An overview of car occupant fatalities in the European countries

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Abstract Car occupants have a high level of mortality in road accidents, since passenger cars are the prevalent mode of transport. In 2013, car occupant fatalities accounted for 45% of all road accident fatalities in the EU. The objective of this research is the analysis of basic road safety parameters related to car occupants in the European countries over a period of 10 years (2004-2013), through the exploitation of the EU CARE database with disaggregate data on road accidents. Data from the EU Injury Database for the period 2005 - 2008 are used to identify injury patterns, and additional insight into accident causation for car occupants is offered through the use of in-depth accident data from the EC SafetyNet project Accident Causation System (SNACS). The results of the analysis allow for a better understanding of the car occupants' safety situation in Europe, thus providing useful support to decision makers working for the improvement of road safety level in Europe.

INTRODUCTION

The principal mode of passenger transport is that of the passenger car, since it is linked to the desire for greater mobility and flexibility. Car use is growing rapidly in many countries worldwide and in 2014 alone, a record 67 million passenger cars came into circulation on world's roads [1]. In the European Union in 2013, passenger cars accounted for 83,2% of inland passenger transport, with motor coaches, buses and trolley buses (9,2%) and trains (7,6%) both accounting for less than a tenth of all traffic (as measured by the number of inland passenger-kilometres (pkm) travelled by each mode) [2]. The high dependence on the use of the car as a means of passenger transport, as well as the subsequent increase in interaction between cars, heavy vehicles and vulnerable road users have contributed to more conflicts and road accidents.

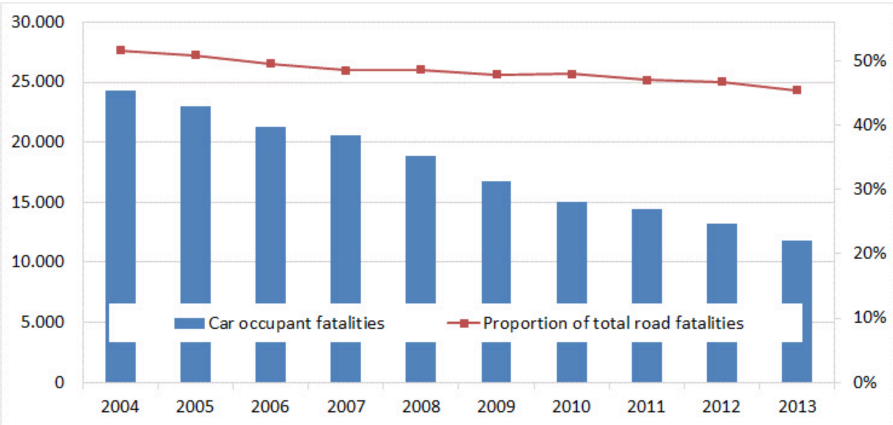
Around 180.000 car occupants were killed in road accidents in the EU during the decade 2004 - 2013. Car occupant fatalities hold the largest part of road fatalities in the Europe, constituting almost half of them. However, in the 2004 - 2013 period, car occupant fatalities were reduced more than the overall accident death rate (51% and 45% respectively) and thus, more than the rate for other road users. Car occupants have therefore benefitted more than other road users from road safety measures adopted over those years. This is not surprising, as many of those measures were targeted at car occupants including increased enforcement of the main traffic offences, improved vehicle occupant protection, and, to a lesser extent, improved infrastructure [3]. Despite that considerable decrease, the number of car occupant fatalities still remains high and an analysis of their characteristics would be useful in the better understanding of the effects of the implemented measures on their evolution.

The objective of this research is the analysis of basic road safety parameters related to car occupants in European countries, through the exploitation of the EU CARE database with disaggregate data on road accidents, the EU Injury Database (EU IDB) and the SafetyNet Accident Causation System (SNACS). More specifically, time-series road accident data involving car occupants from CARE for 27 EU countries over a period of 10 years (2004 - 2013) are correlated with basic safety parameters, such as road type, presence of junction, season of the year, day of the week and time of the day, as well as person related characteristics, like age and gender. Moreover, EU IDB data for the period 2005 - 2008 are used to identify injury patterns and improve the assessment of injury severity. Additional insight into accident causation recorded for car occupants is offered through analysis of a set of in-depth data, collected for the period 2005 – 2008, using a common methodology for samples of accidents that occurred in Germany, Italy, the Netherlands, Finland, Sweden and the United Kingdom. The paper is based on work done within the development of the Traffic Safety Basic Facts 2015 – Car Occupants (European Commission, 2015), as well as through SAFETYNET and DaCoTA EC co-funded research projects and the European Road Safety Observatory (ERSO - http://ec.europa.eu/transport/wcm/road_safety/erso/index-2.html).

