MOTAC

Motorcycle Accident Causation

Background

Motorcyclists form a vulnerable group in traffic. They are as unprotected as pedestrians or cyclists but they can go as fast as – or even faster – than a car driver. The contacting surface of a motorcycle tire is moreover very small: it is approximately of the size of a credit card. Motorcyclists have a fatality risk that is 12 as large as that of the average user of a motorized vehicle. In the previous years each year more than 100 motorcyclists have died in a road traffic accident and more than 500 were severely injured.

Against this background the Federal Public Services for Mobility and Transport asked the Belgian Road Safety Institute to carry out a study, the goal of which was to register the causal and aggravating factors of severe motorcycle accidents in Belgium and to investigate the situations in which the accidents occurred to be able to formulate recommendations for measures to reduce the high risk of motorcyclists.

It is the first time in Belgium that such an investigation like this was conducted and it has yielded many interesting results and new insights. The study can therefore be considered a milestone in the research of motorcycle accidents. Nevertheless there are limitations to this study. In some of the accidents investigated the available data did not allow conclusions about particular factors such as exaggerated speed or possible use of alcohol. These limitations, however, did not interfere with the identification of accident types and groups of motorcyclists where these factors played a role.

Sample and methodology

The study executed by the Belgian Road Safety Institute includes only those motorcyclists who have been involved in severe accidents. We are consequently dealing with a very small group of motorcyclists. In Belgium there are estimated to be more than 400,000 motorcyclists, of which circa 700 are severely or fatally injured yearly, less than 0,2%. The characteristics of the sample investigated are consequently not representative of motorcyclists in general.

• Sample

200 accidents involving at least one motorcycle were studied. About half of the accidents (103) were fatal, in the other half (97) at least one person was severely injured but no one was killed. The majority of the accidents took place in 2010 (84%) and the rest (16%) in 2009. Fatal and severe accidents in the sample can be considered representative of those fatal and severe motorcycle accidents registered by the police.

• Methodology

The analysis is based on a list of 200 possible causal factors and situational characteristics. In the analysis process one or more of these factors was attributed to each accident. Subsequently all accidents were clustered according to these characteristics in 5 large accident groups and one rest category.

In half of the accidents investigated the victim was killed, in the other half severely injured.

BIVV-IBSR

The study is based on the analysis of court files.

The analysis was based on information retrieved from the court files of the accidents. The Prosecuting office granted the Belgian Road Safety Institute access to these files. In 30% there was the report of an accident expert. In the other cases information over causal factors (e.g., exaggerated speed, alcohol, road surface problems) was deduced from the sketches (length of the traces, flying distance), pictures, the police report, and in exceptional cases also from witness statements[1].

• Additional sources

The motorcyclists who were involved in an accident were compared with a representative sample of motorcyclists.

The information about the licenses of the motorcyclists who were involved in the accidents was completed on the basis of the driver's license database of the Federal Government Service for Mobility and Transport. Moreover, the characteristics of the motorcyclists in the accidents (age, profession, type of motorcycle) were compared to those of a representative sample of 200 Belgian motorcyclists who were weighted by the kilometers they rode.

• Limitations

When coding the accidents, speculations were rigorously avoided. The results over possible causes like exaggerated speed and alcohol consequently suffer from a relatively large number of cases where the information is unknown. Nevertheless it was possible to sketch the groups of riders and the types of accidents in which these problems played a role.

Another limitation of the study concerns details of the accident causation (e.g. the underlying conditions for problems like "loss of control" or "did not see the motorcyclist", the state of the vehicles involved before the accident, injury mechanisms…) that could often not be investigated on the basis of information available in the court files.

One last important limitation of the study is that it could only take into account the accidents that were registered by the police. From other research we know that not all accidents (and not all types of accidents to the same extent) were registered by the police. The accidents investigated here are, however, representative of severe accidents as registered by the police.

Accident types and causes

• Single vehicle accidents

35% of the accidents involved only one motorcyclist. In the other 65% the motorcyclist collided with another road user.

35% of the accidents were single vehicle crashes in which the motorcyclist did not collide with another vehicle.

In 90% of the cases, the accidents were caused by the motorcyclist himself. The other 10% were caused by external effects or the cause was unknown. The problem with the motorcyclists was usually a riding error like loss of control or slipping when braking (80%).

[1] Under the condition that the witness was (a) able to judge the facts that he was reporting (e.g., someone who knows his own speed and is overtaken by another vehicle can make an estimation of the speed of that vehicle, someone at the side of the road cannot) and (b) had no reason to purposefully report incorrect information.

More than half (58%) of the single vehicle accidents happened in a curve, in the majority to the left (21 of 37). Only one out of 10 single vehicle accidents took place on an interception.

• Crashes between road users

17% of the two-sided accidents took place at the exit of a private property.

In 65% of the cases a motorcyclist collided with another road user[2]. 17% of these two-sided accidents took place at the exit of a private property and 42% took place on intersections. Only 13% of the two-sided accidents took place in a curve the majority of which (2 out of 3) was to the right.

