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Vulnerable road users: summary

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Data source:

Czech In-depth Accident Study (CzIDAS)

Transport Research Centre (CDV)

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Introduction

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 an accident and serve to identify the characteristics leading to the accident causation and how they affect its consequences. The in-depth accident investigation teams document all relevant information about the traffic environment, vehicles, and human factors, at the scene immediately after the occurrence of a traffic accident. The investigation includes an individual interview by a psychologist with traffic accident participants, focused on all relevant information related to causes, actual mental and physical condition of a participant, driving habits and experience, and basic and sociodemographic information about the participant.

One of the results of the CzIDAS project is a comprehensive and detailed database analysis utilized in other projects and other activities related to increasing road safety and provides a basis for preventive activities of the Road Safety Department of the Ministry of Transport.

CzIDAS findings indicate that the number of traffic accidents has common features in causes or consequences in the form of increased vulnerability of some of the traffic accidents participants. Therefore, a detailed analysis of selected risk factors contributing to the occurrence of traffic accidents of these road users was carried out within the CzIDAS project. The accident mechanism, the most numerous or the most hazardous accidents of the vulnerable road users, and especially the factors and causes contributing to the occurrence of these accidents were analysed - either some form of failure of the vulnerable road user or his collision opponent.

Accidents involving vulnerable road users in 2019 accounted for 37 % of all people killed and 55 % of the seriously injured in road traffic accidents in Czechia. The aim of this study was therefore the analysis of human functional failure leading to the accidents involving vulnerable road users and selected factors influencing injury severity of vulnerable road users.

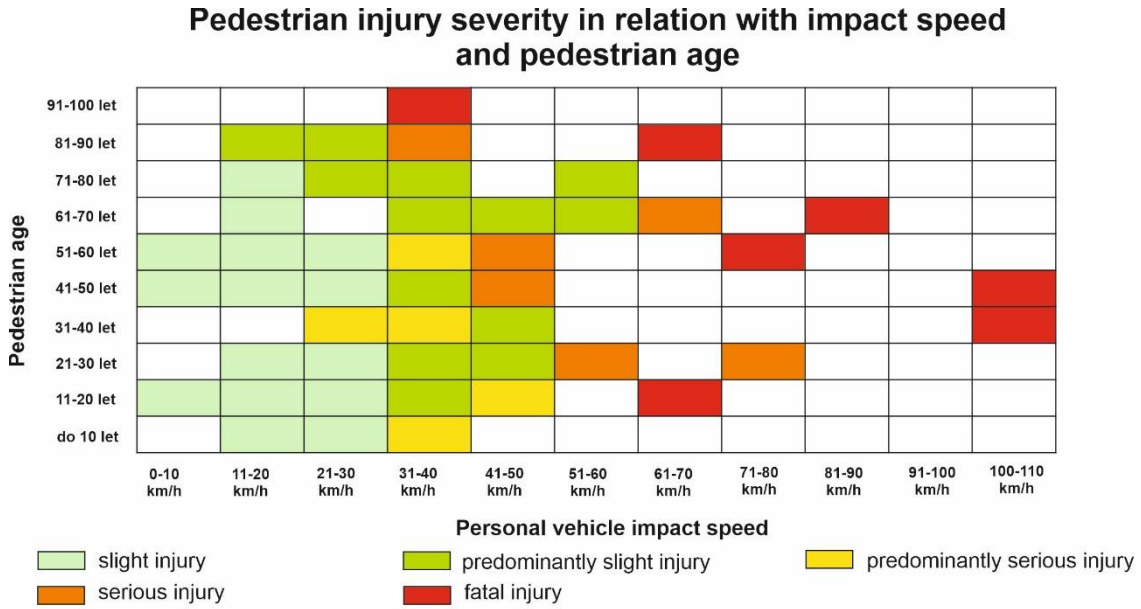
1 Pedestrians

1.1 Collision mechanisms and factors influencing injury severity

The essential step in the accident analysis involving pedestrians and vehicles is the determination of collision mechanism and associated injury. From a technical standpoint, the course of a collision between a vehicle and a pedestrian is divided into three phases: the contact phase, the flight phase, and the subsequent movement of the pedestrian on the road surface. As the accident data show, when the vehicle collides with a pedestrian, the lower limbs, head, or upper limbs are most often injured.

