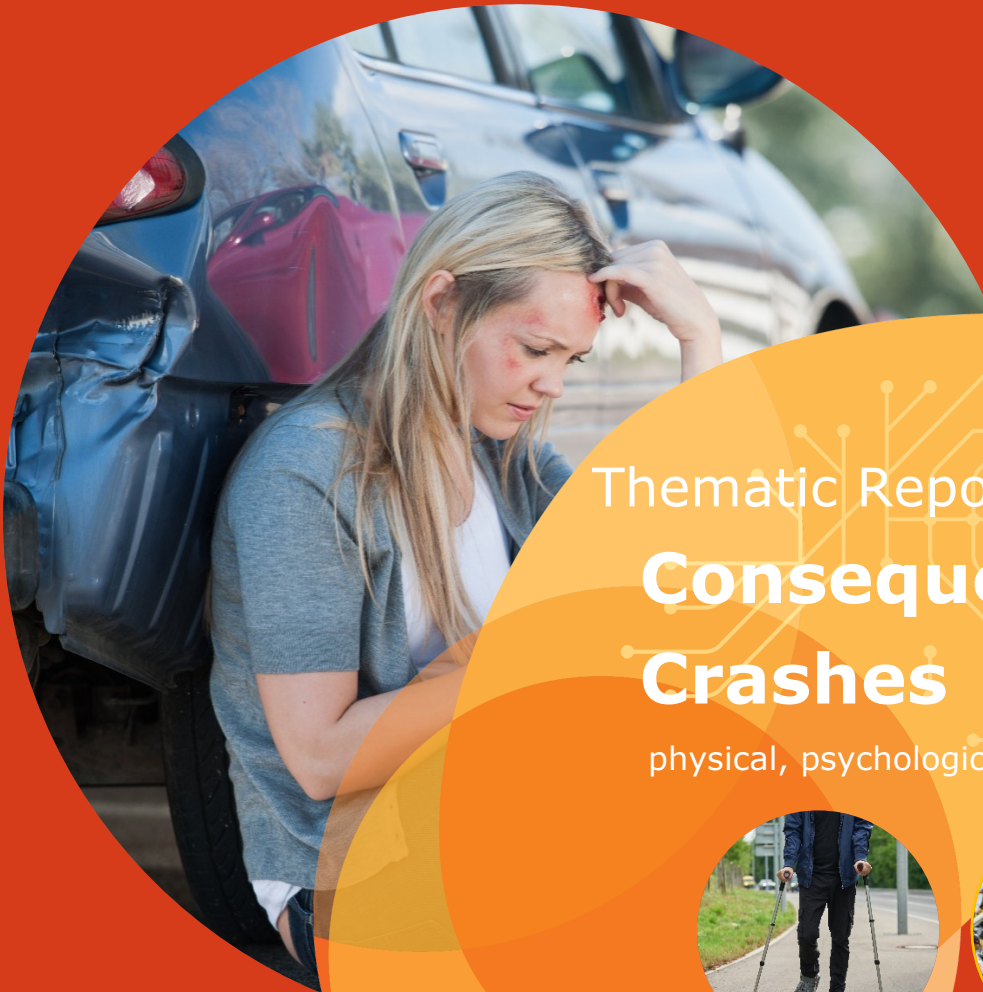




European
Commission



Thematic Report

Consequences of Crashes

physical, psychological, economical



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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About this document

This document provides an overview of the health-related consequences of road traffic accidents. The report presents a major update of a preceding report on this subject (European Commission, 2023a). For reasons of consistency with the former report, the term crash is used also in this report. However, where reference is made to studies and data, the original designation of “a crash” is used to avoid misinterpretation. If not stated otherwise, the different terms used are synonymous to “a road traffic accident resulting in an injured person”, or RTI for short.

Summary

Road crashes can affect all aspects of human activity: functional aspects, mental and emotional aspects, as well as social and professional life. Diagnosis-based public health indicators for the severity of injuries, permanent impairments and loss of quality of life allow for a quantitative assessment of a wide spectrum of consequences of crashes. In this report three types of consequences are distinguished: physical, psychological, and socio-economic.

At EU level, 2.2 million **hospital-treated road traffic casualties** compare to 1.1 million police-reported ones, indicating a substantial underreporting in police-based crash statistics and an underestimation of the impacts of crashes.

- About 20% of hospital-treated casualties had to be admitted as inpatients, with an average length of stay of 6 days. Half of the inpatients were treated for fractures.
- For every fatality, around 5 **serious injuries** were classified as such according to the international, diagnosis-based MAIS3+ definition (a score higher than 2 on the 6-grade Abbreviated Injury Scale; EU estimate for 2023). The corresponding ratio of fatalities to serious injuries according to “police-definitions” is around 1 to 8.

Some countries have extended the definition of serious injuries (MAIS3+) to include injuries leading to **permanent medical impairment (PMI)**. Swedish data show that every fifth injured road user has a PMI at a degree of at least 1% (e.g., an unstable ankle joint would be a PMI at a degree of 7%).

Disability Adjusted Life Years (DALYs) quantify the overall impact of road traffic injuries on the quality of life by capturing both mortality (life years lost, YLLs) and the years lived with disability (YLDs).

- DALYs decreased sharply between 1990 and 2014, mainly because of a reduction of life years lost, and remained stable since.
- Among young ages (15-34 years), road traffic injuries have the highest share of DALYs of all adverse health effects.
- Overall, road injuries constitute about 2% of total DALYs in the EU; 75% of DALYs were caused by YLLs and 25% by YLDs.

Psychological impacts. Studies indicate that about one third of road traffic casualties has self-reported symptoms of Post-Traumatic Stress Disorder (PTSD), every fifth casualty reports symptoms of depression. Drivers show a significantly lower presence of PTSD, compared to passengers or pedestrians. If these symptoms are left untreated, there is a high probability of progressing to a serious mental disorder.

Economic impact assessment of crashes comprises not only medical costs and lost productivity, but also intangible losses such as pain and suffering (human costs). EU wide, crashes are estimated to generate a total cost of injury of about 353 billion Euro (2024 prices; not considering underreporting). The median share of crash costs of national Gross Domestic Products is 1.3% (from 31 European countries). The wide range of this indicator, from 0.4% to 4.1%, can be mostly explained by methodological differences.

The integration of burden of injury metrics and standardised severity classification systems represents a crucial evolution in traffic safety research and policy. By adopting these **public health approaches**, stakeholders can develop more effective, evidence-based strategies that address not only the prevention of crashes but also the minimisation of their (long-term) health consequences for individuals and society.