The results of the analysis allow for a better understanding of the car occupants' safety situation in Europe in comparison to other modes of transport, thus providing useful support to decision makers working for the improvement of road safety level in Europe.

OVERALL ROAD SAFETY TRENDS FOR THE CAR OCCUPANTS IN THE EUROPEAN COUNTRIES

In 2013, 11.838 car occupants were killed in road traffic accidents in the 27 EU countries (CARE, 2015). This represents 45% of all road fatalities in the EU in 2013. Of these 11.838 killed car occupants, 8.116 were drivers and 3.722 were passengers. In order to monitor the evolution of the car occupants' safety level in Europe, accident trends for the decade 2004 - 2013 were considered. Figure 1 presents the number and proportion of car occupant fatalities in the EU countries for the period 2004-2013. In general, the proportion of car occupant fatalities has decreased by 12% over this ten year period.



Source: CARE database, data available in May 2015

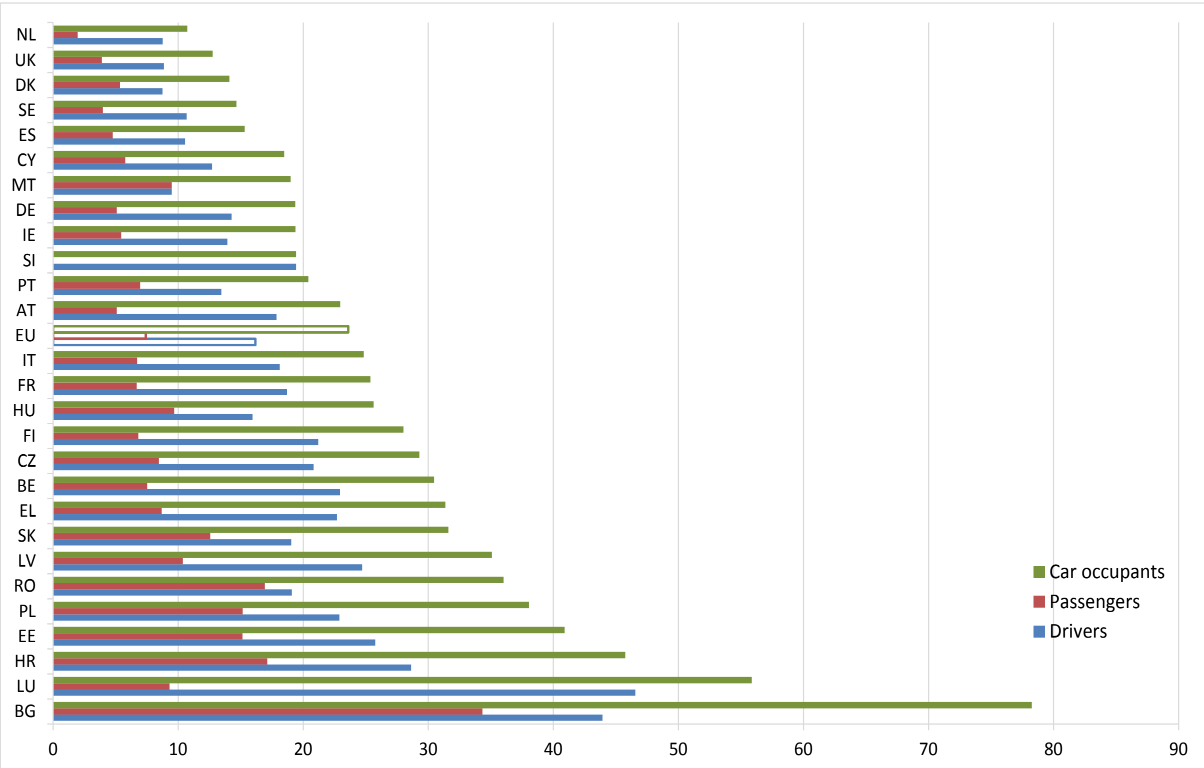
Figure 1. Number of car occupant fatalities and percentage of all road fatalities, EU, 2004- 2013