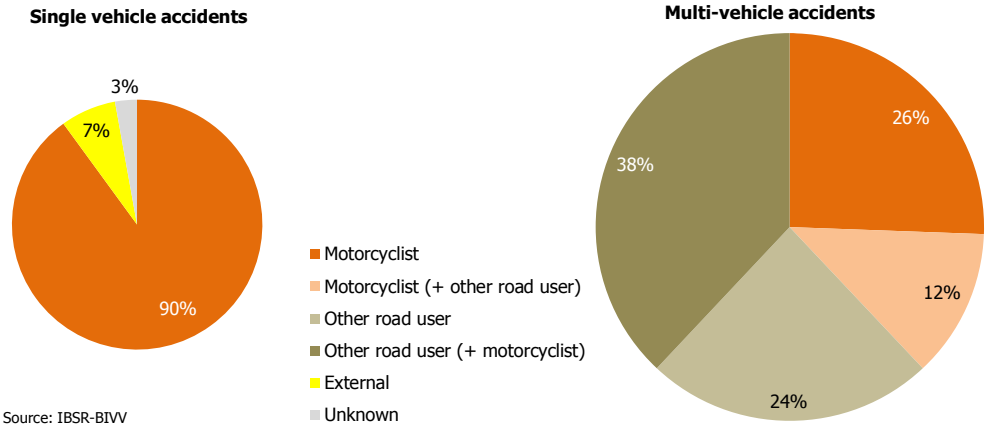
Accidents usually have several interacting causal factors. The "initiator" is the road user whose action turned the accident from an equilibrium into a crisis situation. Often, there is moreover a "contributor" who did not do what was necessary to avoid the accident or who aggravated the consequences.

Two-third of the two-sided accidents were initiated by the other road user.

Motorcycle crashes with another road user were mostly (62%) initiated by that other road user. Nevertheless it turned out that in 1 out of 3 accidents that were initiated by the other road user, the motorcyclist contributed to the accident as well. 38% of the crashes with another road user were initiated by the motorcyclist, but again in 1 out of 3 accidents of that kind the other road user had contributed as well.

In Figure 1 these results are presented graphically.

Figure 1: Initiator of the accident (contributor in parenthesis) according to the type of accident.



Source: IBSR-BIVV

The other road user in the two-sided accidents often did not see the motorcyclist (54%) or they underestimated how quickly he would approach (10%). Almost half of the motorcyclists involved in a crash with another road user had not sufficiently anticipated for unexpected maneuver from their opponent. 15% had made a wrong decision (e.g. overtaking where it is not possible, taking a curve too fast) and 11% had not seen the other road user.

[2] In 3 accidents the motorcyclists lost control because he had to avoid another road user who took his right of way. These accidents were coded as "accidents between vehicles" although in fact there was no collision between road users.

All accidents considered jointly were initiated by the motorcyclist in 56% of the cases and by the other road user in 41% of the cases. In 3% of the cases, the accident was caused by an external factor.

Accident scenarios

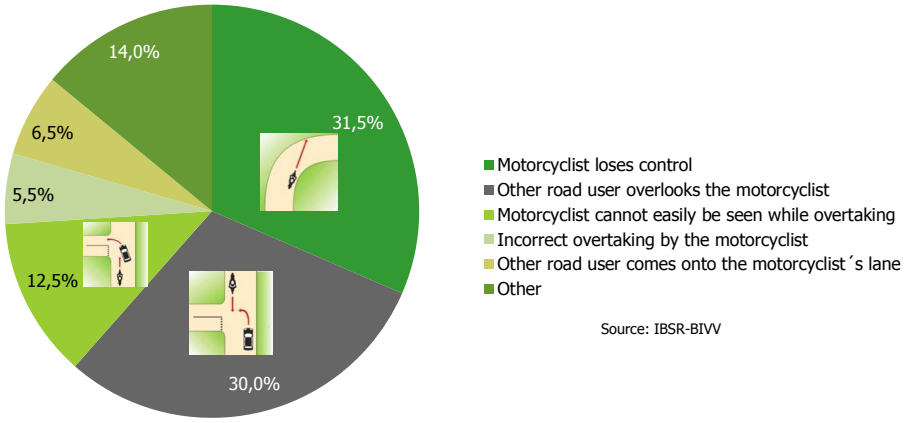
To prevent accidents it is important to register the possible causes and typical accident scenarios.

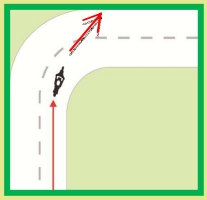
The classification of single vehicle accidents and crashes with another road user used above is also used in the general accident statistics. This classification is based on the consequence of the accident but does not necessarily describe the causation. For example, the motorcyclist who lost control can either hit an obstacle along the road or het can crash into another road user driving on the opposite lane. The first accident would be classified as single vehicle accident, the second one as crash with another road user although both have similar causes. The following classification is therefore based on the scenarios that *caused* the accidents.

The most frequent accident situations are "motorcyclist loses control" and "other road user overlooks the motorcyclist".

On the basis of the causal analysis 5 typical profiles were discovered: (1) the motorcyclist loses control; (2) the other road-user overlooks the motorcyclist; (3) the motorcyclist is not visible during overtaking; (4) the motorcyclist overtakes in the wrong way; and (5) the other road user enters the motorcyclist's lane. 86% of the cases studied could thus be categorized. The rest was summarized in category (6) other. The most frequent accident scenarios are "motorcycle loses control" and "other road user overlooks motorcyclist" (see Figure 2). In the following, each profile will be explained shortly.