1. Introduction

1.1 Outcome indicators and data sources

Although road safety in the EU has improved considerably over recent decades, road traffic accidents are still regarded as one of the greatest risks in everyday life (World Risk Poll 2021. Lloyd's Register Foundation, 2022). This perception is substantiated by the persistently high ranking of road traffic injuries within European mortality and morbidity statistics, for example:

- Road accidents remain a frequent cause of premature death (European Union, 2024)
- Road accidents are the most severe among all domains of accidents (like workplace, home, or sports; Carannante et al., 2024).
- Road transport has the highest socio-economic toll of human life when compared with other modes of transport (European Commission, 2019).

Furthermore, any road user can be involved in a fatal or serious crash, but pedestrians, cyclists or motorcyclists, are at the highest risk (trending upward; European Union, 2024).

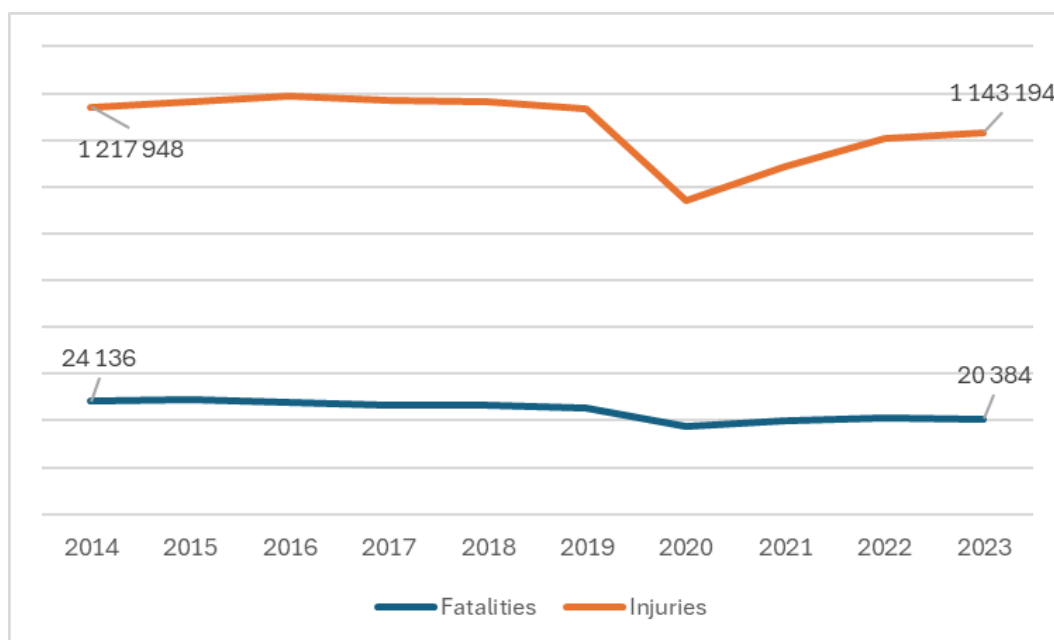


Figure 1. Trends in road injuries in the European Union 2014–2023. Source: Annual statistical report on road safety in the EU. European Commission (2025).

In 2023, according to **police data**, road crashes in the 27 Member States of the European Union left more than **1.14 million people injured** (256 per 100,000 inhabitants; Figure 1). With regard to

serious injuries, two different indicators are currently used within the EU (European Union, 2024). Based on definitions applied by the police (which are subject to different national standards), there were approximately 8 **serious injuries** for every fatality, reported in 2023.

According to the international MAIS3+ definition, there were around 5 serious injuries for every fatality in the EU in 2023. The MAIS-3 indicator was adopted in the EU in 2017 and is based on **hospital diagnostic data** (European Commission, 2025; see also chapter 2.1.2).

However, the MAIS-3 indicator on its own does not automatically allow access to medical data, such as precise diagnoses or details regarding the type and duration of treatment. Without this information, and its potential linkage to police crash data, assessing the consequences of crashes — particularly the physical outcomes — remains challenging (Soltani et al., 2024)

Linking police and medical records has been extensively discussed since years in many countries (Janstrup et al., 2014; Michael Branion-Calles, 2025), but so far only few such systems are in place (e.g. the Swedish Traffic Accident Data Acquisition STRADA; Amin et al., 2022). In most countries, police-recorded crash data and medical data on traffic injuries (usually hospital data) have to be analysed in parallel, highlighting the issues of comparability between and underreporting within these sources.

"With health outcomes front and centre stage in the challenge presented by road collisions and injuries, it can no longer be acceptable to view this data in isolation. Instead, it needs to become part of more widespread ambitions to join up data across the public sector and healthcare."

(Yalamanchili, 2024)

At **international level**, there are only few data systems that allow for the analysis of injury patterns of road accidents. For very severe injuries, like multi-trauma or serious brain injury, detailed information on both the injury diagnoses and the external cause of the injury (accident circumstances) are recorded by trauma-centre networks, mainly for research purposes (Koch et al., 2023).

A data system with a broader scope is the European Injury Database (EU IDB). The EU IDB is a prevention-oriented, hospital-based injury surveillance system originally invoked by the European Commission in the 1990s (EuroSafe, 2020).

According to the recent EU IDB report based on 2021 and 2022 data, **2.2 million cases of road accidents had to be treated in EU**

hospitals (488 cases per 100,000 inhabitants, Carannante et al., 2024). This estimate differs enormously from the number of road injuries recorded by the police (1.14 million; data made accessible at EU level in the CARE database¹; European Commission, 2025. See Figure 1).

The huge discrepancy between these figures results mainly from hospital-treated injuries that are not (necessarily) recorded by the police (e.g., many bicycle crashes without any counterpart are only reported to the emergency room). A national comparison of road traffic crashes recorded by the police and in hospitals in Austria is shown in Figure 2.

Underreporting is not only a statistical issue but also a road safety issue. Underreporting of cyclists in police statistics, for instance, is apt to introduce biases into the types of collisions that are available for analysis (Gildea et al., 2021).