Analysis of the car occupants' road accident data showed that a considerable decrease by 51% in the number of car occupant fatalities was recorded during the decade 2004 - 2013, which is higher than the respective reduction of the overall road fatalities by 45%. The highest decrease in car occupant fatalities was recorded in Spain (73%), followed by Latvia and Slovenia (69% and 68% respectively). On the contrary, Romania experienced the lowest reduction in car occupant fatalities during that period (29%), less than half the EU reduction on average.

Analysis on the trends of different categories of car occupant fatalities (i.e. car drivers and car passengers) has been also carried out. In the decade 2004-2013, the number of drivers killed in road accidents in the EU was almost twice the respective number of car passengers, while this proportion seems to have an increasing trend. Moreover, car passenger fatalities recorded higher reduction than the car drivers (55% and 49% respectively), which more or less was the case for all the EU countries, except Belgium, Denmark and Romania. It should be noted that the latest available data are used as proxies for missing data for the year 2013, meaning 2009 data for Bulgaria and Estonia, 2010 data for Malta and Slovakia and 2012 data for Ireland.

In road safety analysis exposure data is often used to calculate risk estimates, being defined as the rate of the number of accidents (or casualties) divided by the amount of exposure of a population over a time period [6], [7]. The vehicle kilometres travelled indicate the risk to which a road user is exposed while traveling on the road, and so this better indicates relative levels of safety. However, since data about vehicle kilometres or person kilometres travelled are not currently available in all EU countries, mortality rates have been used as a measure for comparison (population used as exposure). The calculated risk figures may be used for different purposes, but their main objective is to enable the comparison of safety performance among different units, populations or countries.

In Figure 2, car occupant, driver and passenger fatality rates per million population in the EU countries are shown, sorted by the car occupant fatality rates. Fifteen EU countries had higher car occupant fatality rates than the EU on average, with Bulgaria being on the top of the list. The Netherlands had the lowest driver fatality rate (9) per million population, as well as the lowest occupant rate (11). Considering passengers of cars, the Netherlands (2), Sweden and the United Kingdom (4) had the lowest fatality rates per million population, whilst Slovenia had not any car passenger fatalities.

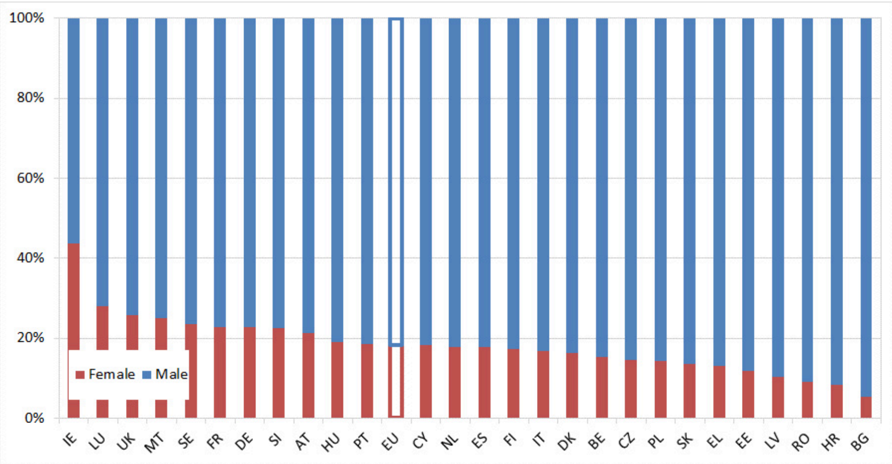


Source: CARE database, data available in May 2015

Figure 2. Fatality rates of car occupants, drivers and passengers per million population by country, 2013 or latest available year

