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In-depth analysis of fatal road traffic accidents on Belgian motorways between 2009 and 2013

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Doden op de snelweg. Diepteanalyse van de dodelijke verkeersongevallen op de Belgische autosnelwegen van 2009 tot 2013.

Les tués sur les autoroutes. Analyse approfondie des accidents de la circulation mortels sur les autoroutes belges pendant la période 2009-2013.

Objective and methodology

In Belgium, 36% of all kilometres driven by vehicles are driven on motorways. Although just 7% of all accidents that result in injury take place on a motorway in the period 2009-2013, the severity score is clearly higher than on other types of roads with 35 fatalities per 1,000 accidents resulting in injury. Moreover, European comparisons show that Belgium scores poorly in terms of fatal accidents on motorways. With 60.1 deaths per 1,000 km of motorway (data from 2010), Belgium is one of the worst performing European Member States.

The severity of these accidents on Belgian motorways thus constitutes a problem, which therefore means that a comprehensive analysis of serious road traffic accidents on motorways is required. These types of analyses should allow us to gain more of an insight into the nature and causes of these accidents, and consequently to formulate recommendations to prevent such accidents or reduce their severity. This study is a first step in this direction. It focuses on fatal accidents on Belgian motorways and is primarily based on data from police reports, compiled following fatal road traffic accidents on motorways in the 2009-2013 period.

We point out that the reports are not always complete from a research perspective. A number of interesting facts are fairly systematically missing in the police reports. These involve, for example, results of blood tests, accident sketches, photographs of the accident, detailed information about damage to the vehicles and the speed the vehicles were travelling. It is important to mention that these are not 'incomplete' reports. It is more a problem of data transmission. Not all parts of the police report are delivered to the devolopment policy department of the Federal Police, and are therefore also not delivered to the Belgian Road Safety Institue.

Main results

Key figures

In the 2009-2013 period, there were 521 fatal accidents on Belgian motorways, 5 of which occurred in the Brussels-Capital Region, 269 in the Flemish Region and 247 in the Walloon Region. During this period, a decrease was observed in the number of fatal accidents on motorways. These accidents involved 65 pedestrians, 964 drivers and 483 passengers. The accidents proved fatal for 582 of the individuals involved.

General circumstances

The main findings related to the general circumstances in which the accidents occurred are as follows:

- 14.4% of the fatal accidents occurred at night during the week and 20.7% occurred at night during the weekend. We find a different distribution for all accidents with injury in the same period: 5.9% took place at night during the week and 9.1% at night during the weekend. A comparison with accidents on motorways resulting in injured victims also reveals a higher percentage of fatal accidents on motorways at night, particularly at nights during the weekend;
- On average there were 30 deaths per 100 km of motorway during the period concerned. Notably, the number of deaths per 100 km of motorway differs considerably between the provinces. The number of deaths per 100 km of motorway also fluctuates per road segment;
- The majority of fatal accidents on motorways (85.8%) occurred in normal weather conditions. It was raining when 9.6% of accidents occurred. In Belgium it rains between 6% and 7% of the time. Therefore this means that the chance of a fatal accident is slightly higher in wet weather compared with dry weather.

- Light conditions play a major role in fatal accidents on motorways. 19.8% of the fatal accidents on motorways occurred at night (with no public lighting). If we look at all accidents with injury in the same period, onlu 2.9% of the accidents occurred at night without public lighting. This effect could be explained by the fact that risky behaviour such as driving under the influence of alcohol and tiredness occur more frequently at night.