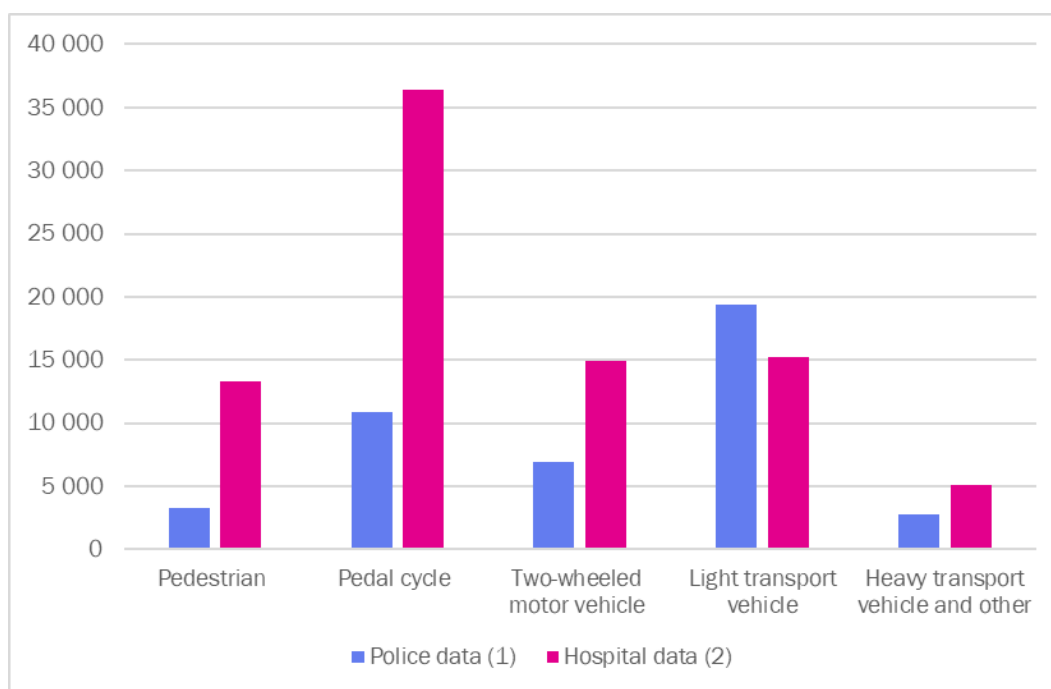


Figure 2. Road traffic injuries recorded by the police and in hospitals in Austria. Source: (1) Statistics Austria, 2023. Road traffic injuries in 2022. (2) KFV, 2023. IDB Austria. Causes of injury in Austria in 2022.

¹ CARE is a Community database on road accidents

1.2 AIS, COI, DALY: Public health concepts in traffic safety

The Abbreviated Injury Scale (AIS) allows for the standardized assessment of individual **injury severity** based on clinical diagnosis, facilitating more precise epidemiological analyses and resource allocation. AIS provides insight into the range and seriousness of injuries sustained in road traffic events, supporting the identification of high-risk scenarios and informing the design of targeted safety measures and trauma care protocols. MAIS3+ (AIS score higher than 2) is an important additional traffic safety indicator, addressing the full spectrum of injury outcomes (European Commission, 2023).

The implementation of public health metrics such as the **Burden of Injury** — measured in disability-adjusted life years (DALY) — has significantly advanced the field of traffic safety and injury prevention. DALY quantifies the overall impact of traffic injuries by capturing both mortality and the years lived with disability, offering a comprehensive perspective on population-level health loss attributable to road crashes. This measurement enables policymakers to prioritize interventions by highlighting the full spectrum of injury burden, including the substantial long-term consequences of non-fatal injuries (World Health Organization, 2019).

Applying the **Cost of Injury** (COI) concept to traffic safety enables a comprehensive assessment of the economic impact of road traffic incidents, encompassing medical costs and lost productivity. Typically, road crash cost studies add intangible losses such as pain and suffering (human costs) to the pure economic costs. By translating injury impacts into monetary terms, Cost of Injury analyses facilitate cross-sector collaboration, guide resource allocation, and support cost-benefit analyses, ultimately promoting strategies that reduce both the financial and human burdens of traffic injuries across society (European Commission, 2019).

2. Consequences of crashes

The consequences of road injuries can affect all aspects of human activity (Meunier & Dupont, 2017): functional aspects (pain, fatigue, mobility, daily activities, etc.), mental health (post-traumatic stress disorder, depression, anxiety, etc.), social and emotional life, and professional life (absenteeism, reorientation, etc.). These consequences can be long-lasting or even permanent, with severe economic and financial impacts (for example loss of income).

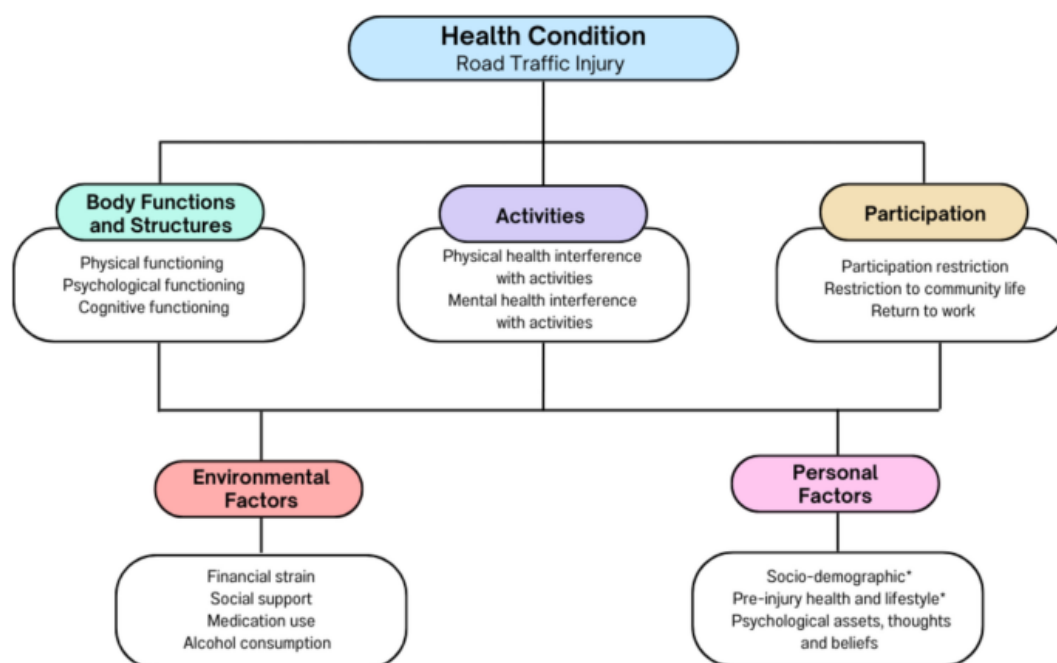


Figure 3: Health burden-related factors of the WHO International Classification of Functioning, Disability, and Health (ICF). Source: Reproduced from Pozzato et al. (2025).

In a controlled prospective study, Pozzato et al. (2025) investigated the cumulative health burden and complex challenges to adjustment following road traffic injuries. They found significantly worse outcomes across all measured ICF² components, including higher pain, fatigue, psychological distress, and cognitive impairment than in non-injured controls even at 12 months after the accident. Their findings highlight the importance of evaluating multiple biopsychosocial factors and adopting a holistic framework to fully understand recovery patterns, and that addressing these factors simultaneously across multiple systems is essential to improve recovery outcomes (Figure 3).

In this report, the consequences for road traffic casualties are grouped into three categories: physical consequences (acute and long-term, Disability Adjusted Life Years), psychological and socio-economic.