Figure 2: Distribution of the 6 accident profiles (n=200)



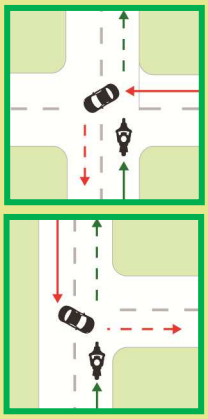


• Profile 1 – The motorcyclist loses control (n=63 ; 32%)

The largest group are accidents where the motorcyclist leaves his lane without interaction with another road-user (at least not in the first place). In 11 cases the motorcyclist eventually crashes into another road user, but this only happened *after* he lost control.

Although this is the most frequent profile, we know very little about these accidents. The motorcyclist, even if he survived, could often not remember the accident. This sort of accident is often situated on a difficult trajectory, in particular

those with sharp curves. Apart from the trajectory, most causes involve behavioral problems: speeding, riding under the influence, and inexperience. The road surface and other infrastructural problems play a limited role.



- **Profile 2 – The other road user overlooks the motorcyclist (n=60 ; 30%)**

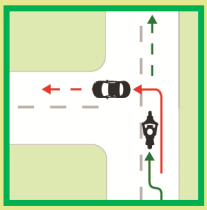
This profile contains two types of accidents, for which the causal factors are similar.

1 (32) a road user (mostly a car driver) wants to enter the traffic flow for which he has to give priority. He overlooks the oncoming motorcyclist and cuts him off when entering the road.

2 (28) The other road user and the motorcyclist ride on the same road in opposite directions. The other road user wants to turn left and does not see the oncoming motorcyclist and turns right in front of him.

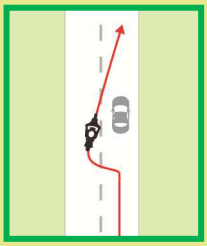
The opponent either did not see the motorcyclist (84%) or he underestimated how quickly he would approach (13%). The motorcyclist usually did see the other road user (59%) but did not expect him to engage into his maneuver right in front of him. When the other road user crosses the motorcyclist´s path it is too late for the latter to break or to avoid the vehicle. The motorcycle usually drove frontally into the other vehicle´s side.

The other road user´s attention is the most important causal factor with the speed of the approaching motorcycle as aggravating factor. For sub-profile 2 (the road user turns left and hits oncoming motorcycle) the light conditions contributed to the accident in several cases (10 out of 28 accidents took place in the dark or in twilight).



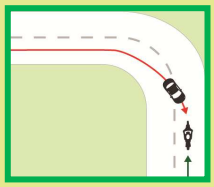
- **Profile 3 – The motorcyclist cannot easily be seen while overtaking (n=25 ; 13%)**

This profile summarizes a number of situations, where a motorcyclist overtakes another road user (12) or a queue (13). While the maneuver in itself was executed correctly, the fact that the other road user was overtaking made him difficult for those he overtook to detect. In most cases both participants were in principle visible for each other but the other road user did not look for the motorcyclist on the lane to his left (20) and often turned left right in front of him (16). The responsibility for this sort of accidents is usually shared between the motorcyclist and the other road user.



- **Profile 4 – Incorrect overtaking by the motorcyclist (n=11 ; 6%)**

While the last profile included overtaking maneuvers that were executed correctly, in this profile the accidents were caused by an overtaking maneuvers that was executed at the wrong moment, the wrong place or in the wrong way. The motorcyclist lost control (6) or he collided with an oncoming vehicle (4).



- **Profile 5 – The other road user comes onto the motorcyclist´s lane (n=13 ; 7%)**

For various reasons, the other road user suddenly drives onto the motorcyclist´s lane – because he lost control, because of inattention or because he wanted to overtake someone and did not see the motorcyclist. All causal factors – alcohol, risky driving and violations – are registered with the other road users.

- **Profile 6 – Other (n=28 ; 14%)**

These accidents did not fit the profiles above (25) or it was unknown how the accident took place (3).

Place and Time

- **Region**

Except for Brussels, the large majority of the accidents took place in the motorcyclists' home-region.

Half of the accidents (50%) took place in Flanders, 45% in Wallonia and the rest in Brussels. While the accidents in Flanders involved almost exclusively Flemish riders, the accidents in Wallonia also involved 7% Flemish motorcyclists. In Brussels they even constituted almost half of the motorcyclists in our sample (44%). We can conclude that except for Brussels, the large majority of the accidents took place in the motorcyclists' own region.

- **Place**

The majority of the accidents took place in rural areas (65%) and on a road section between intersections (70%). The proportion of accidents on intersections was approximately the same in urban and rural areas.

- **Time of the day**

4 accidents out of 5 happened during day-time. Nearly half of the accidents occurred in the afternoon.

About two thirds of the accidents (64%) took place during the week. Three quarters of the accidents (78%) took place in daylight and most accidents took place between 2 p.m. and 7 p.m. (44%). The single vehicle accidents and especially the fatal ones show a different pattern with 63% of the accidents taking place between 7 p.m. and 6 a.m. Only fatal single vehicle accidents have a significant share of accidents in darkness (33%) or twilight (5%).

- **Seasonal variation**

The number of severe motorcycle accidents peaks in April and July.

The months from April to July are the ones with the highest occurrence of accidents for motorcyclists. Two thirds of the accidents (62%) took place in these four months, with two peaks in April when motorcyclists rejoin the road after the winter break and in July where the summer vacation begins. The dependence on good weather for motorcyclists riding behavior is also reflected in the fact that 96% of the accidents took place in the absence of rain or other precipitation.