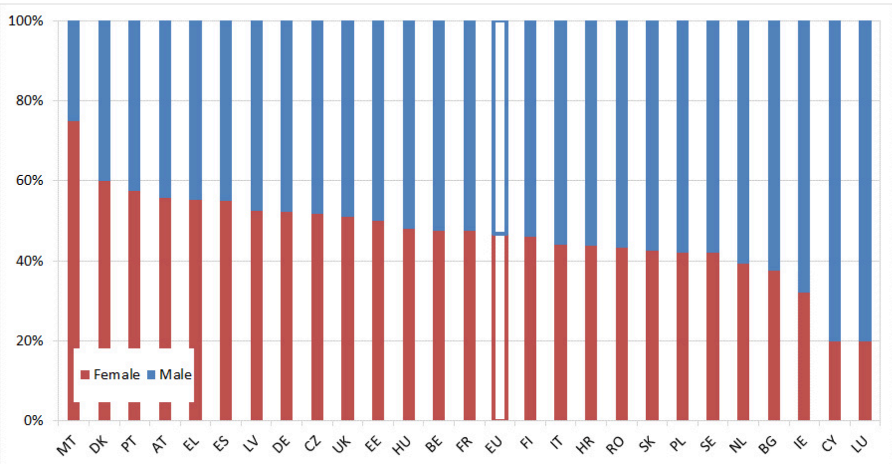
According to the results of a more detailed analysis by age groups and gender, the majority of car occupant fatalities were males (73%), while the case differs significantly between drivers and passengers. In fact, the percentage of male car driver fatalities was significantly higher than the respective percentage for female drivers (82% versus 18%), while the percentage of male car passenger fatalities was a bit more than the half passenger fatalities (53% for males and 47% for females).

Among the EU countries, Ireland had the highest proportion of female driver fatalities (44%), while Croatia and Bulgaria had the lowest percentages (8% and 5% respectively). It is noted that Cyprus, Luxemburg and Malta are excluded from interpretation due to their very low population As regards car passenger fatalities, Denmark had the highest proportion of female car passenger fatalities (60%), while the lowest proportion of female car passenger fatalities was found in Ireland (32%).



Source: CARE database, data available in May 2015

Figure 3. Distribution of car driver fatalities by country and gender, 2013 or latest available year



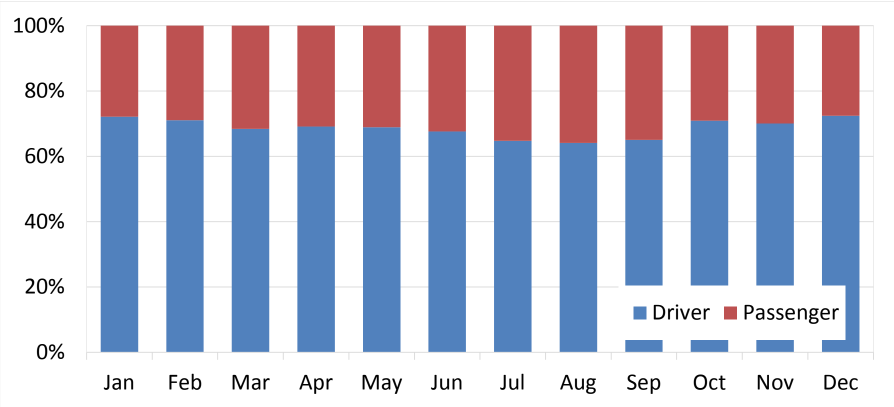
Source: CARE database, data available in May 2015

Figure 4. Distribution of car passenger fatalities by country and gender, 2013 or latest available year

When considering the age groups, the highest percentages of both driver and passenger fatalities in the EU countries were found in the age group of 25-49 years old. It is worth noticing that while the proportion of male passenger fatalities is much higher for the age group 18-49 years, the opposite is true for the car passengers older than 50 years. In fact, in the age group of 65+ years old, female passenger fatalities are about 2,5 times higher than the male fatalities, confirming the results of studies showing that elderly female car passengers are at greater risk of being killed in a road accident compared to male car passengers [8]. Much of these findings are likely to be related to the percentages of drivers and passengers within each gender group and age group, as well as to kilometres travelled. For example, several studies confirm that older women are more often passengers when travelling by car [8].