The severity of pedestrian injuries is affected by several aspects.

- Vehicle **impact speed:** as the vehicle speed increases, the probability of serious injuries increases. The risk of fatal injury increases almost exponentially with increasing vehicle speed. With increasing vehicle speed so does its kinetic energy. This fact is directly reflected in the overall damage to the vehicle - just as the risk of serious or fatal injury increases, the number of recorded vehicle deformations increases as well.
- **Pedestrian age:** With increasing age, the likelihood of serious injuries increases, especially with the elderly, the risk of fatal consequences may be observed with lower collision speeds. The age of pedestrians affects not only the consequences of traffic accidents but also their occurrence and causes.

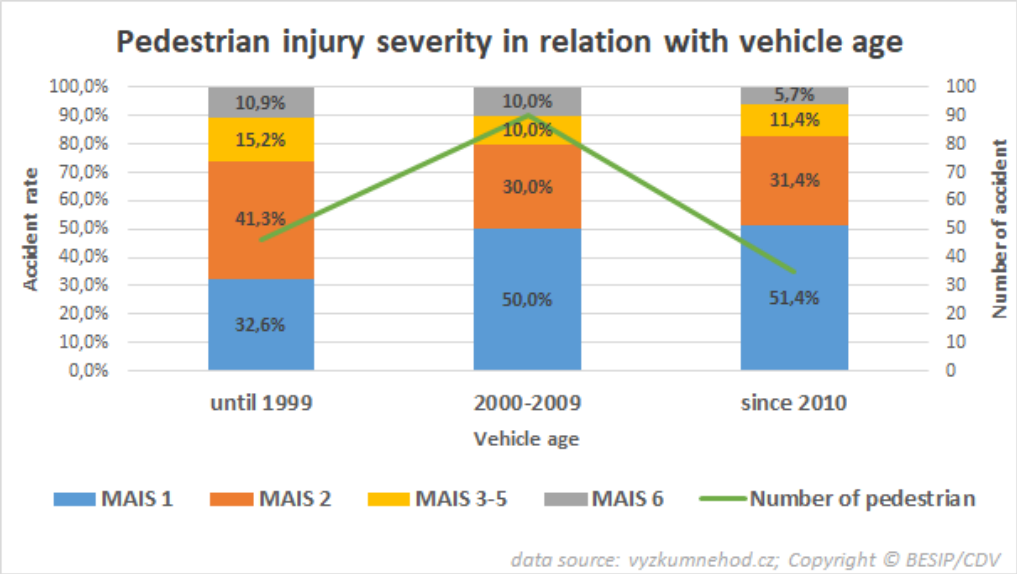


data source: vyzkumnehod.cz; Copyright © BESIP/CDV

- **Vehicle body style (especially depending on the vehicle front shape):** The severity of a pedestrian injury is affected by the type of the vehicle, resp. the shape of the vehicle. Among

the most dangerous are vehicles with a perpendicular front – i.e. so-called TRAMBUS and BUS vehicle front shape. Compared to pontoon front shape, vehicles with SUV and VAN front shapes present a higher injury severity. However, there is not a sufficiently representative sample in the database for separate analysis of these vehicle front shapes.

- **Collision type:** the greatest probability of serious injury occurs when the vehicle hits the pedestrian from behind. However, a collision between a vehicle and a pedestrian generally occurs most often when a pedestrian crosses the road. This type of collision can particularly be prevented or at least mitigated by AEB systems. The first contact between the vehicle and a pedestrian occurs more often with the right side of the vehicle during the pedestrian crossing from the right side (almost ⅓ of investigated cases), which involves, among other things, a sudden run-in of pedestrians (from the driver's right).
- **Vehicle age**: The age of the vehicle is also a risk factor in terms of pedestrian injury severity, especially considering the development in the field of vehicle passive safety. Modern vehicles are designed to be more pedestrian-friendly in the event of a collision. Among the elements that have undergone the most development is the front bumper. The development is also evident in the transition between the mask and the hood of the vehicle, and in the form of a recessed vehicle door handles. For vehicles manufactured before 1999, minor injuries occurred in less than 33% of cases; for vehicles manufactured after 2010, the proportion of minor injuries rose to more than 51%. The age of the vehicle also affects the location of pedestrian injuries, especially the lower limb injuries, with a decrease in severe injuries regarding accidents of newer vehicles.