Infrastructure characteristics

We established the following with regard to infrastructure characteristics:

- In 10.9% of fatal accidents on motorways, there was no hard shoulder. In 10.1% of accidents, the central reservation was not protected by a crash barrier. The percentage is much higher for the right-hand side of the road: there was no crash barrier present there in 39.1% of the accidents studied. This is particularly dangerous for road users that leave the road and therefore risk crashing into an unprotected obstacle;
- 6.7% of the accidents studied occurred at an exit, 2.1% took place at an entry. On average there are 21 exits and entries per 100 km of motorway in Belgium. However there were just 1.5 fatal accidents at an exit and just 0.2 fatal accidents at an entrie per 100 km of motorway. Therefore entrances and entries are not the most dangerous places on a motorway. It was however not possible to perform an analysis of the risk of accidents on motorways close to an entry or exit;
- There are 2.2 interchanges per 100 km of motorway. There were 28 fatal accidents at interchanges; this equates to 1.4 fatal accidents at an interchange per 100 km of motorway. At interchanges too there were thus relatively fewer fatal accidents than elsewhere on motorways;
- Road works were involved in 8.7% of fatal accidents on motorways. This figure is significantly higher compared with the percentage of accidents that resulted in injury on all types of roads involving road works (1.0%) in the 2009-2012 period. We also observe a lower percentage of accidents with injuries on motorways during road works (3.4%) compared with fatal accidents on motorways. Road works therefore constitute a greater risk factor for fatalities on motorways than on other roads.

Characteristics of vehicles and road users

Several important findings related to the characteristics of vehicles and road users are:

- There were 1,512 people involved in the 521 fatal accidents on motorways studied: 964 drivers, 65 pedestrians and 483 passengers. A pedestrian is a person who travels on foot. We distinguish between two types. Firstly there are drivers who leave their vehicle because it has broken down or because they have had an accident, and become a pedestrian. There are also people who enter the motorway on foot from a car park or the side of the road;
- The average age of the drivers involved was 41 years; the average age of the drivers killed was 39 years. 15% of the drivers involved could be considered as young drivers (18 to 24 years). The percentage of young drivers killed was slightly higher, at 19.6%;
- The average age of the pedestrians involved was 40 years. Almost all the pedestrians involved in a fatal road traffic accident on a motorway died as a result of that accident. We see a number of very young children included in the pedestrians. These are children who entered the motorway with one of their parents. They were mostly cases of (family) suicide;
- The majority of drivers involved (86.6%) were male. This was also true for the pedestrians (70.8% men compared with 29.2% women). The distribution between male and female passengers was almost proportional (56.5% of men compared with 43.5% of women).

- Only 70.3% of drivers and pedestrians involved in the accidents studied turned out to be Belgian nationals: 16.9% originated from one of our neighbouring countries and 12.7% originated from a different country;
- 4.2% of all vehicles involved were not insured. Furthermore, 6.1% of drivers involved could not produce a valid inspection certificate;
- 2.9% of the drivers involved did not possess the correct type of driving licence authorising them to drive the vehicle concerned at the time of the accident. 1.4% of drivers involved did not even possess a driving licence. 0.5% of drivers were driving during a driving ban.

Course of the accident

The **course of the accident** was first mapped out in order to perform the accident analysis. 62.8% of those involved were travelling in a professional capacity or commuting and 37.2% were engaged in leisure travel. In the period leading up to the accident, a large number of the drivers concerned (82.4%) were moving at a more or less constant speed.

The situation or the conflict that initiated the accident was divided into five categories:

- *Loss of control and deviating from the driving lane* (46.5%): the driver loses control of his or her vehicle. This means that the vehicle starts to drift across the road, after which the driver is not able to regain control of the vehicle. Gradually deviating from the driving lane to the left or right also falls under this category;
- *Accidents in longitudinal road traffic* (37.9%): the vehicles drive behind one another;
- *Accidents involving a crossing pedestrian* (7.1%): a pedestrian crosses the driving lane from the left or right side of the road;
- *Accidents involving stationary traffic* (1.2%): accidents involving a driving vehicle and one that was stationary on the left-hand or right-hand side of the road;
- *Other types of accidents* (7.3%): this category includes, among others, accidents resulting from alcohol or fatigue, as well as impacts with an animal or an obstacle in the road.