ROAD SAFETY PARAMETERS OF THE CAR OCCUPANTS IN THE EUROPEAN COUNTRIES

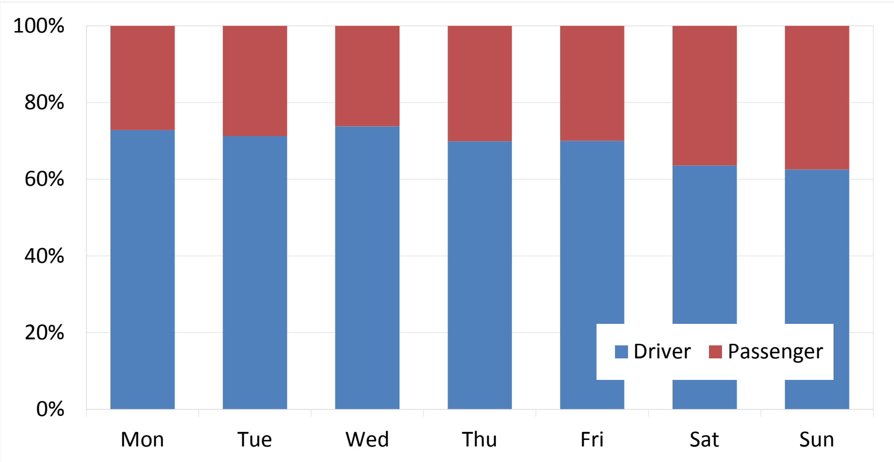
According to the analysis of the fatalities seasonal distribution, the percentages of EU fatalities per month in 2013 varied between 7,1% in February and 9,7% in October with the number of car occupant fatalities being slightly increased during the period between July and October. Figure 5 presents the proportion of car driver and passenger fatalities in the EU per month. In general, the distribution is relatively stable over the year and around one-third of the car occupant fatalities are passengers. In July, August and September, however, the proportion of car passenger fatalities is relatively higher (35% - 36%).



Source: CARE database, data available in May 2015

Figure 5. Distribution of car driver and car passenger fatalities by month, EU, 2013 or latest available year

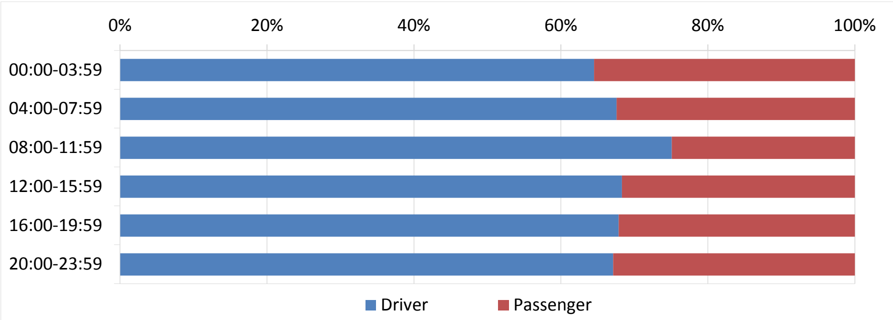
Day of the week and time of the day were also considered. These data indicate that for the EU, the majority of car occupant fatalities occurred either on a Saturday or a Sunday (34,7%), while the lowest percentage occurred on Wednesdays (11,4%). Figure 6 presents the proportion of fatalities of car drivers and passengers for the EU by day of the week for the year 2013. The percentage of passenger fatalities is higher in weekends compared to the respective percentage on weekdays.



Source: CARE database, data available in May 2015

Figure 6. Distribution of car driver and car passenger fatalities by day of the week, EU, 2013 or latest available year

A notable difference for the EU is evident between the lowest percentage of fatalities (from 0:00 to 04:00 - 11,6%) and the highest percentage of fatalities (from 16:00 to 20:00 - 21,8%), while in twelve countries the highest percentage of fatalities occurred between 12:00 and 16:00 hours. Figure 7 presents the proportion of fatalities of car drivers and passengers for the EU countries by time of the day in 2013. The percentage of car passenger fatalities is highest (35%) between 0:00 and 04:00, but there is little variation during the day.