The participants

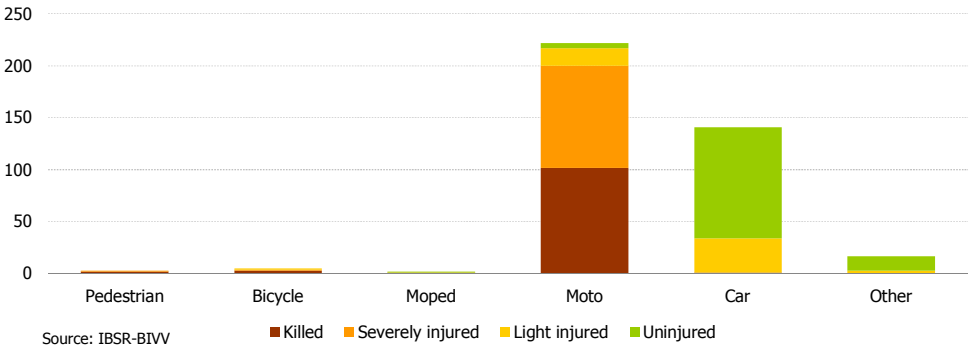
Altogether, 330 parties were involved in the accidents investigated: 203 motorcyclists and 127 other road users (104 car drivers, 13 drivers of trucks, tractors, or busses; and 10 pedestrians, cyclists, and moped riders).

• Victims

Most fatally or severely injured victims were motorcyclists or their passengers. A few were other vulnerable road users.

108 persons died in the accidents studied: 102 motorcyclists or their passengers, 5 cyclists and pedestrians, and 1 car occupant. 101 persons were severely injured: 98 motorcyclists or their passengers and 3 other road users. Finally 54 persons were slightly injured (61% car occupants, 31% motorcyclists or passengers, 8% other road users). The distribution of the victims is presented in Figure 3.

Figure 3: Distribution of the road users (drivers and passengers) according to level of injury (n=390).



• Gender

Almost all motorcyclists in the accidents studied were men (98%)[3]. Among the riders who had an accident there were only four women, who were all involved in a crash with another vehicle. In all 4 cases this was an accident with another vehicle.

• Age

The motorcyclists in the severe accidents were on average 40 years old.

The mean age of the motorcyclists in the accidents was 40 years.

Young motorcyclists, in particular those between 25 and 34 years, have an increased risk of severe accidents, and in particular for fatal ones. They do, however, not constitute the majority of the motorcyclists in the accidents. Three groups – 25-34, 35-44, and 45-54 – form three quarters of the motorcyclists in the accidents and all three groups are approximately of the same size.

The elevated risk of the young riders is a phenomenon frequently seen in all kinds of accident investigations, although for car drivers this peak is situated at an even younger age (18-24 rather than 25-34). Contrary to car drivers, however, for motorcyclists the differences between the age groups are relatively small and we do not see a strong reduction after the age of 35.

[3] In the representative sample of motorcyclists from the SARTRE project, 91% of the motorcyclists were men.

44% of the motorcyclists have acquired their car-drivers' license (B) before 1989 which allows them to ride a motorcycle without further exams.

License and experience

The analysis of the drivers licenses of the motorcyclists involved showed that almost half (44%) of them had gotten their car drivers license (B) before 1989 and was therefore allowed to ride a motorcycle with it. Similarly to the results above, the share of this group (who were 40 or older in 2010) in the accidents is not more but also not less than in the riding population. This group did not show differences in results as compared to those middle-age motorcyclists who had to take a specific exam for their motorcycle license.

On the contrary, the beginners (driver's license for one year or less) are a rather small group (8%), but as compared to the riding population they are still strongly overrepresented, in the severe – and in particular in the fatal - accidents. 6 motorcyclists (3%) had a temporary license.

Social background

Half of the motorcyclists were blue collar workers, 1 out of 5 was white collar worker and 1 out of 10 was unemployed. Freelancers, managers, graduate employees, retired, students, and housewives formed together less than 20% of the motorcyclists.

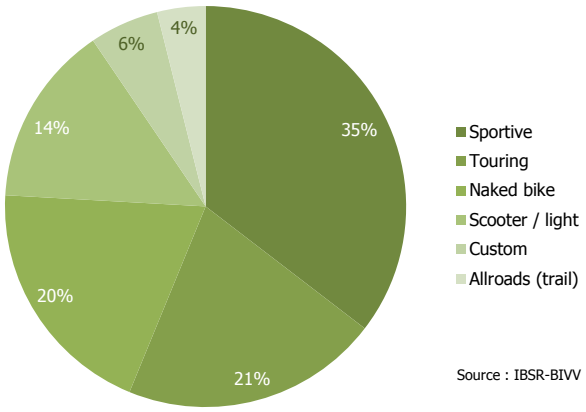
White collar workers and freelancers have a lower risk of severe accidents than the other professional groups, especially as compared to the workers. If they have accidents, these are more often non-fatal accidents and crashes with another road user. This group is especially strong among motorcyclists over the age of 35 and in particular among those aged 45 or more.

Half of the motorcyclists in severe accidents (even 2 out of 3 in fatal accidents) are blue collar workers or professionally inactive. This suggests that low-educated motorcyclists run a higher risk to have a severe accident.