Slightly less than half of the accidents (45.5%) involved a one-sided accident, which refers to an accident that did not involve another road user.

Functional error was also established. The method's basic principle is the observation that problems leading to accidents can arise during different phases: perception, processing, prediction, decision, execution and global errors. Errors of perception and execution errors were both observed among 4 out of 10 road users involved in fatal accidents. No functional error could be identified for a quarter of those involved. These are drivers who "passively" participated in the accident and therefore did not make any errors.

In one-sided accidents, an execution error was noted for three quarters of the road users involved. In this respect, these accidents clearly differ from accidents involving more than one vehicle. Global errors, such as driving under the influence of alcohol, are more frequent in one-sided accidents compared with accidents involving more than one vehicle.

Accident factors

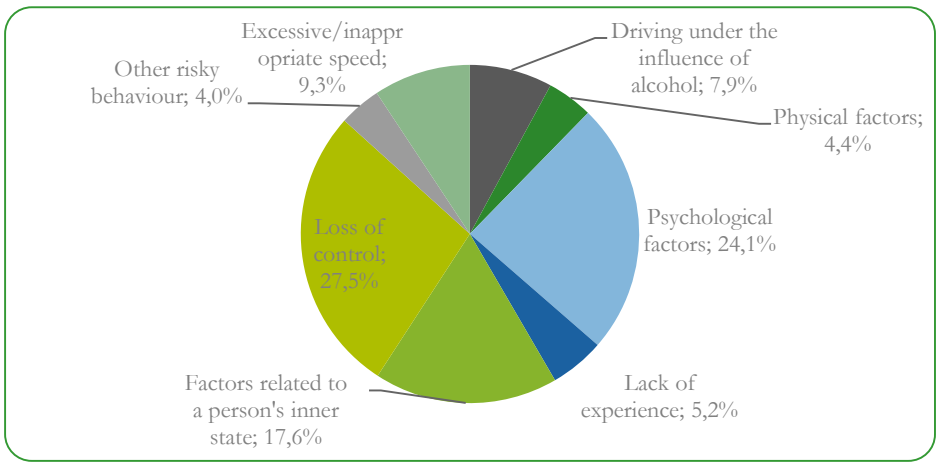
All the **accident factors** that played a role in causing an accident and all factors that influenced the severity of the accident were listed for each driver and pedestrian involved in a fatal road traffic accident on a motorway. We distinguished between human behaviour, the vehicle, infrastructure and the environment. In total 1,744 accident factors were identified for 1,029 road users. At least one human factor was observed for 54.1% of the drivers and pedestrians involved, at least one vehicle factor for

12.6% and at least one infrastructural or environmental factor for 47.3%. These percentages add up to 114% because up to five different accident factors could be established for each road user.

Human accident factors

The distribution of human accident factors is shown in the following chart.

Human accident factors in the accidents studied



Slightly more than half of the accident factors (53.1%) involve human behaviour.

Factors related to losing control of the vehicle are most frequent. Here we include losing control of the vehicle during or after a manoeuvre, and loss of control resulting from the execution of an evasive manoeuvre. The vehicle starts to drift and the driver is not able to get the vehicle back into the lane. Often the underlying cause of the loss of control is unknown. We suspect that excessive and inappropriate speed is closely linked to the loss of control of the vehicle.

The "psychological factors" category is the second largest group of human factors. In this category we included distraction, failure to pay attention, not focusing on the driving task, etc.

Factors related to the inner state and the driving task include committing violations, incorrect assessment of the danger presented by a situation, navigation issues, etc.