2.1 Acute physical consequences

2.1.1 Injury patterns

The term injury pattern refers to the type and location of lesions incurred after a crash. In injury prevention, this knowledge is most

² World Health Organization International Classification of Functioning, Disability, and Health (ICF)

relevant in the development and improvement of safety devices and personal protective equipment, and in the safe design of vehicles and equipment used for transportation, occupation and recreation (Xu et al., 2022). Injury patterns, i.e. the specific injury diagnoses, are also the basis for the assessment of injury severity and the prognosis of possible permanent medical impairments (Babaie et al., 2023; see next chapters).

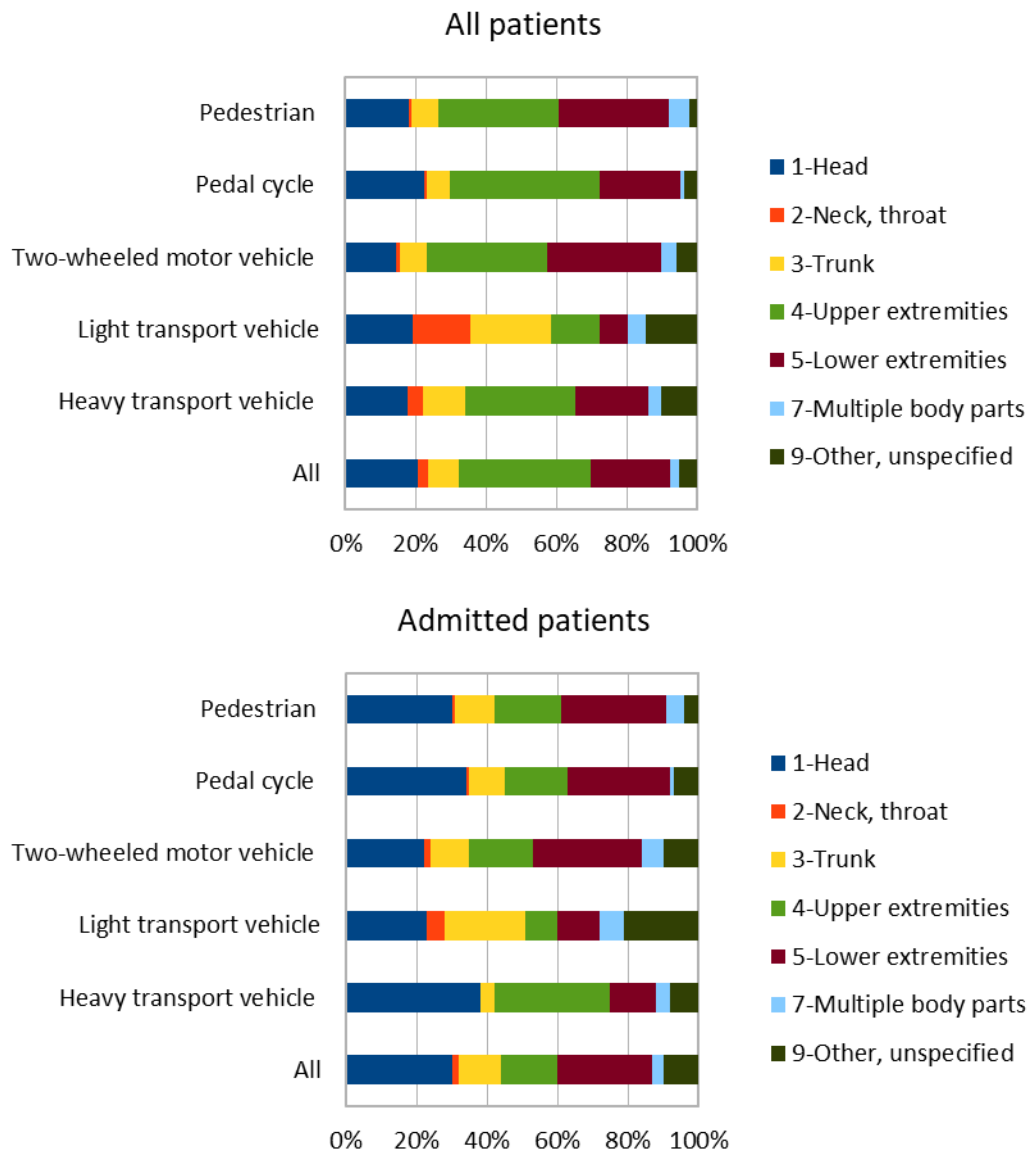


Figure 4. Road traffic injury patterns: Body part injured by mode of transport and type of hospital treatment (n -all=51,072; n -admitted=10,568). Source: European Injury Database (EU IDB). Most severe injury only. Estimates. Data 2020-22 (Austria, Germany, Luxembourg, Netherlands, Slovenia).

The Transport Module of EU IDB features data items for mode of transport, counterpart, and role of injured person, which can be combined with the data items body part injured, type of injury, type of treatment and length of stay, for a basic analysis of injury patterns (Carannante et al., 2024).

Figure 4 illustrates the pattern of body parts injured in road traffic accidents by mode of transport, for all patients and for admitted patients. Admitted patients (inpatients) are generally considered more severely injured than patients sent home after treatment (outpatients). Most noticeably, in Figure 4, the overall shares of head injuries and, to a smaller extent, of injuries of the lower extremities, are higher in admitted patients as compared to all patients. Compared to cyclists, head injuries are less common among motorcyclists, which may be due to the fact that the latter are more likely to wear helmets (cp. Bouwen et al., 2022).

Table 1. Road traffic injury patterns: Top 5 types of injuries by mode of transport and type of hospital treatment (n-all=51,072; n-admitted=10,568). Source: European Injury Database (EU IDB). Most severe injury only. Estimates. Data 2020-22 (Austria, Germany, Luxembourg, Netherlands, Slovenia).

	Pedestrian	Pedal cycle	Motorcycle	Light transport vehicle	Heavy transport vehicle	All
All patients						
Fracture	46%	39%	40%	21%	26%	36%
Contusion, bruise	18%	16%	20%	28%	33%	20%
Concussion	8%	11%	8%	9%	4%	10%
Brain injury, other	6%	7%	4%	4%	4%	6%
Open wound	5%	7%	5%	3%	8%	6%
Admitted patients						
Fracture	54%	52%	57%	41%	54%	51%
Brain injury, other	14%	17%	11%	10%	21%	15%
Concussion	10%	12%	7%	9%	8%	11%
Internal organs	2%	4%	8%	12%	4%	6%
Contusion, bruise	5%	3%	2%	7%	8%	4%

In admitted patients, five types of injuries account for about 80% of all injuries within all types of road users; the ranking of injuries is led by fractures both in admitted patients and all patients (Table 1).