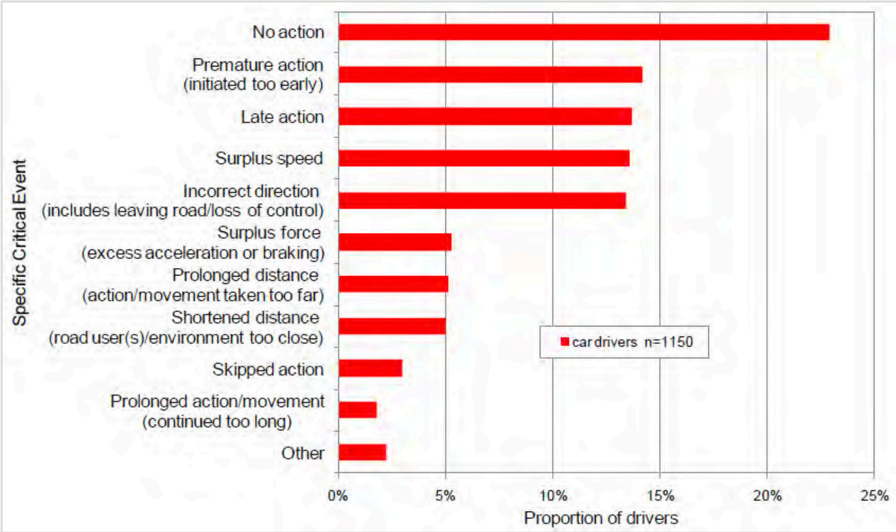
Source: CARE database, data available in May 2015

Figure 7. Distribution of car driver and car passenger fatalities by time of the day, EU, 2013 or latest available year

According to the analysis, 70% of the car occupant fatalities in the EU countries occurred outside urban areas on non-motorways. Finland and Sweden were the countries which experienced the highest numbers of fatalities outside urban areas (91%), while in Croatia only 52% of car occupant fatalities were recorded outside urban areas. Around one-fifth of car occupant fatalities in the EU countries occurred inside urban areas. Additionally, the majority of car occupant fatalities occurred away from a junction, with only around 11% of the fatalities occurring at junctions in the EU countries. The data indicate that among the larger countries, the United Kingdom had the greatest share of fatalities at junctions (26%), while Slovakia had only 7% of fatalities at junctions.

ACCIDENT CAUSATION ANALYSIS

Additional insight into accident causation can be offered by in-depth data, such as those collected during the EU co-funded SafetyNet project. During that project, in-depth data were collected using a common methodology for samples of accidents that occurred in Germany, Italy, the Netherlands, Finland, Sweden and the United Kingdom [9], [10]. The SafetyNet Accident Causation Database was formed between 2005 and 2008, and contains details of 1.006 accidents covering all injury severities. A detailed process for recording causation (SafetyNet Accident Causation System – SNACS) attributes one specific critical event to each driver, rider or pedestrian. Links then form chains between the critical event and the causes that led to it. For example, the critical event of late action could be linked to the cause observation missed, which was a consequence of fatigue, itself a consequence of an extensive driving spell. Links are established by trained personnel directly involved in the investigation according to the SNACS coding system, with full case evidence available to them. These data have been analysed to compare the causation recorded for car drivers and other drivers/riders in car accidents. Of the accidents in the database, most accidents (82%) involve a car. Of the car drivers, 65% were male and the mean age of drivers involved was 41 years. Figure 8 gives the distribution of specific critical events for car drivers.



Source: SafetyNet Accident Causation Database 2005 to 2008 / EC N=1.150, date of query: 2010

Figure 8. Distribution of specific critical events – car drivers

Specific critical events under the general category of 'timing', 'no action', 'premature action' and 'late action' are recorded most often for car drivers. 'No action' describes those drivers who have not reacted at all (or at least in an effective time frame) to avoid a collision, for example, to avoid an oncoming vehicle. A 'premature action' is one undertaken before a signal has been given or the required conditions are established, for example entering a junction before it is clear of other traffic.

Following these 'timing' events, surplus speed and incorrect direction are recorded in equal measure. Surplus speed describes speed that is too high for the conditions or manoeuvre being carried out, travelling above the speed limit and also if the driver is travelling at speed unexpected by other road users. Incorrect direction refers to a manoeuvre being carried out in the wrong direction (for example, turning left instead of right) or leaving the road (not following the intended direction of the road). 'Loss of control' type accidents can fall into either critical event depending on the specific situation.