1.2 Human factor failure in pedestrian accidents

Part of the study was a detailed analysis of human failures at various levels of information processing, which can lead to traffic accidents involving pedestrians.

Traffic accidents involving pedestrians most often occur because of failures at the level of stimulus detection, not only by drivers but also by pedestrians (44% of male pedestrians and 47% of female pedestrians). This type of failure is most often associated with the **inattention** of drivers and pedestrians.

For pedestrians, the most common is a **cursory or hurried information acquisition** (20%), but also a **deliberate violation of safety rules** (17%). Differences in pedestrian failure subtypes also depend on the gender of the pedestrian. The most common is a failure at the level of detection, regardless of gender. However, for female pedestrians, the second most common contributing factor is a failure at the predictive level (25%). For male pedestrians, the second most common contributing factor os a failure at the decision stage (21%).

Analysis of pedestrian failure by age showed that the highest percentage of failure at the detection stage was evident with children under 15 years of age (73%). A typical scenario of children's accidents is entering/running into the road without proper control of the situation. Thus, the educational activities of children as road users should be supported. Emphasis must also be placed on reducing the negative patterns of parents and other family members. Failure at detection level also predominates in adolescents and young adults (42%). In adults (25-64 years), in addition to failure at the detection level, overall failure is also common. The overall failure is most often caused by intoxication. The most common failure for people over the age of 65 is at the foresight level (43% of cases). We explain this by the involutional changes associated with old age.

Partial information retrieval dominates driver failure in pedestrian accidents (32%) - this occurs in cases where the driver is occupied in other activities related to driving and does not pay enough attention to the surrounding stimuli. The second most common type of driver failure is the failure to register a pedestrian due to limited visibility (22%) - impaired visibility or reduced visibility.

Inattention has been the riskiest factor of pedestrian-vehicle accidents (inattention is a contributing factor in pedestrian-vehicle accidents in 35 % of pedestrians and 47 % of vehicle drivers). Inattention does not have to be related only to secondary tasks like the use of a mobile phone.

Typical risky behaviour of a pedestrian is the sudden entry into the driving corridor of the vehicle (especially from the area of obstructed view, e.g. from behind stopped or parked vehicles). Typical locations where this behaviour occurs include bus or public transport stops. To point out the risky behaviour of pedestrians, an animated clip was created (a combination of a traffic accident simulation with photographs of the accident scene). *Communication campaigns should target the risky behaviour of pedestrians, who often have a better chance of preventing the collision.*

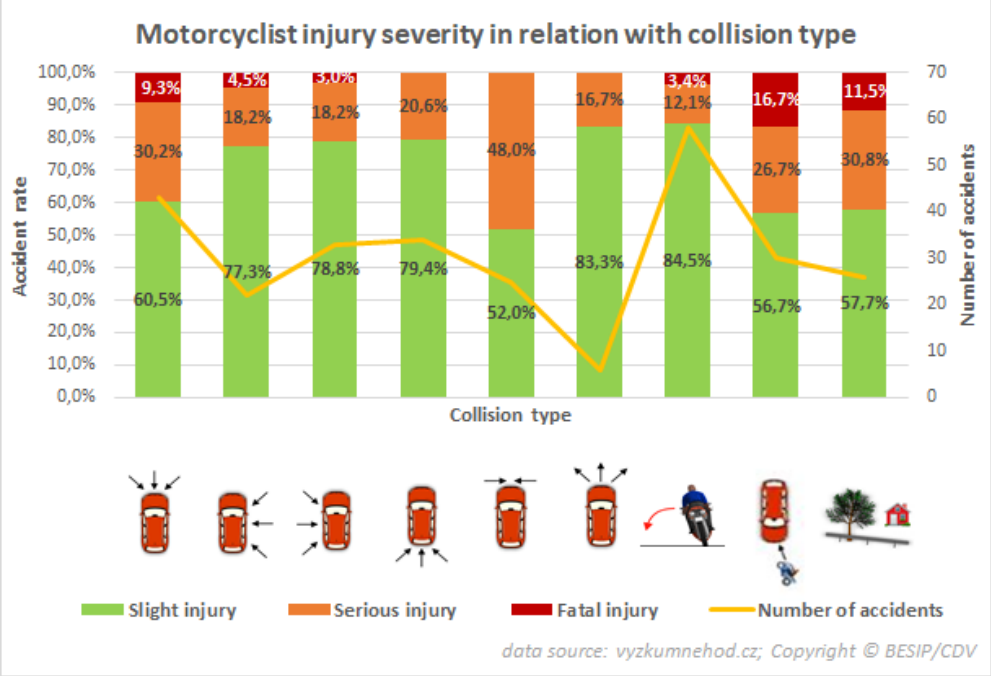
2 Motorcyclists

2.1 Collision mechanism and factors affecting motorcyclist injury severity

The severity of motorcyclist injuries can be affected by several aspects.