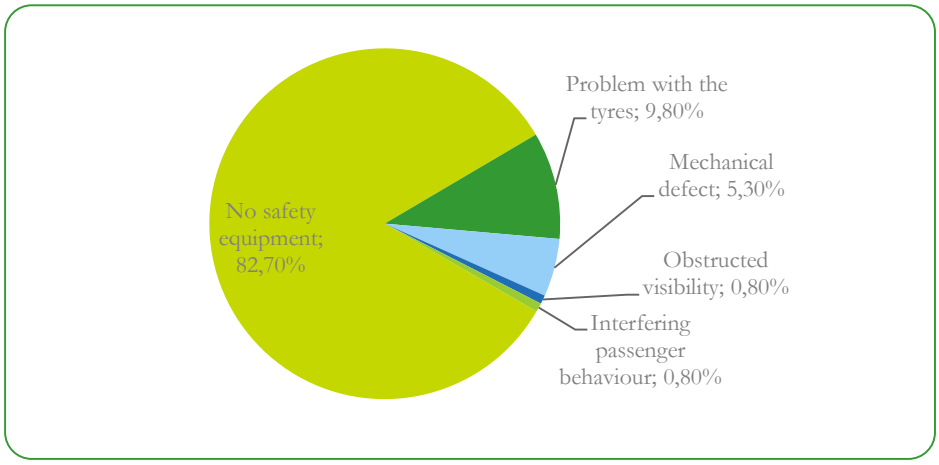
The adoption of risky behaviour such as excessive or inappropriate speed and driving too close to the vehicle in front is also frequent.

Driving under the influence of alcohol and a lack of driving experience were also identified as factors involved in accidents. Lastly physical factors include tiredness, illness, becoming unwell while driving, etc.

Vehicle-related accident factors

The following chart shows the distribution of the vehicle-related accident factors. These represented 7.6% of accident factors.

Vehicle-related accident factors in the accidents studied

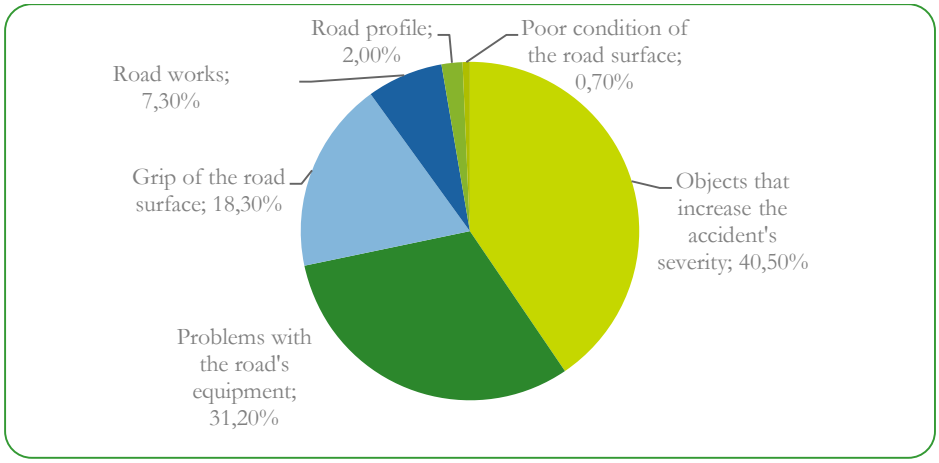


In the vehicle-related factors the failure to use or the lack of safety equipment, usually the seatbelt, is most frequent. In addition we found that some vehicles had problems with tyres. Mechanical defects, obstructed windscreen visibility as a result of objects placed on the dashboard and a passenger who tried to take over control of the vehicle were also noted as causal factors.

Infrastructure and environment-related accident factors

The distribution of the infrastructure-related accident factors are shown in the following chart. These factors represented 17.3% of the accident factors.