Table 1 gives an indication of the most frequently recorded causes and the most frequently recorded links between these causes. 'Faulty diagnosis' and 'observation missed' are two dominant causes for car drivers. 'Faulty diagnosis' is an incorrect or incomplete understanding of road conditions or another road user's actions. It is linked to both 'information failure' (for example, a driver thinking another vehicle was moving when it was in fact stopped and colliding with it) and 'communication failure' (for example, pulling out in the continuing path of a driver who has indicated for a turn too early).

The causes leading to 'observation missed' can be seen to fall into two groups: 'physical obstruction to view' type causes (for example, parked cars at a junction) and 'human factors' (for example, not observing a red light due to distraction or inattention).

'Inadequate plan' can also be seen to be frequently recorded and describes a lack of all the required details or that the driver's ideas do not correspond to reality. It is most often linked to 'insufficient knowledge' (for example, not understanding a complex junction layout) but it is also linked with 'under the influence of substances' (alcohol, drugs or medication).

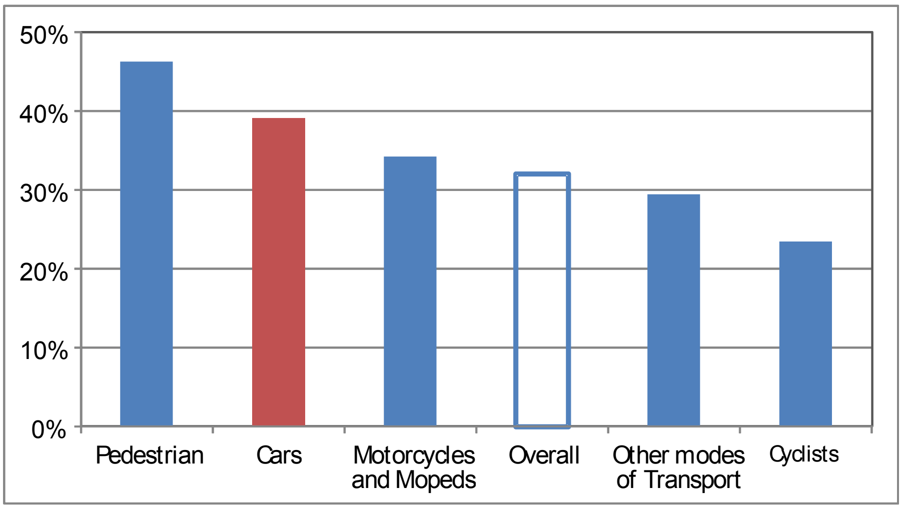
Table 1: Ten most frequent links between causes – car drivers

Links between causes	Frequency
Faulty diagnosis - Information failure (driver/environment or driver/vehicle)	209
Observation missed - Distraction	86
Observation missed - Temporary obstruction to view	83
Observation missed - Faulty diagnosis	77
Faulty diagnosis - Communication failure	66
Inadequate plan - Insufficient knowledge	62
Observation missed - Permanent obstruction to view	60
Observation missed - Inadequate plan	52
Observation missed - Inattention	47
Inadequate plan – Under the influence of substances	45
Others	516
Total	1.303

Source: SafetyNet Accident Causation Database 2005 to 2008 / EC, date of query: 2010

ROAD ACCIDENT HEALTH INDICATORS

Injury data variables obtained through the EU Injury Database (EU IDB) can complement information from police records and thus, provide a better insight for injury patterns and the improved assessment of injury severity in road accidents. EU IDB is a system developed following a recommendation issued by the EU Council that urges member states to use synergies between existing data sources and to develop national injury surveillance systems rooted in the health sector. At present, thirteen member states are routinely collecting injury data in a sample of hospitals and delivering these data to the EC (http://ec.europa.eu/health/data_collection/databases/idb/index_en.htm). IDB data used in this research comes from nine EU Member States (DE, DK, LV, MT, AT, NL, SE, SI, CY) and concerns accidents that occurred between 2005 and 2008. Figure 9 shows that overall 32% of road accident casualties recorded in the IDB were admitted to hospital, compared with 39% of car occupants. Additional analysis of the IDB data showed that the overall average length of stay in the hospital for injured in road accidents was eight days, but six days for car occupants.



Source: EU Injury Database (EU IDB AI) - hospital treated patients. IDB AI Transport module and place of occurrence (code 6.n [public road]); n-all = 73.600: n-admitted = 23.568 (DE, DK, LV, MT, AT, NL, SE, SI, CY, years 2005-2008).