- **Motorcycle collision speed**: As the motorcyclist's speed increases, so does the severity of the motorcyclist's injury. If the collision speed of the motorcycle is increased by 10 km/h, the probability of serious injury will increase 1,4 times compared to the probability of minor injury.
- **Opponent's collision speed**: If the collision speed of the other accident participant is increased by 10 km/h, the chance of serious injury increases 1,3 times compared to the probability of minor injury.
- **Accident location**: rural/urban: If an accident occurs in a rural area, there is a 2,3 times higher chance of serious injury compared to a minor injury in an urban area.
- **Type of collision partner**: The highest proportion of severe and fatal injuries in a frontal collision is evident with TRAMBUS vehicle front shape.
- **Collision mechanism**: The fall of a motorcyclist and a motorcycle and the consequent uncontrollable skidding of motorcyclist's body before collision increases the risk of serious and fatal injuries (approximately 40 % of cases). The probability of serious injury to a motorcyclist increases even in the event of a secondary or multiple collision**.** Communication

campaigns and educational activities should focus primarily on the need to adapt and improve upon driving techniques and crisis response.



- **Used protective equipment** (helmets and other protective clothing). Emphasis must be placed not only on the actual use of protective equipment but also on the use of certified (homologated) protective equipment - especially helmets. During CzIDAS activity, cases were identified where the driver used a home-modified helmet, which did not fulfil a sufficient protective function.

The analysis of the anatomical location and severity of injuries of motorcyclists showed that the injuries of the lower limbs, upper limbs, and head occur most often. Injuries to the lower limbs are also more often more severe (AIS 3+ injuries).

2.2 Human factor failure in motorcycle accidents

Among the most frequent factors contributing to traffic accidents caused by motorcyclist failure, are high or excessive speed, inattention, or incorrect evaluation of the situation. From the viewpoint of collision opponents, the most common factors contributing to traffic accidents involving motorcycles are inattention, incorrect assessment of the situation, or a restricted view.

The most common motorcyclist's failures are:

- At the identification level (48 % of cases), specifically due to an incorrect evaluation of route difficulty. Statistically, most often motorcyclists fail to adjust speed to the condition of the road surface. The second most common representation is exceeding the speed limit. Motorcyclists under the age of 24 will most often fail at identification level (66 %) - this is influenced by inexperience and the increased tendency of young motorcyclists to take risks.
- Failure at the foresight level (16 % of cases) and decision-making level (12 % of cases) are strongly correlated with deliberate traffic violations and collisions due to an unexpected obstacle.

Drivers of other vehicles (whose failure leads to a collision with a motorcyclist) most often fail at the level of stimulus detection - in the particular, cursory, or hasty acquisition of information. However, the smaller visual profile of motorcyclists may also affect the situation.

Communication campaigns should, therefore, focus on the most numerous types of accidents or the most serious causes of accidents and related driver risky behaviour. The most serious consequences of accidents are associated with the main causes of accidents - excessive speed or overtaking (whether the accident is caused by the motorcyclist or the collision opponent). However, the most common cause of an accident involving a motorcyclist (if caused by the collision opponent) was a failure to give way. The analysis of pre-crash scenarios and driver reactions could also result in the innovation of motorcycle driver education.