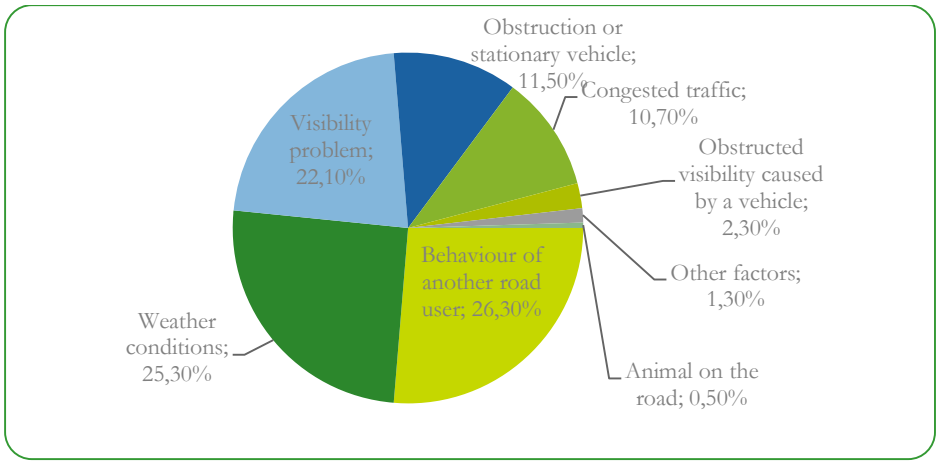
Infrastructure-related accident factors in the accidents studied



The accident factor "objects that increase the severity of an accident" relates to obstacles along the side of the road that are not protected by a crash barrier. This factor often appears in combination with a problem with the road's equipment, more specifically the lack of a crash barrier. Problems with grip on the road surface also appear regularly. The road is wet, slippery or dirty, making it difficult for drivers to maintain control of their vehicle. The presence of road works sometimes played a role too. Other accident factors identified were problems with the road's profile, such as a sharp bend when taking an exit and poor condition of the road surface.

The following chart shows the distribution of the environment-related accident factors. These represented 22.0% of the accident factors.

Environment-related accident factors in the accidents studied



The behaviour of another road user makes up the largest group of environment-related accident factors. In this category we include, for example, road users who do not indicate they are about to perform a manoeuvre or who perform an atypical manoeuvre.

The weather conditions were noted as a causal factor for a great many of the persons involved. Visibility problems, particularly as a result of darkness, were also frequent. The next important factor is obstruction caused by an obstacle or a stationary vehicle in the driving lane. Congested traffic or a traffic jam was also considered as a causal factor for a large number of people involved.

Accident factors that emerged less frequently include obstructed visibility by a vehicle driving in front, other factors such as obstruction caused by a previous accident and the presence of a wild animal on the road.

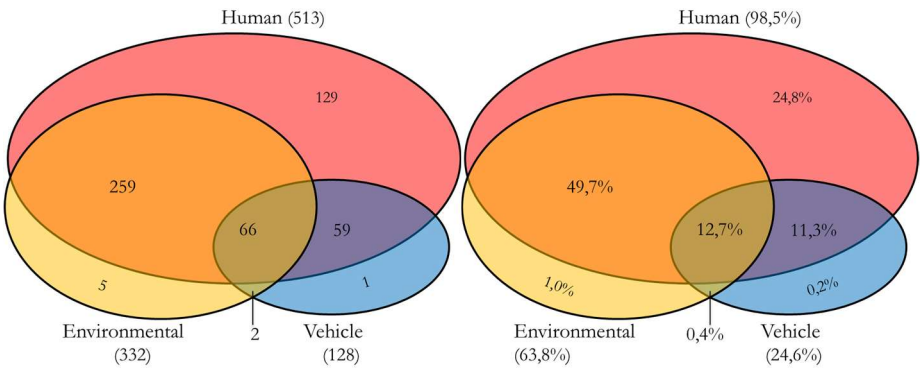
The interaction of accident factors

The extent to which human, vehicle and environmental factors appear in a single accident and interact is also interesting. The infrastructural and environmental factors were combined to facilitate the analysis.

Below we examine the interaction between the different factors at the level of the accident. The accident factors attributed to the drivers and pedestrians involved in a single accident were combined.

