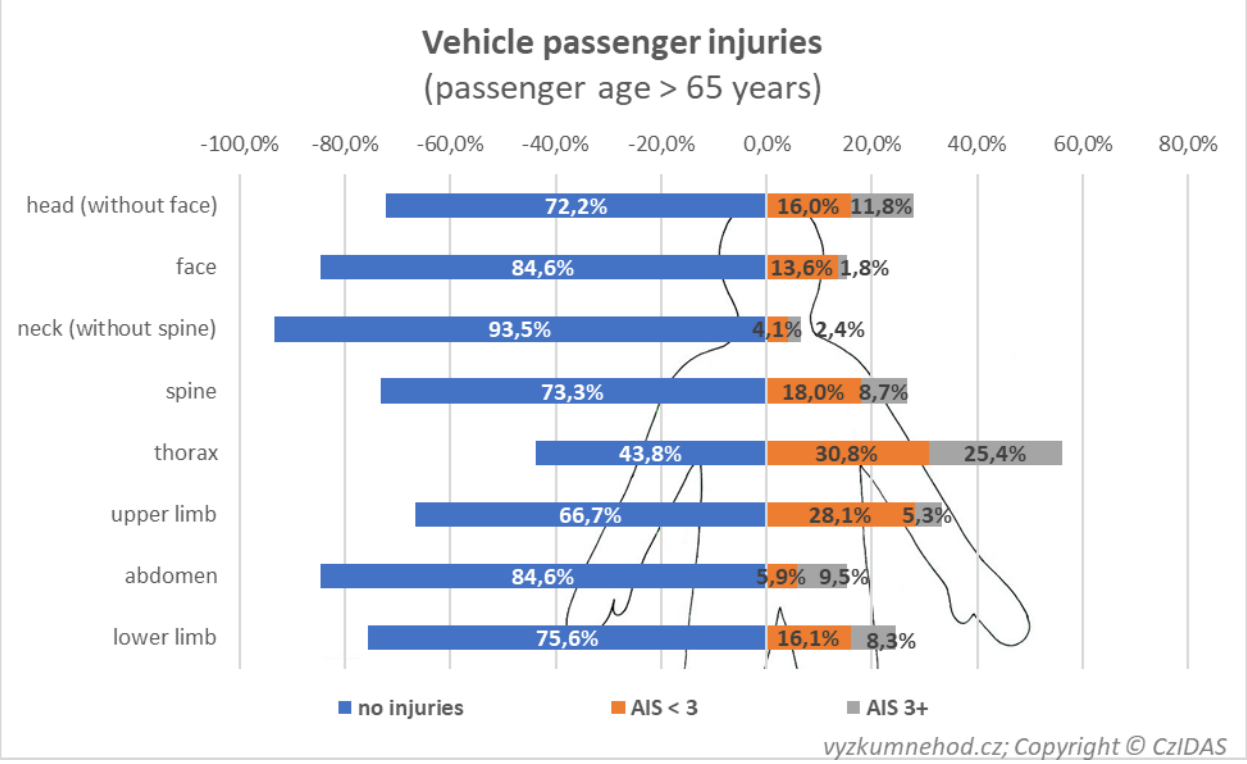
[30] Skyving, M., Berg, H. Y., & Laflamme, L. (2009). Older drivers' involvement in fatal RTCs. Do crashes fatal to them differ from crashes involving them but fatal to others?. *Safety science*, *47*(5), 640-646.

[31] Rich, J., Prato, C. G., Hels, T., Lyckegaard, A., & Kristensen, N. B. (2013). Analyzing the relationship between car generation and severity of motor-vehicle crashes in Denmark. *Accident Analysis & Prevention*, *54*, 81-89.

[32] Farmer, C. M., & Lund, A. K. (2006). Trends over time in the risk of driver death: what if vehicle designs had not improved?. *Traffic injury prevention*, *7*(4), 335-342.

[33] Wisch, M., Lerner, M., Vukovic, E., Hynd, D., Fiorentino, A., & Fornells, A. (2017, September). Injury patterns of older car occupants, older pedestrians or cyclists in road traffic crashes with passenger cars in Europe—Results from SENIORS. In *Proceedings of the 2017 IRCOBI conference, Antwerp, Belgium* (pp. 13-15).





4 Conclusion

Ageing is related to the deterioration of motoric and cognitive abilities including hearing and vision (seniors more often need vision correction for driving). The elderly are predisposed to a variety of

diseases and more often need to take medication which also could affect their driving abilities and also vulnerability – predisposition to more serious injuries and longer hospitalization.

- Not only that the probability of severe and fatal injuries increase with higher age, but even lower-speed crashes could, with higher probability, result in severe or fatal injuries

With an increase in the number and proportion of the elderly population, there is a greater need for developing suitable measures, including:

- Improving the road environment considering a reduction in motoric, perceptual and cognitive capabilities
    - Improvement of intersection design including reduction number of collision points – the collision points and crash rate could be reduced by roundabouts with physical separation of cyclists.
    - Improvement of pedestrian crossings – design of traffic islands, traffic signals, etc.
    - Improvement of cyclist infrastructure
- improved protection in the vehicle
    - senior higher vulnerability in the thorax area
- focusing on preventive strategies and educational activities:
    - Older cyclists were identified as a risk group for head injuries and related low percentage of helmet use
    - Educational activities for the elderly focused on the situations where they have higher chance of a crash, such as:
        - Pedestrian – vehicle crashes when vehicle turning or backing
        - Cyclist – vehicle crashes at intersection especially when cyclist turn left.
        - Vehicle crashes at intersections especially turning left
    - Educational activities focused on the other road users informing about vulnerability and limits related to the older road traffic users.

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