2.1.2 Injury severity

Injury severity is an important road safety performance indicator, adding a qualitative outcome dimension to the mere count of injured persons. The European Commission aims at reducing serious injuries

by 50 percent by 2030 and getting close to zero by 2050. Various criteria are currently used in the EU to indicate the severity of an injury (European Union, 2024), for example:

- The type of injury is included on a legally established list of injuries.
- Injured persons required hospitalisation.
- Injury is classified by the hospital.
- MAIS3+ trauma scale.

Indicated by the **share of admitted patients**, road accidents are the most severe among all domains of accidents (Source: European Injury Database. Minimum Dataset. Estimates. Data 2020-22. Austria, Germany, Luxembourg, Netherlands, Slovenia. Carannante et al., 2024).

- Road Traffic Accidents 21% admitted
- Home accidents 18%
- Sport accidents 15%
- Workplace Accidents 13%
- School accidents 7%

On average, 1 in 5 road accident patients has to be admitted to hospital, and has to spend 6 **days in hospital**. Admission rate by type of road user is highest for pedestrians, with an average length of stay in hospital of 7 days (Source: European Injury Database. Minimum Dataset. Estimates. Data 2020-22. Austria, Germany, Luxembourg, Netherlands, Slovenia. Carannante et al., 2024):

- Pedestrian 29% admitted 7 hospital days
- Light transport vehicle 24% 7
- All modes of transport **21%** **6**
- Two-wheeled motor 20% 8
vehicle
- Pedal cycle 19% 5
- Heavy transport 17% 8
vehicle

The **Abbreviated Injury Scale (AIS)** is an anatomically based system that classifies injuries by body region (head, chest, abdomen, etc.) and the type of injury sustained (fracture, contusion etc.) into 6 scores:

1. Minor
2. Moderate
3. Serious, but not life-threatening
4. Severe and life-threatening
5. Critical
6. Maximal (currently untreatable or not survivable)

MAIS3+ injuries (Maximum Abbreviated Injury Scale) comprise all casualties with at least one AIS-score higher than 2. With the adoption of the MAIS3+ definition in 2017, the European Commission aims to have a common, international and more precise indicator of serious injuries in future (European Commission, 2023).

In practice, MAIS3+ scores are not directly measured but mapped from ICD-coded³ diagnoses to AIS scores (European Commission, 2023). In a Finnish study, an ICD-AIS mapping identified almost 7% of admitted patients in road traffic accidents as seriously injured according to MAIS3+ (Airaksine et al., 2018).

Due to remaining methodological problems, the interpretation and comparisons of MAIS3+ numbers at EU level still faces some restrictions (European Union, 2024). According to available EU data for 2023, there were around 5 MAIS3+ injuries for every fatality (European Commission, 2025; see also chapter 1.1).

The distribution of AIS scores varies considerably by **mode of transport and age**. According to the German In-Depth Accident Study (GIDAS; Liers, 2023), “two-wheeled motor vehicle” is the mode of transport with the highest proportion of MAIS3+ injuries (about 9%). The proportion of MAIS3+ injuries rises considerably for older car passengers, cyclists and pedestrians (e.g. from 3.3% to 7.8% in cyclists, 65-74 years old, compared to the age group 18-64 years). The lowest proportion of MAIS3+ injuries was found in car passengers, age group 18-64 years (about 3%). The highest share of MAIS3+ injuries by **body part** injured, mode of transport and age was found for: thorax (6%) in car occupants 75+ years, lower extremities in cyclists 75+ years (4%), and pedestrians 64+ years (6%).

In a retrospective study of severely injured motorcyclists and car occupants with a primary admission to a trauma centre, Koch et al. (2023) conclude that the severity of injuries and their incidence, especially head injuries, have decreased over the years and seem to contribute to a decreasing hospital mortality of polytraumatized motorcyclists and car occupants.

2.2 Long-term physical consequences

Some countries have extended the definition of serious injuries (MAIS3+) to include injuries leading to **permanent medical impairment (PMI)**. An “impairment risk table” based on AIS coding has been established by consensus amongst experts that is used to

³ International Statistical Classification of Diseases and Related Health Problems (WHO)

predict the rate of limitation of physical or mental functioning associated with an injury (Malm et al., 2008). An impairment is considered permanent when no further improvement in physical and/or mental functioning is expected despite continued treatment (Berg et al., 2016; Babaie et al., 2023).

The proportions of injuries leading to PMI were calculated by Amin et al. (2022) for different **road user categories**, including pedestrian fall injuries without any counterpart or transport device. The results show that every fourth pedestrian fall injury (25%) and every fifth pedestrian collision injury (21%) led to a permanent medical impairment of at least 1% (PMI1+). For injuries that led to a more severe impairment of at least 10% (PMI10+), a significantly higher proportion was seen among pedestrians in collisions (4%) compared with other types of road users:

- | | | |
|------------------------|-----------|-----------|
| • Pedestrian fall | 25% PMI1+ | 2% PMI10+ |
| • Pedestrian collision | 21% | 4% |
| • Car occupants | 14% | 2% |
| • Cyclist | 19% | 2% |

As stated in Weijermars et al. (2016), there is a correlation between **injury severity and physical consequences**: studies quite consistently show that the risks of mainly functional and socio-economic consequences increase as a function of injury severity. According to Malm et al. (2008), the risk for car occupants of sustaining a permanent medical impairment greater than 10% rises from 1% in the AIS1 class to 13% in the AIS3 class. Higher proportions of long-term health consequences were found by Weijermars et al. (2016) among pedestrians and motorcyclists, both groups also having a high share of severe injuries (Liers, 2023).

However, minor injuries, such as strain injuries to the spine, may also have grave long-term consequences. Parallel to this, Stigson et al. (2020) mention the fact that some injuries with low MAIS levels (MAIS 1-2) can lead to long-term consequences while some injuries with high MAIS scores (MAIS 3+) are low risk in terms of long-term consequences.

2.3 Disability-Adjusted Life Years (DALYs)

Disability-Adjusted Life Years (DALYs) in the context of road safety combine the impacts of fatal and non-fatal road injuries and express them in one unit of measurement — one DALY is one lost year of healthy life:

- Years of Life Lost (YLL) are lost life years due to premature death. In the context of road safety these are the lost life years of road fatalities. YLL are calculated as the remaining life years of road fatalities, taking into account average life expectancy.

- Years Lived with Disability (YLD) express the loss of quality of life due to non-fatal injuries and diseases. In the context of road safety YLDs quantify the health loss of (seriously) injured road users.

DALYs were first developed for quantifying the **global burden of disease**, the losses of healthy life associated with different causes of disease and injury (Murray & Lopez, 1996). In the last global burden of disease study, it was estimated that **“Transport Injuries”⁴ constitute 2.1% of total DALY rates** in the EU27 (or 427 DALYs per 100,000 inhabitants; World Health Organization, 2019). The largest decreases in age-standardised DALY rates since 1990 were observed for “HIV/AIDS and sexually transmitted diseases” and “transport injuries” (Santos et al., 2024).