The chart first shows the number of accidents in which at least one human factor, at least one vehicle factor or at least one environmental factor was involved. The chart also shows the number of accidents in which the interaction of different factors occurred.

Interaction of human, vehicle and environmental factors in the 521 accidents studied



In general we can say that human factors occur most frequently. At least one human accident factor played a role in no less than 98.5% of the accidents studied. 24.8% of the accidents involved human factors exclusively, while 73.7% of accidents involved a combination of at least one human factor with at least one vehicle or environmental factor.

We also find that:

- At least one vehicle factor played a role in 128 accidents. Only one accident involved exclusively vehicle factors. Therefore in 127 accidents there is interaction between at least one vehicle factor and at least one human or environmental factor. In this case it involved accidents in which there were problems with the vehicle's tyres or in which another mechanical problem was established;
- Environmental factors alone played a role in just five accidents (1.0%). An environmental factor occurred in combination with (predominantly) human factors or with vehicle factors in 327 accidents;
- Almost half of the accidents involved a combination of at least one human factor with at least one environmental factor. Combinations involving a loss of control with an infrastructure-related problem (lack of a crash barrier, obstacles along the side of the road, the formation of a traffic jam, etc.) were particularly frequent;
- Other combinations with human factors were scarcer. The combination of at least one human factor with at least one vehicle factor occurred in 11.3% of accidents. Here we mainly see a combination of loss of control and the failure to wear a seatbelt;
- The combination of at least one human, vehicle and environmental factor was established in 12.5% of accidents. In these cases one combination stands out: loss of control, failure to wear a seatbelt and an obstacle along the side of the road.

The three killers in traffic

In this study we also examined the extent to which the three major killers in traffic - excessive and inappropriate speed, driving under the influence of alcohol and the failure to wear a seatbelt - occurred in fatal accidents on motorways.

Excessive or inappropriate speed was noted for 27.0% of drivers about whom we possessed information.[4] Given that we did not possess any information relating to speed for 45% of the drivers involved, this is the lower limit of the number of drivers who drove too fast. The true percentage is probably higher. Excessive or inappropriate speed plays a major role in one-sided accidents in particular. A difference was also observed according to the type of road user involved. Over half of the primary road users did not respect the speed limits or drove too fast for the conditions. Half of secondary road users also drove too fast or at an inappropriate speed. Hardly any speed limit violations were established among passive and reactive road users. Moreover we suspect that excessive and inappropriate speed also played a major role in accidents resulting from losing control of the vehicle.

The percentage of **drivers under the influence of alcohol** among the road users involved was between 12.8% and 24,5%[5]. It is not possible to formulate a more accurate figure at the moment because no

[4] Excessive or inappropiate speed was coded as an accident factor for 86 drivers involved. However, we noted that 144 drivers were driving at excessive or inappropriate speed prior to the accident. This discrepancy can be explained by the fact dat speed wasn't coded as an accident factor whenever we only surmised the driver must have been speeding. Furthermore, a driver can be speeding without the speed itself playing a role in the accident

[5] 75 drivers were driving under the influence of alcohol, but this was coded as an accident factor for only 70 drivers. The discrepancy can be explaine by the fact that some drunk drivers didn't play any role in the accident. Because they were 'passive' drivers, no accident factors were coded.

alcohol tests were performed for 45% of the road users and the results of 65% of the blood tests are unknown.
45.0% of those involved were only subjected to a breathalyser test, 11.5% were only subjected to a blood test. 28.4% of drivers involved in one-sided accidents were driving under the influence; alcohol therefore plays a major role in this type of accident. Furthermore, alcohol use was observed above all among initiators of the accidents. Between 20.4% and 55.5% of these road users were driving while intoxicated. Driving under the influence of alcohol was rare (between 0.6% and 5.0%) among the other types of road users involved in the accidents.