3 Cyclists

The popularity of cycling is ever-growing. The analysis of cyclists traffic accidents showed:

- With AIS 3+ injury severity, cyclist head injury dominates. In general, injuries are most common in the upper and lower limbs, followed by head injuries.
- There have been many factors that influenced injury severity – one of the most important is the vehicle impact speed. The use of helmets also has a significant effect on the severity of the injury. As part of communication campaigns, it is necessary to emphasize the use of helmets. The injuries of cyclists who wore a helmet were mostly mild to moderate in nature. If the cyclist wore a helmet during a personal vehicle-cyclist accident, there were head injuries in 27 % of investigated cases, if they did not wear a helmet, the cyclist suffered head injuries in 55 % of investigated cases. **Cyclists who did not wear a safety helmet at the time of the accident had a significant increase in head injuries.** A helmet can save a cyclist's life. According to CDV research (Bíl et al., 2018)[1], up to 37 % of cyclists could survive an accident if they wore a helmet.
- The largest proportion of fatally injured cyclists is evident in the frontal collision of a cyclist and a vehicle, as well as front to back collisions (cyclist being in the front).

Communication campaigns should focus on the typical risky behaviour of cyclists leading to accidents. In terms of factors contributing to the occurrence of accidents involving cyclists, it is clear that:

- The most common factors contributing to cyclist accidents include cyclists' inattention and alcohol intoxication. Also, one of the risky cyclist's behaviour is riding across a pedestrian crossing.
- In the case of collision partners of cyclists, the most common factors contributing to the occurrence of accidents include inattention, restricted visibility (not caused by heavy traffic), glare, or incorrect evaluation of the situation.
- Drivers of motor vehicles often state that they have not seen a cyclist. Cyclists are vulnerable road users, among other things, due to their chance of being overlooked, especially during intersection collisions, a cyclist can be hidden behind the A-pillar of the vehicle. Cyclists should therefore also pay attention to the use of means that increase their visibility (bright-coloured clothing, bicycle equipment), i.e. increase the probability of early detection by drivers of other vehicles.

[1] Bíl, M., Dobiáš, M., Andrášik, R., Bílová, M., Hejna, P., 2018. Cycling Fatalities: When A Helmet is Useless and when it Might Save Your Life. Safety Science 105C, 71–76

E-bikes and similar (e-scooters, hoverboards, etc.) experience a huge boom in last years. In the frame of in-depth analysis of traffic accidents, some cases with the participation of e-bike have been investigated. Collision speed at the investigated traffic accidents oscillated between 10 and 30 km/h (speeding was the main cause only one of the accidents).

One of the investigated accidents involved an e-bike which, with regards on its parameters, was not suitable for road traffic (due to Czech legislation) - it exceeded by its performance up to 7 kW and a maximum speed up to 70 km/h by the important way legal limits for e-bikes. **In this connection, it is necessary to appeal to riders of these means of transport to operate exclusively e-bikes designated for traffic on the roads and not tune their performance or speed.**

Compared to pedestrians, cyclists can achieve a much higher speed of movement, but in the event of a collision, they are protected only by a helmet. Furthermore, if they ride from behind an obstacle and other road users cannot see them, they do not give other drivers a chance to react in time. To draw attention to the risk of serious consequences in such situations, an animated clip was created within the CzIDAS project, which consists of a combination of real accident photographs and a simulation of the real accident.

Conclusion

Carrying out an in-depth analysis of traffic accidents in the Czech Republic draws on a long tradition and experience from abroad. Providing up to date analyses, evaluating changes in participant's behaviour and other characteristics of causes and circumstances related to traffic accidents is possible only if the database is constantly expanded with data from in-depth analysis of traffic accidents.

This report provides only a summary of the project focused on vulnerable road users. Based on the obtained outputs, mainly risk aspects were defined, which should be paid attention to within the framework of education and communication campaigns and preventive action of the Road Safety Department of the Ministry of Transport. The obtained outputs are the expert background for prevention activities of the Action Program of the Road Safety Strategy for the next decade 2021-2030.

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The Transport Research Center (CDV) is a public research institution, established according to Act 341/2005, Coll., as the only research organisation under the jurisdiction of the Ministry of Transport. Having been established by the resolution of the minister of transport as per January 1st 1993, it is the legal successor of the Czech section of the federal Research Institute of Transport in Žilina. The Transport Research Center follows on the activity that began in 1954, and, therefore, has more than 60 years of tradition.

We conduct traffic accident research within the National Centre of Czech In-Depth Accidents Analysis (CzIDAS). One of its aims is cooperation with entities that could further use the results of research, for example road owners or administrators, vehicle designers and others. Our activities are realized in long-term horizon and all the research is subjected to strict conditions, including personal data protection. www.vyzkumnehod.cz/en/

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