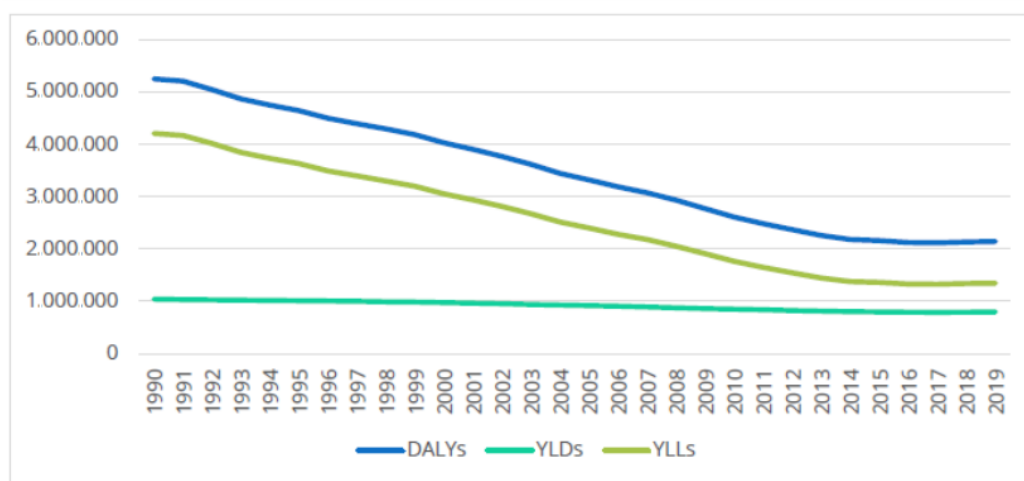


Figure 5. Trend in DALYS, YLDs and YLLs due to road injuries in the European Union (1990-2019). Source: World Health Organization (2019).

Figure 5 shows that DALYs have been decreasing between 1990 and 2014 and remained stable over the next five years. The YLLs have declined more sharply (minus 68% between 1990 and 2019) than the YLDs (minus 24% between 1990 and 2019).

In a German burden of disease study, conducted in 2017, the share of road injuries of total DALYs was estimated to be 1.8%, or 256 DALYs per 100,000 inhabitants, about 75% of which were caused by YLLs and 25% by YLDs (Porst et al., 2022).

In the age group 15 to 34 years, road injuries were responsible for the greatest share of the total DALYs, the rate for males being almost 2.4 times higher than the rate for females (Figure 6). This

⁴ Transport Injuries consist for the largest part of road injuries.

gender gap is mainly due to fatal road injuries (YLL), while the share of YLD is similar in both sexes (Porst et al., 2022).

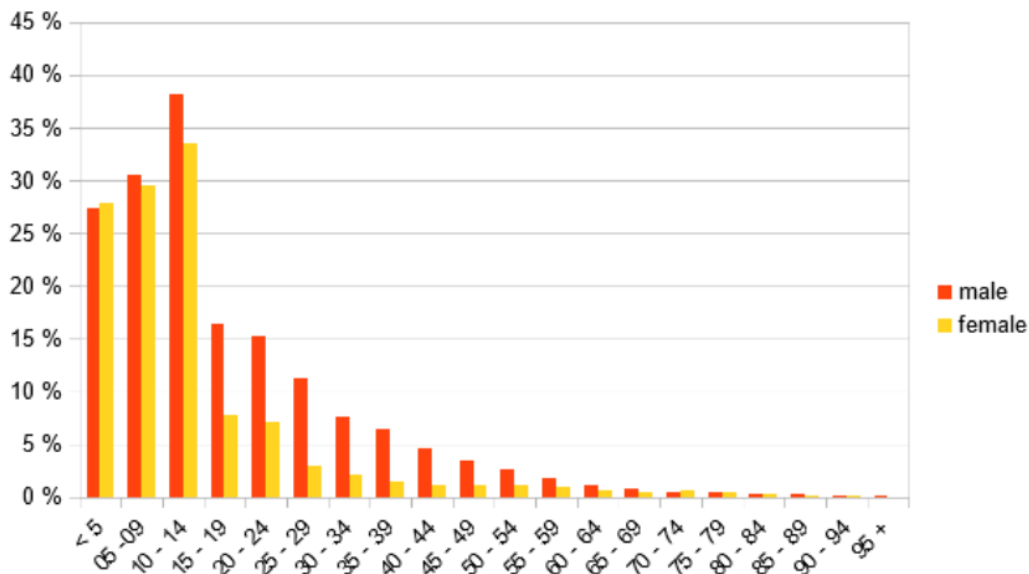


Figure 6. Burden of disease (DALY per 100 000 population) for road injuries by sex and age group. Source: German BURDEN study. Porst et al. (2022).

According to Porst et al. (2022), **52% of DALYS were attributed to vulnerable road users** (pedestrians, cyclists and motorcyclists). Compared to the road traffic fatalities in Germany by mode of transport in the same year, it is the share of pedestrians (14%) that differs most from their share in DALYs (19%).

2.4 Psychological consequences

In addition to physical injuries, traffic accidents are often categorised as traumatic events and can result in significant psychological problems. Also, there are reports of violent behaviour and substance abuse post-injury (Marasini et al., 2022). If these symptoms are left untreated, there is a high probability of progressing to a serious mental disorder. Already previous studies claimed that the cost of illness might double if the elevated rates of psychological distress were considered in injured people (Chan et al., 2003). Therefore, early mental health screening and interventions are important to reduce the psychological consequences of traffic accidents.

As for the **prevalence of psychological consequences** of crashes, a recent review of studies indicates that symptoms of post-traumatic stress disorder (PTSD) and depression were the most consistently reported mental health outcomes: PTSD symptoms were reported by about 35% of casualties one-month post-injury, by 40% at 6 months and by about 20% at one-year post-injury. Likewise, depression was

reported by 20% one-month post-injury, by 33% at 6 months and by 23% at one-year post-injury (Papadakaki et al., 2024).

Kovacevic et al. (2020) have investigated the psychological consequences and associated factors in road crash survivors in Croatia, one month after experiencing the crash. They found that

- PTSD symptoms were associated with female gender, below-average self-perceived economic status, previous psychiatric illness, medication use, psychiatric medication use, not being at fault in the road traffic crash, claiming compensation, and injury-related factors.
- Symptoms of depression were associated with below-average self-perceived economic status, irreligiousness, medication use, psychiatric medication use, and injury-related factors (such as hospitalisation).
- Anxiety symptoms were associated with previous chronic or psychiatric illness, previous permanent pain, psychiatric medication use, and self-perceived threat to life.