One group of people involved in fatal accidents on motorways that should not be overlooked involves those that were **not wearing their seatbelt**. This percentage amounted to 45.9% for drivers, 40.7% for passengers sitting in the front of the vehicle and 71.7% for rear passengers. Failure to wear a seatbelt therefore constitutes a real problem in fatal accidents on motorways. The percentage of road users that were not wearing their seatbelt is greatest among the fatalities.

Typical accident profiles

Based on the characteristics of the accident, we divided the 521 fatal accidents studied into 16 categories (and one "other" category). The most frequent accident profiles are:

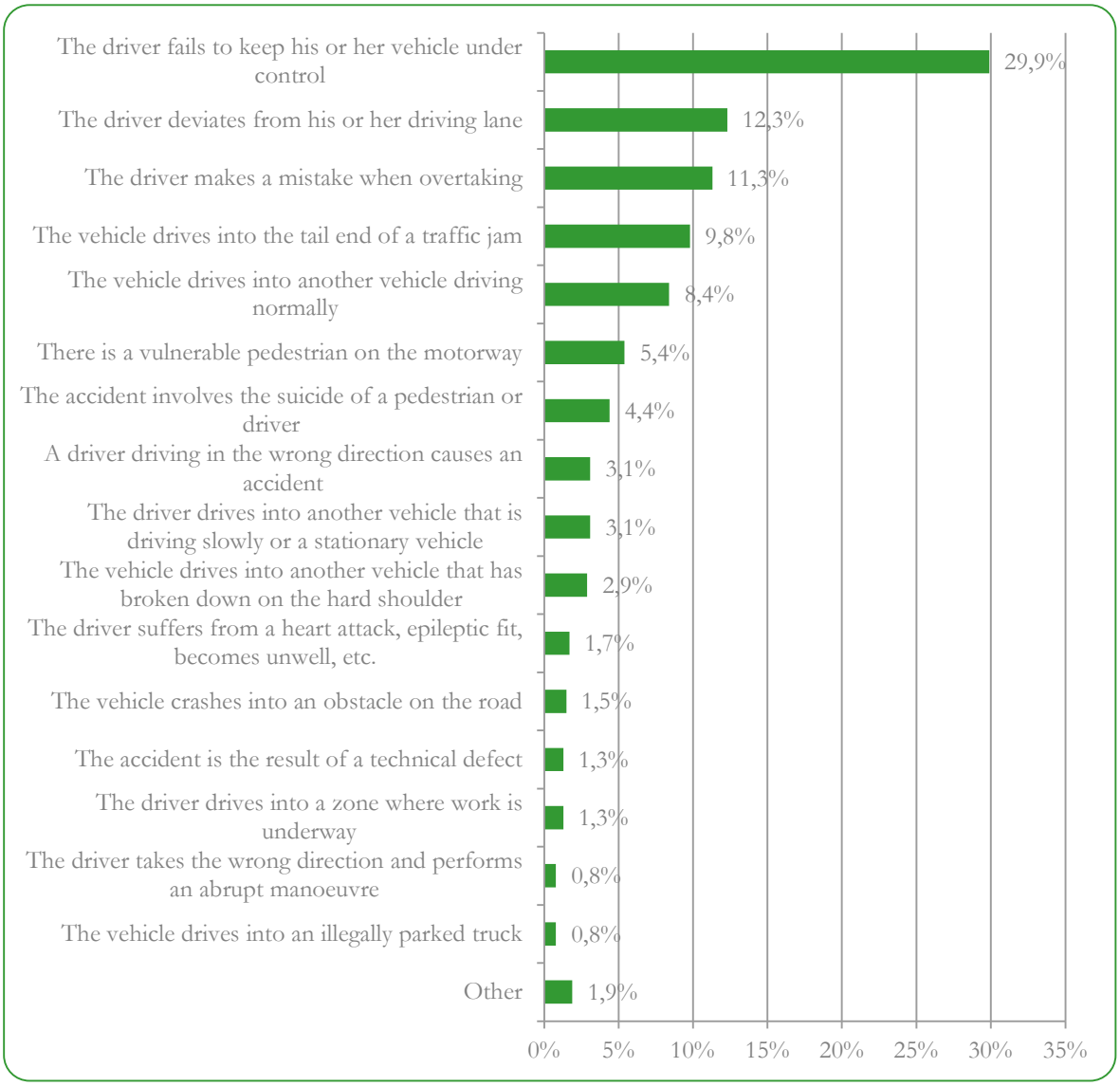
- The driver fails to keep his or her vehicle under control;
- The driver deviates from his or her driving lane;
- The driver makes a mistake when overtaking;
- The vehicle drives into the tail end of a traffic jam;
- The vehicle drives into another vehicle that is driving normally.