Figure 9. Percentage of non-fatal road accident casualties who were admitted to hospital by mode of transport

Figure 10 illustrates the distribution of body parts injured of the various road user types. Car occupants, for example, show the greatest proportion of neck and throat injuries among all types of road users, presumably linked to the incidence of whip-lash.

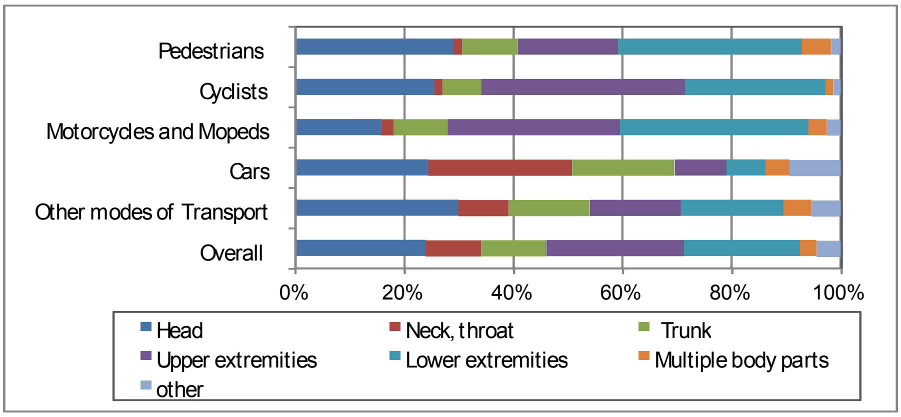


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Figure 10. Distribution of non-fatal road accident casualties by mode of transport and body part injured

CONCLUSIONS

As cars comprise a considerable share of the vehicle fleet, better understanding of the characteristics specific to this user group provides an opportunity to address a high proportion of fatalities recorded every year in Europe. The various road safety parameters examined revealed that the safety problem for the car occupants vary among the countries, reflecting different levels of infrastructure development and traffic enforcement, as well as behavioural characteristics.

Analysis of the car occupants' road accident data derived from the EC CARE database for the decade 2004 – 2013, showed that a considerable decrease by 51% in the number of car occupant fatalities was recorded within that decade, which is higher than the respective reduction of the overall road fatalities by 45%. It was also found that in 2013, the majority of driver fatalities in the EU countries were males, while male passenger fatalities were slightly higher than half the car occupant fatalities. Moreover, the percentage of female car passenger fatalities was significantly higher than the respective percentage of female drivers. When considering the age groups, the highest percentage of driver fatalities in the EU countries was found in the age of 25 and 49 years old. In addition, most of the car occupant fatalities in the EU countries occurred outside urban areas, on non-motorways, with the percentages varying among the examined countries.

The analysis of other types of data such as in-depth accident data and injury data, allowed for additional insight into accident causation recorded for car occupants, as well as for the identification of injury patterns improvement of the assessment of injury severity for casualties of this road user group.

The results of the analysis allow for a better understanding of the car occupant safety problem in the European road network, providing thus useful support to decision makers working for the improvement of safety in the European road network. Certainly, the effort of data-collection is an on-going challenge and there are additional data that could help shed light to the problem of the car occupants' road safety. Of particular interest are exposure data related to the mobility of road users (veh-kms, passenger-kms travelled). Furthermore, the macroscopic analysis presented in this paper could be also combined with more detailed analysis using statistical models, which is necessary for the identification of the combined correlation of the parameters with an impact on car occupants' road safety and the underlining reasons behind their casualties.

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APPENDIX A – COUNTRY ABBREVIATIONS

Belgium	BE
Bulgaria	BG
Czech Republic	CZ
Denmark	DK
Germany	DE
Estonia	EE
Ireland	IE
Greece	EL
Spain	ES
France	FR
Croatia	HR

Italy	IT
Cyprus	CY
Latvia	LV
Lithuania	LT
Luxembourg	LU
Hungary	HU
Malta	MT
Netherlands	NL
Austria	AT
Poland	PL
Portugal	PT

Romania	RO
Slovenia	SI
Slovakia	SK
Finland	FI
Sweden	SE
United Kingdom	UK

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