In addition, the number of days of hospitalisation and subjective trauma appraisals (such as traumatic fear and negative cognition about the self) were found to be significant predictors of PTSD symptoms (Măirean & Cimpoeșu, 2020).

Few differences have been identified in the psychological consequences of crashes according to the **mode of transport** used. However, passengers appear to suffer greater consequences than other road users, especially regarding travel anxiety (Meunier et al., 2018). They are particularly anxious about re-occupying a passenger seat in a car. Another study also suggests that motorcyclists are at lower risk of developing PTSD than occupants (passengers or drivers) of four-wheel vehicles (Chossegros et al., 2011).

In a systematic literature review of the psychological consequences of motor vehicle injuries Marasini et al. (2022) found:

- Those not physically recovered from their accident, or those with severe injuries were significantly more likely to have negative psychological consequences.
- Posttraumatic stress disorder (PTSD) was the main psychopathology observed in car-only accidents involving adults.
- Drivers had significantly lower presence of PTSD, compared to passengers or pedestrians.
- For cyclists, it was hypothesised that their perception of risk (vulnerability) brings them greater resilience as compared to car occupants (lower perceived danger) and could offer psychological protection against trauma and physical injury.

- All studies that involved children and adolescents reported perception and behaviour changes after a traffic accident. About 50% of the children rated themselves as having been frightened “a lot” during the accident or thought they were going to die or be badly hurt.

2.5 Socio-economic consequences

Social impacts include consequences for the everyday life of the family, impact on leisure activities, and impacts on emotional life and (sexual) relationships (Weijermars et al., 2016). Social consequences usually depend on injury severity: Tournier et al. (2014) showed that more than half of the severely injured participants (MAIS3+) reported that the accident had had an impact on the everyday life of their family. This was twice as many as in the mild-to-moderate injury group (MAIS1 or 2). Severely injured persons reported relational difficulties (20%), impaired sexual life (16%), and the rate of separation was significantly higher than in the mild-to-moderate injury group (Weijermars et al., 2016). The mean time off work was significantly longer in the severe injury group: 32% of the severe injury group who had stopped work had not returned one year later, compared to 5% of the mild-to-moderate injury group (Hours et al., 2013).

The monetary valuation of the adverse impacts of crashes emphasizes the large **economic burden** of road crashes, and also serves as input for decision-making on road safety investments through cost-benefit analysis (Wijnen et al., 2025). Road crash cost studies typically incorporate monetary valuation of the intangible impacts related to the loss of quality of life and life years (“human costs”).

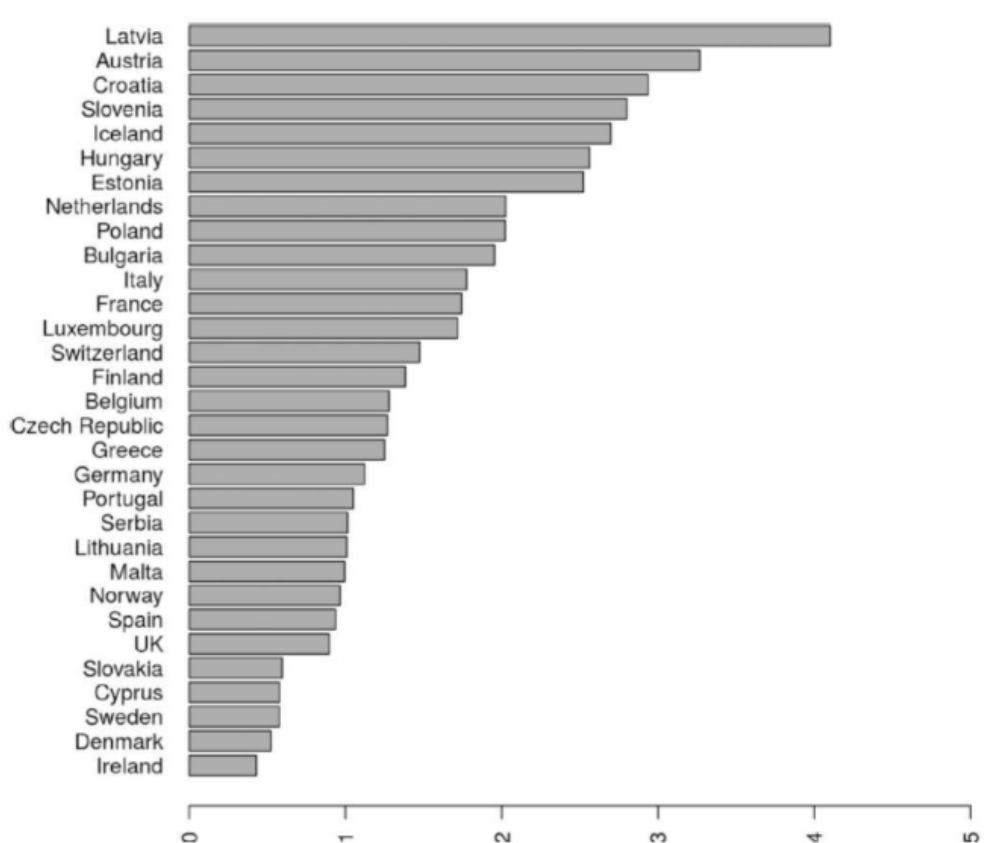


Figure 7. Total costs of road crashes as a percentage of GDP (2015).
Source: Wijnen et al. (2019)

The European SafetyCube project collected official **cost estimates from 31 European countries** (EU28, Switzerland, Norway and Iceland; Wijnen et al., 2019). A comparison between costs per casualty and total costs showed that there are large differences between countries that are largely explained by the cost components included and the calculation methods used (Figure 7):

- The share of total crash costs of GDP (Gross Domestic Product) ranged from 0.4% in Ireland to 4.1% in Latvia, the median share was 1.3% (Belgium).
- Costs per fatality ranged from €0.7 million to €3.0 million in 2015.⁵
- Costs per serious injury ranged from 2.5% to 34.0% of the costs per fatality, and the costs per slight injury from 0.03% to 4.2% of the costs per fatality.

⁵ For an update to a more recent price, the cumulative inflation rate in the Eurozone between 2015 and 2024 of 1.26 could be applied to these values. ©Inflation Tool 2025.

To help improving the comparability of national crash costings, the EU project SafetyCube (Wijnen et al., 2019) updated the guidelines from former European studies (Alfaro et al., 1994; Bickel et al., 2006) and recommended the classification of costs as shown in Figure 8.