Motorcycle type

In accordance with the OECD guidelines for the investigation of motorcycle accidents, the motorcycles are categorized into 6 different types:

Figure 4: Share of different motorcycle types in the accidents (n=203).



1 out of 3 motorcyclists rode a sportive motorcycle.

The risk of severe accidents is especially high for motorcyclists with sportive machines. That for fatal accidents even more.

Sportive

Sportive motorcycles are derived from racing models that are used in competitions. Their cylinder volume is not necessarily very large, but due to their light build they have a very good power-to-weight ratio and consequently a high acceleration. 1 out of 3 motorcycles in the severe accidents studied here was a sportive one.

Sportive motorcycles are used by all age groups, but while among the young riders 3 out of 5 rode a sportive motorcycle among those over the age of 45 only 1 out of 5 rode a sportive motorcycle.

The proportion of motorcycles in the accidents is more than two times higher than their share among the kilometers ridden. It means that riders of this type have a strongly increased risk of severe accidents, in particular for fatal ones. The accidents are more often single vehicle accidents than for the other types. Moreover, riders of sportive motorcycles rode too fast, under the influence of alcohol, or without a valid license than riders of other types.

Touring

These motorcycles for long distances, with fairing, are characterized by an almost vertical seating position. They have a lot of room for a passenger and additional luggage. In 1 out of 5 severe accidents the motorcyclist rode a touring bike, which is more than their share in the kilometers ridden. This type of motorcycle is consequently also overrepresented in the accidents and has an increased risk. Touring bikes are especially popular amidst the motorcyclists over the age of 45 among whom 1 out of 3 rode such a motorcycle. The accidents are more often single vehicle accidents than those of the other motorcycle types (except for sportive motorcycles).

Naked bike / basic

This type of motorcycle got its name from the fact that it has a simple design but no fairing. Their share in the accidents (1 in 5) equals more or less that of the touring bikes. However, considering their much greater share in the kilometers ridden (29%), this share is actually less than expected. We can therefore conclude that this type of motorcycle has a relatively low risk[4] for severe accidents.

Light motorcycles and motor scooters

Scooters are powered two-wheelers with a footrest in the middle. Most scooters are light motorcycles (between 51 and 125 cc) or mopeds (≤50cc, not studied here). There are however, also scooters – called motor scooters here --, that formally constitute a motorcycle because their XXX cylinder volume exceeds 125cc.

In this study motor scooters, light scooters, and other types of light motorcycles were considered jointly. They constitute 15% of the motorcycles in severe accidents which is in proportion with their share among the kilometers ridden. Only 5 riders in this group were tested for alcohol, 3 of whom were positive.

[4] Even if this type of motorcycle has a lower risk than other types it is important to keep in mind that naked bikes still have a higher risk of severe accidents than any other road user type.

While everyone who has a B license and at least 2 years of experience is allowed to ride a light motorcycle, motor scooters (>125cc) require a specific license for motorcycles. Among the 10 riders of a motor scooter in the accidents, there were 3 who did not have such a license. Transformed into percentages these results (alcohol and license) must be considered problematic. However, the numbers in the accidents investigated are too low to draw any conclusions.

Other types

Motorcycles of the "Custom" type require a specific riding position where the feet are directed to the front. The body style is similar to the American machines from the years 1930-1960, like the Harley-Davidsons. Their share in the severe accidents (6%) is less than half of that in the kilometers ridden (15%). This type consequently has a lower risk of severe accidents than other types of motorcycles.

All road motorcycles are designed for "off road" as well as "on road" use. These machines are derived from Enduro or Cross motorcycles but completely equipped for road traffic. This type was rare in the accidents investigated (4%).

In Table 1, an overview is given of the risks of the different types of motorcycles. Column 2 gives the share in the accidents. The third column contains the accident risk. This is the ratio of the share in the accidents and the share in the kilometers ridden. 100% implies a medium risk. The fourth column contains the fatality risk, the ratio between the share among the fatal accidents and the share among the non-fatal ones. Again 100% implies a medium risk. In the last column it is indicated if particular types of infractions (see below for a more detailed description) the motorcycle type in question has a particularly high share. Riders of sportive motorcycles have the highest share in sever accidents, the highest risks en the highest share in the infractions.

Riders of sportive bikes have the highest share in the accidents, the highest risks, and the largest share in the infractions.

Table 1: Classification of motorcycle types according to different risks.

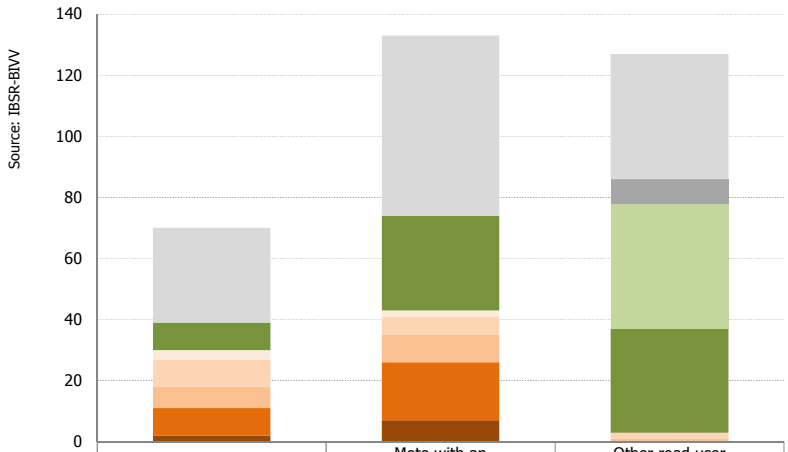
	Share in accidents	Accident risk	Fatality risk	Infractions
Sportive	35%	216%	177%	Speed, alcohol, papers
Touring	21%	145%	131%	Speed
Naked bike	20%	68%	56%	Speed
Scooter & light	15%	95%	95%	Alcohol, driving license
Custom	5%	38%	167%	
All road	4%	38%	32%	

Infractions registered

• Too high speed

In Figure 5, the registered speed is indicated per accident type and type of road user.