Loss of control of the vehicle appears to be a major factor in fatal accidents on motorways. "Loss of control of the vehicle" was considered as an accident factor for 255 road users, while 156 accidents were included in the "the driver fails to keep his or her vehicle under control" accident profile[6].

In 46.5% of accidents, loss of control of the vehicle or deviating from the driving lane was considered as the situation that led to the accident. The "the driver fails to keep his or her vehicle under control" and "the driver deviates from the driving lane" accident profiles are thus the two most frequently occurring types of accidents (29.9% and 12.3% respectively). A large number of these accidents involve one-sided accidents.

[6] The discrepancy between the percentage of loss of control of the vehicle as an accident factor and the percentage of accidents in the "the driver fails to keep his/her vehicle under control" profile can be attributed to the fact that in one accident this involves the percentage of loss of control of the vehicle among road users and in the other, loss of control of the vehicle during accidents.

The distribution can be seen in full in the following chart.



Recommendations

As a result of the analyses performed, we are formulating the following recommendations, which are intended to lead to a reduction in the number of fatal accidents on motorways and/or reduce their severity.

- **Continuous efforts to increase awareness** are necessary, especially with regard to excessive speed, driving under the influence and wearing a seatbelt. Specific points of concern are:
  - Drivers must understand that excessive speed can also be fatal at night on a "deserted" motorway - to themselves and others;
  - Adapting speed to specific circumstances such as ice, snow and road works;
  - Wearing a seatbelt;
  - The particular vulnerability of pedestrians on a motorway.
- Increasing awareness goes hand in hand with **enforcement**. Intensive and continuous checks ensure long-term behavioural effects. Examples we are thinking of include the use of mobile radar, police checks using unmarked vehicles, more speed cameras, etc.

- Taking a number of **infrastructure**-related measures. Specifically:
    - The presence of obstacles along the side of the road combined with the lack of a crash barrier plays a particularly grievous role in fatal accidents on Belgian motorways. Therefore it is best that obstacles along the side of the road are always separated by a crash barrier to reduce the severity of accidents;
    - Other infrastructural measures that can reduce fatal accidents on motorways are: additional dynamic traffic signs, a radio station entirely devoted to traffic information and further research into accidents near motorway entries and exits.
- Promoting **Intelligent Transport Systems** that can help prevent accidents or reduce the severity of accidents. Possibilities include:
    - "Lane departure warning systems" and "lane keeping systems", to avoid accidents resulting from a vehicle deviating from the driving lane;
    - "Adaptive cruise control systems" and "Collision warning systems" that help prevent rear-end accidents;
    - "Night vision systems" that help prevent accidents that occur at night;
    - Intelligent Speed Assistance (ISA), which can reduce the number and severity of accidents.
- This study also reveals that more detailed information is necessary for us to better understand the origins and causes of severe and fatal accidents. **In-depth research into road traffic accidents** is needed. This involves a team of specialist researchers visiting the site following an accident. Only by inspecting the vehicles, interviewing those involved, requesting and analysing medical data and analysing the infrastructure can additional information be gathered about the accident and all causes of the accident be mapped.

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