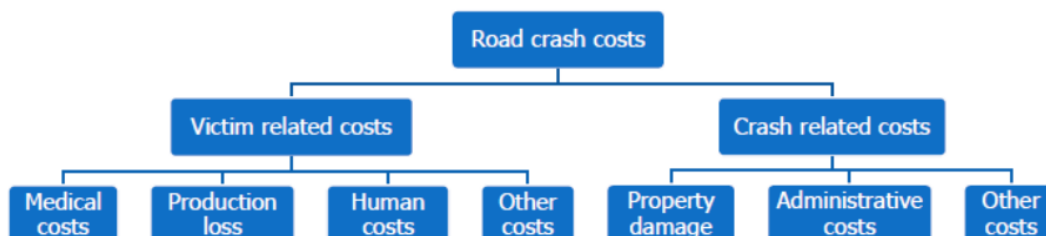


Figure 8. Classification of road crash costs. Source: Wijnen et al. (2019).

Cost components related to road casualties:

- Medical costs include all costs related to the medical treatment of road casualties, either at the crash location, in the hospital, or by other medical institutions such as rehabilitation centres.
- Costs related to production loss result from road casualties who temporarily or permanently are not able to work. Mostly market production only is considered, while some studies also estimate non-market production loss such as in households or volunteering.
- Human costs express the suffering that road crashes cause for those involved and their relatives, but also the loss of quality of life due and the loss of life years due to premature death. These are intangible costs: they have no market price and are therefore less easy to quantify than the other costs. Nevertheless, they are routinely included in the calculation of social costs since they represent a significant loss of social welfare (Schoeters et., 2022).

Cost components related to the road accident:

- Costs related to property damage result from damage to both private and public property caused by road crashes. The largest share consists of damage to (passenger) vehicles, and a smaller part represents damage to road infrastructure and freight traffic loads. Costs related to property damage are a cost component almost unique to road accidents. This should be considered when cost figures are compared among disease and other injury domains.
- Administrative costs include the working hours of police and fire departments at the crash location, but also the services provided by insurance companies and the legal costs of prosecuting offenders.

Furthermore, there are also several other cost items that relate either to the casualty or the crash. These include funeral costs, congestion

costs, costs related to vehicle unavailability, and costs of house adaptations for injured persons that suffer disabilities due to a road crash.

The SafetyCube recommendations have largely been taken up in the 2019 version of the EU handbook on the external costs of transport that provides cost estimates for all EU countries (European Commission, 2019; a further methodological update of the valuation of the “statistical life” has been proposed by Wijnen et al., 2025). The average accident costs for the EU28 per casualty and cost component are shown in Table 2.

Table 2. Accident cost per casualty and cost component for the EU28 in 2016. Source: EU handbook on the external costs of transport (European Commission, 2019).

	Human costs (€)	Production loss (€)	Medical costs (€)	Administrative costs (€)	Total cost per casualty (€)
Fatalities	2,907,921	361,358	2,722	1,909	3,273,909
Serious injuries	464,844	24,055	8,380	1,312	498,591
Slight injuries	35,757	1,472	721	564	38,514

Based on these estimates, the **total cost of road crashes in the European Union (EU 28, including United Kingdom) was estimated to be about 353 billion Euro in 2024⁶**. This value does not yet take into account the underreporting of road injuries mentioned in the introduction, and is therefore still an underestimation of real costs (Wijnen et al., 2017).

Table 3 shows the results of the most recent injury costing in Austria: absolute numbers and proportions of individual crash cost components, including the sum of costs with and without human suffering (human cost). Human costs are estimated by the “Willingness to Pay”⁷ method and are by far the largest component in crash cost estimates (Schoeters et al., 2022).

⁶ Cumulative inflation rate of 1.26 (Eurozone 2015-24) applied to 2015 value of 280 billion Euro.

⁷ Willingness to Pay: Maximum monetary amount an individual is ready to pay to avoid a negative health outcome.

Table 3. Austrian crash cost study 2021 results by cost categories.
 Source: Road accident cost accounting 2022 (Austrian Ministry of Climate Action and Energy, 2023). Year of data 2021.

Cost category	Accident costs (Mio. EUR)	Costs without human suffering (%)	Costs with human suffering (%)
Medical treatment costs	146	2.8%	1.3%
Production losses	1,176	22.2%	10.6%
Material damages	2,476	46.7%	22.4%
Costs for police	32	0.6%	0.3%
Costs for fire department	8	0.2%	0.1%
Costs for the legal system	268	5.0%	2.4%
Administration costs of insurance sector	1,112	21.0%	10.1%
Other liability insurance costs	64	1.2%	0.6%
Costs for ambulance	21	0.4%	0.2%
Costs for time losses	3	0.1%	0.0%
Sum without human suffering	5,307	100%	48.0%
Human suffering	5,860	-	53.0%
Sum with human suffering	11,064	-	100%

Who bears the cost of crashes? This question can also be put the other way round: Who could profit from a reduction of the cost of crashes? Obviously, everyone who is potentially affected by the consequences of crashes would benefit. This is captured in the “Willingness to Pay” for preventing human suffering due to accidents. When it comes to measurable expenses directly linked to an accident, institutional payers can be identified.

Medical costs are borne by the health system and its financiers (social and private insurance, federal and regional governments, private households, depending on the national financing system of health care). Production loss, in terms of sick leaves and replacements costs, are borne mainly by employers. Long-term production loss is mostly borne by the injured person (income loss), and through compensation payments from government and insurances.

In the short, medium or long term, depending on the type of cost, a reduction of crashes and/or mitigation of their consequences would reduce not only human suffering, but also the required resources and compensation payments — a potential incentive for more investments in road safety.

3. Further Reading

Data linkage in road safety: Bridging the divide to support better health outcome. Yalamanchili, S. (2024).

Public health consequences of road traffic injuries – Estimation of seriously injured persons based on **risk for permanent medical impairment**. Berg, H.-Y., Ifver, J., & Hasselberg, M. (2016).

A comprehensive description of **socio-demographic factors** of the physical and psychological health outcomes of transport crashes in Australia can be found in Sharwood et al., (2022).

Recent reviews of studies about the **psychological consequences** of motor vehicle accidents were compiled by Marasini et al. (2022) and Papadakaki et al. (2024).

A recent review of studies on the **socio-economic costs** of road traffic crashes stresses the importance of controlling for countries' characteristics including road safety outcomes and population density (Bougna et al., 2022).

4. Abbreviations

Abbreviation	Full Term
AIS	Abbreviated Injury Scale (6 scores)
BOI	Burden of Injuries
COI	Cost of Injuries
GDP	Gross Domestic Product
EU	European Union
IDB	Injury Database
MAIS3+	Maximum Abbreviated Injury Scale, AIS score of 3 or more
RTI	Road Traffic Injury
YLD	Years Lived with Disability - health loss of (seriously) injured road casualties
YLL	Lost life years due to premature death (fatal road injuries)
WHO	World Health Organisation

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