Figure 5: Distribution of drivers involved in an accident according to speeds (n=330).



	Moto alone	Moto with an other road user	Other road user with a moto
Unknown	31	59	41
Unapplicable (pedestrian of bicycle)	0	0	8
Low speed (manoeuvre)	0	0	41
Legal speed	9	31	34
Unadapted speed (expert)	3	2	0
Presumption of excessive speed	9	6	2
0 - 20 km/h above the speed limit	7	9	1
20 - 40 km/h above the speed limit	9	19	0
+ 40 km/h above the speed limit	2	7	0

At least 1 out of 3 motorcyclists in the accidents was speeding.

For 36% of the motorcyclists an exaggerated speed was registered. Given the large number of cases in which the speed was unknown (44%) and the results from other countries we must suspect that rather 1 out of 2 than 1 out of 3 motorcyclists in severe accidents rides too fast.

We assume that speeding plays an even larger role for motorcyclists who become involved in a severe accident than for car drivers. In a French study speed was registered as the causal factor for 45% of the accidents for motorcyclists, while for car drivers this was only 23%.

The risk of speeding can be seen in the difference between fatal and severe accidents. While in the severe accidents only 21% were speeding, for the fatal accidents this was 50%.

Speeding bears a triple risk: (1) losing control; (2) not being able to stop in crisis situations; (3) not being seen by the other road users.

Speeding was one of the major factors for the accidents in Profile 1 (motorcyclist loses control) but also for Profile 2 (other road user overlooks motorcyclists). The results suggest that speeding bears a triple risk of motorcyclists – to lose control over the motorcycle, not to be able to break in an emergency situation, and being less visible for other road users.

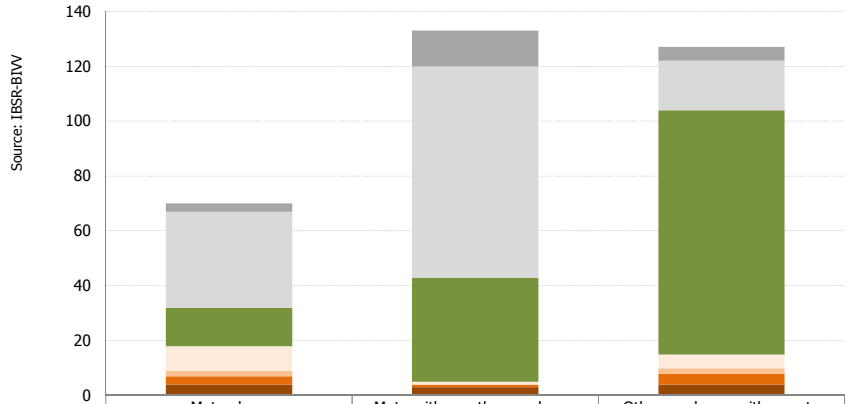
The other road users in the accidents investigated have rarely been speeding. This is because they were usually about to execute a maneuver.

1 out of 5 motorcyclists in the accidents was riding under the influence of alcohol. This is less than for car drivers in severe accidents.

• Riding under the influence of alcohol

When riding a motorcycle even the smallest mistake can lead to the loss of control. Being under the influence of alcohol is therefore extremely dangerous when riding a motorcycle. While research has shown that motorcyclists are less prone to drink and ride than car drivers, our analysis of the severe accidents showed that at least 20% of the motorcyclists who were tested for alcohol were positive (more than 0.22 mg/EAA).

Figure 6: Distribution of drivers involved in an accident according to the result of the test of alcohol (n=330).



	Moto alone	Moto with an other road user	Other road user with a moto
Unknown	3	13	5
Not tested	35	77	18
Negative	14	38	89
Suspicion of alcohol influence	9	1	5
Positive >.05	2	0	2
Positive >.08	3	1	4
Positive >1.5	4	3	4

The share of accidents without information about the degree of intoxication was very large (63%, see Figure 6), because in 2010 most killed and some severely injured motorcyclists were not tested for alcohol. We suspect that among the unknown cases the share of riders under the influence is even larger than for the known ones. The percentage of 20% is consequently rather an underestimation.

Recent results from an investigation of road accident victims in Belgian hospitals indicate that the role of alcohol in motorcycle accidents was, however, lower by half as compared to car drivers in severe accidents.

Motorcyclists who were riding under the influence lost control more often than other motorcyclists.

We can see in Figure 6 that alcohol played a much larger role in accidents involving only a motorcycle as compared to accidents with another vehicle. For the tested motorcyclists in Profile 1 (motorcyclist loses control), 47% were positive. Among the motorcyclist who collided with another vehicle (where the other road user was often the initiator) this was only 10%.

For the other road users the percentage tested is relatively large and the percentage who tested positive is 10%. However, just like for motorcyclists, drivers in single vehicle accidents are more often intoxicated than those in crashes with another vehicle. Consequently, the percentages found for the other road users in this study can certainly not be considered representative.

20% of the motorcyclists in the accidents did not have a valid registration, insurance or drivers' license.

• Missing license or other documents

For 20% of the motorcyclists for whom information was available on license, registration, and insurance, there was a problem with one of these. 17% of the motorcyclists did not have a valid license. The proportion was especially high among motorcyclists who rode a sportive motorcycle (26%). It was also particularly high in Brussels where 5 out of 11 motorcyclists rode without a valid license. For 12% of the motorcycles there was a problem with the registration or with the insurance. The non-registered motorcycles had usually a license plate from another (registered) motorcycle fastened to them. In fatal accidents problems with the documents are more frequent than in non-fatal accidents (27% vs. 13%).

These findings are probably an indirect effect. For example, it is conceivable that motorcyclists, who ride without a license or with an unregistered and uninsured vehicle, tend to ignore other rules as well. Because of this, we should certainly assume that the share of motorcyclists without valid documents is certainly *not* representative of motorcyclists in general.

Infrastructure

For 17% of the accidents problems were noticed in the infrastructure that might have contributed to the accidents. In 7% of the cases there were problems with the road surface. The other problems mainly concerned a road structure that invited speeding (4%), suboptimal signalization (2%), difficult trajectories or sharp curves (2%) or bad visibility due to bad lightning (1%) or vegetation (1%). The infrastructure problems were usually additional causes rather than the main cause.

• State of the road surface

In 7% of the accidents, the road surface possibly contributed to the accident.

For 87% of the accidents (96% of the accidents with one motorcyclist only) the state of the road surface was known. In 7% of the accidents for which this information was available, there was a problem with the surface that might have played a role in the accident. These problem almost exclusively concerned the single-motorcycle accidents, which implies that road surface damages like potholes, constitute a risk for this type of accident in particular. The frequency of these problems was however, relatively low in comparison with infractions like speeding or driving/riding under the influence of alcohol.

• Forgiving roads

Concerning the forgivingness of the road - that is their ability to compensate possible mistakes by the riders or drivers - the absence of guard rails is the most important problem. One third of the motorcyclists in the fatal accidents hit a tree, a pole, or a wall. Only in 3 out of 50 cases the obstacle was protected by rail.

In a specific sub-study concerning the effect of guard rails, all curve accidents on rural roads were specifically analyzed with respect to possible effects of the guardrails. Negative effects due to the absence of a guard rail (e.g., rider hit a tree or fell down a hillside) were found for 6 out of 38 curves. We also looked for possible problems that were actually caused by a guard rail (e.g., a motorcyclist slides under the guard rail and hits one of its posts). This was the case in 4 of the 38 cases. To sum it up, for 10 out of the 38 curves investigated, we suspect that a

better guard rail infrastructure would have reduced the consequences of the accident.

Equipment of the motorcyclist

Given that the motorcyclists were overlooked in one third of the accidents, the (lack of) visibility of motorcyclists is the largest concern. Helmets were worn in 95% of the known cases. The information about other protective clothing is too incomplete to carry out an analysis. The same is true for the technical state of the vehicle. Problems with the vehicle were reported in 3% of the cases. However, it cannot be assumed that vehicle problems existing prior to the accident would necessarily have been identified by the police.

Recommendations

The recommendations are restricted to those in direct relation with the results of this study. They concern the three E's education, enforcement, and engineering. Moreover recommendations for further research are given.

- ### Education

Initial riding training

Riders training has to address the control of the vehicle as well as risk perception.

Young and inexperienced motorcyclists are overrepresented in the accidents and we see problems with both control over the vehicle and anticipation in critical situations. Both elements should be the focus in rider's training as well as examination.

Right now the initial riders' training is focused on vehicle control, but this should be extended by lessons on risk perception and anticipation in actual traffic situations. These lessons have to prepare the novice riders to their participation in traffic. Partly such training on the perception of hazardous situations and anticipation can be based on pictures, movies, and possibly animations, which can also be used for examination. Nevertheless, novices also need riding lessons in real traffic where the instructor gives feedback on their handling of critical situations.

In this context it is noted that the number of mandatory riding lessons before being allowed to enter the road with a preliminary license is lower in Belgium than in many other European countries (e.g., Netherland, France, Germany, Austria, and Greece). In Belgium there is also no obligation to follow theoretical lessons, e.g. on defensive and anticipating riding, while this is mandatory in most other countries.

Refresher training

Screening and encouragement of refresher courses for motorcyclists over the age of 35.

Middle-aged riders (35-54 years) form half of the accident group, which is in proportion with their share in the riding population. Nevertheless, this is a large group that requires special attention. For other vehicle types, we see a much stronger reduction of the number of accidents for these age-groups. More than half of the motorcyclists in this group has acquired their license B (to drive a car) before 1989 and is therefore allowed to ride a motorcycle without having to pass specific

exams. This group should be screened to ensure that they have the necessary skills to ride a motorcycle. Encouragement to follow refresher trainings is desirable.

Campaigns targeting motorcyclists

Campaigns have to address motorcyclists as well as other road users.

Campaigns should focus on the risk of speeding (not being seen well, losing control, unable to break in critical situations, and a higher risk on fatal injuries) and should take into account the profiles of motorcyclists (age, social background, and type of motorcycle).

Awareness raising among other road users

As almost half of the accidents were initiated by other road users – mostly drivers who overlooked a motorcyclist when turning – the continued addressing of this group is important. This can be done in different ways, such as campaigns that remind other road users to watch out for motorcyclists (as done every year by the Belgian Road Safety Institute), a module on motorcyclists during the initial training for car drivers, or "reach out days", where motorcyclists take other drivers and show them traffic from their perspective.

Such initiatives have been recommended by the EC in their *"Policy orientation on road safety 2011-2020"* and have been evaluated as very effective.

• Enforcement

Speeding

The efficiency of the speed controls of motorcyclists has to be assured.

Speeding came out as a major factor in at least one third, possibly half of the severe accidents. It is therefore vital to direct police controls to motorcyclists and also to prosecute activities that undermine the effectiveness of police controls (e.g. bending the number plate).

Alcohol

Alcohol checks have to be directed at motorcyclists as well.

Although the share of positive motorcyclists is not higher than that for other road users in severe accidents, at least 1 in 5 motorcyclists was under the influence of alcohol. It is therefore important to direct alcohol controls also to motorcyclists who are mostly riding in spring and summer and during the day.

Documents

Given the relatively large number of riders without valid license, vehicle registration, and/or insurance, police controls should also focus on motorcyclists when checking these documents.

• Engineering

Road

Lay-out and maintenance of the roads has to follow the existing guidelines.

Although the bad state of the road was rarely the main cause, bad road conditions played a role in 7% of the accidents. Other problems linked to the infrastructure (lights, signs, visibility, indication of appropriate speed) played a role in another 10% of the accidents. The safety of motorcyclists can therefore be increased by following up the existing guidelines for infrastructure.

Obstacles and guard rails

The results show the deadliness of the contact with solid objects like poles, trees or walls. Under the principle of forgiving roads, all obstacles should if possible be removed from the vicinity of the road or shielded by guard rails. They also must be clearly visible at all times. All guard rails must be equipped with under-run protection avoiding aggravating the accident by hurting a motorcyclist who slides under a guardrail and hits one of its pillars.

Equipment

Information regarding the technical state of the vehicles was insufficient in the court files analyzed for this study to draw conclusions. Only in 3% of the cases problems were mentioned.

The motorcyclists were overlooked by the opponent in one third of the cases. Everything that increases the motorcyclists' visibility will therefore increase their safety -- although these perception problems also have to do with the motorcyclists speed and the other road users expectations. Wearing clothing and especially helmets in colors contrasting with the surrounding should increase their conspicuity.

Helmets and clothing have to contrast with the surrounding.

Recent research results also indicate that extra lighting of motorcycles increases their visibility in day as well as night time and makes them more distinguishable from cars.

- ### Further research

Further research on motorcyclists is warranted concerning the accidents as well as (a representative sample of) the riding population.

In addition to the present research on the basis of court files, in-depth accident investigations in which a multidisciplinary team investigates the accident scene would help to better understand the exact role of speed, alcohol, and infrastructure in the accidents and more systematically investigate other causal factors.

To investigate the motorcycling population, traffic counts, observation studies, questionnaires, and speed measurements need to be executed. Data and information concerning the real driving behavior of motorcyclists can also be collected via naturalistic driving studies.

Data concerning traffic density, speed, the attitudes, and the motivation would help to investigate the specific risks of particular infrastructures or target groups and would make the communication more effective.

Conclusion

200 severe and fatal motorcycle accidents were investigated. Based on the information available in the court files, the main cause was mostly the behavior of the road users involved, especially speeding by the motorcyclists and a lack of attention to the motorcyclists by the other road users. 56% of the accidents were initiated by the motorcyclists and 41% by another road user, where the "initiator" is not necessarily the (only) one responsible in the juridical sense, but his action

turned the accident situation from an equilibrium to a crisis situation. In 3% the accident was caused by an external problem (e.g. a problem with the road surface).

Five recurrent accident patterns were identified, in which 86% of the accidents could be categorized. The most frequent situations are "motorcyclist loses control and leaves his lane" (32%) and "other road user overlooks the motorcyclist when turning" (30%).

Two groups of motorcyclists could gain from extra training: young inexperienced riders and middle-aged riders. The young inexperienced riders have an increased risk of severe accidents. Middle-aged riders (35-54) have no particularly increased risk, but for this age group we see a much stronger reduction in accident numbers for the drivers of other vehicles. The riders' training must be affordable and practical to be attractive for the most important target groups.

The biggest problem in crashes between motorcyclists and other road users (usually an automobilist) is the visibility of the motorcyclist. Therefore awareness raising has to continue among automobilists to continue to increase their attention for motorcyclists and among motorcyclists to remind them that other road users might not see them even if they can see the other one clearly.

The most important recommendations are:

- Warranting an anticipating riding style among motorcyclists – by means of compulsory training; screenings; and availability of (affordable and practical) refresher courses.
- Continuation of awareness raising campaigns. Main issues: motorcyclists' speed and anticipatory driving style; and other road users' attention for motorcyclists.
- Enforcement in spring and summer targeting motorcyclists: speed- and alcohol controls as well as controls of documents.
- Promoting high-conspicuity gear (especially helmets) for motorcyclists and further research on specific lighting of motorcycles to increase their conspicuity.