European Commission

European Road Safety Observatory

Road Safety Thematic Report - Mopeds

This document is part of a series of 20 thematic reports on road safety. The purpose is to give road safety practitioners an overview of the most important research questions and results on the topic in question. The level of detail is intermediate, with more detailed papers or reports suggested for further reading. Each report has a 1-page summary.

The topic "Mopeds" is also addressed in the "Facts and Figures – Powered two wheelers", presenting more detailed and up-to-date European data in addition to this qualitative analysis.

Contract	This document has been prepared in the framework of the EC Service Contract MOVE/C2/SER/2019-100/SI2.822066 with Vias institute (BE) and SWOV Institute for Road Safety Research (NL).
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Referencing	Reproduction of this document is allowed with due acknowledgement. Please refer to the document as follows: European Commission (2023) Road Safety Thematic Report – Mopeds. European Road Safety Observatory. Brussels, European Commission, Directorate General for Transport.

Contents

Summary

Mopeds in road traffic

Mopeds offer a flexible way to get around, while they offer a sense of freedom and flexibility to young drivers. However, moped riders are also among the most vulnerable road users in terms of safety. The category of mopeds includes all two- or three-wheel vehicles with a maximum design speed of no more than 45 km/h. Light mopeds – with a maximum speed of 25 km/h – and speed pedelecs (Speed EPAC) – electric bicycles that provide motor assistance up to 45 km/h – are also included in this vehicle category.

More than 600 moped riders are killed on EU roads each year, even though the number has halved since 2011. No other transport mode shows a greater reduction in fatalities, although it is notable that the number of registered mopeds (with the exception of electric variants and speed EPACs) has also halved over this same period. Although there is a lack of exposure data, it is estimated that the crash risk of powered two-wheelers (PTWs) is about 20 times higher than that of car occupants.

Several factors play a role in moped crashes including poor infrastructure, vehicle safety issues (such as blind spots), and the behaviour of all road users involved in the crash, including speeding. There is a big issue with detection of the moped by other road users, which is a major cause of crashes. The minimum driving age is 16 years, which tends to interest young people as an alternative transport mode. They often lack the skills needed to assess traffic situations correctly and handle the vehicle in traffic. Practical training before obtaining a driver's license is minimal or non-existent in most European countries. Another issue is engine tuning which allows them to go faster than the design speed.

Countermeasures

- Implementation of a rigorous safe system approach. Improving infrastructure, enhancing vehicle safety, the setting of appropriate speeds and behaviour of all road users and adequate enforcement. For example, road design should allow adequate room for rectification of any errors by road users involved in a crash.
- A graduated driver's license could have a positive impact on crashes involving mopeds. The stricter the programme, the more it is likely to reduce the crash rate.
- Higher order skills training, for example hazard perception training.
- Training should also be directed at other road users, considering how detection errors by motorised vehicle drivers are a common causal factor in moped crashes.
- Police enforcement should focus on speed and distraction of all road users, but attention to tuning of moped engines remains important as well.
- The choice of road surface materials, road markings, road maintenance, and repair should be properly investigated before implementation since they produce hazardous and unsafe conditions for moped riders.
- Research shows that the number of crashes and the number of fatalities decrease when mopeds drive on the road rather than on cycle paths.

1 Highlights

- The crash risk of powered two-wheelers (PTWs) in general is about 20 times higher compared to cars, and the crash rate of a moped is four times larger compared to the crash rate of a motorcycle.
- The number of moped fatalities in Europe almost halved in the last decade, together with a reduction in the number of registered ICE mopeds. However, more than 600 moped riders continue to be killed on EU roads every year.
- Mopeds are often not noticed by other road users, partly because there are relatively few mopeds on European roads, and partly because it is more difficult to detect a small vehicle.

2 What is the problem?

2.1 Safety issues for moped riders

Mopeds are defined in the Driving Licence Directive 2006/126/EC (European Union, 2006) as : "Two-wheel vehicles or three-wheel vehicles with a maximum design speed of not more than 45 km/h, as defined in Article 1(2)(a) of Directive 2002/24/EC of the European Parliament and of the Council of 18 March 2002 relating to the type-approval of two or three-wheel motor vehicles (1) (excluding those with a maximum design speed under or equal to 25 km/h), and light quadricycles as defined in Article 1(3)(a) of Directive 2002/24/EC". This category also includes, among others, speed pedelecs and light mopeds (maximum speed of 25 km/h).

A category AM driving licence is required to ride a moped, scooter or light motor-powered vehicle with a maximum engine capacity of 50 cc or a maximum rated power equal to or less than 4 kW (electric motors) and whose maximum speed does not exceed 45 km/h (some exceptions apply). This can be obtained after passing a theoretical test, which is sometimes accompanied by a practical training course and exam. The minimum age for this category is fixed at 16 years (European Commission, 2018).

Speed pedelecs, fast electric bicycles (with obligatory type approval according to EN168/2013) offering pedal support up to a speed of 45 km/h, are a recent innovation. They have been classified as a "moped" by the European Union (European Union, 2013). Even though they look like a bicycle and riders have to pedal in order to move, they have to act in accordance with the traffic rules for mopeds (Vlakveld et al., 2021).

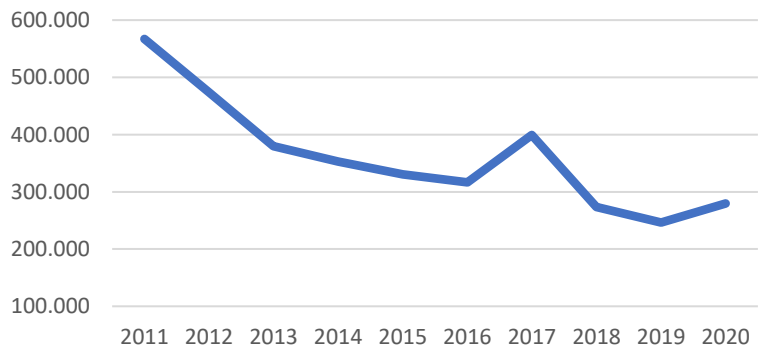
Mopeds offer a flexible way to get around and are a convenient, affordable, and environmental friendly mode of transport. In urban areas, they have the potential to travel relatively quickly, while in rural areas they offer mobility options for users who do not have access to a car. Because mopeds are an individual transport mode, they offer a sense of freedom in personal mobility and flexibility. They are a sustainable urban mode of mobility with minimum footprint in riding and parking space requirements (OECD/ITF, 2015).

However, the enormous vulnerability of mopeds in traffic is the downside of this "light" way of moving. Together with pedestrians, cyclists and motorcycles, moped riders are part of the group of "vulnerable road users" (European Union, 2020). Moreover, mopeds are one of the only types of motorised transport available to 16 year olds, which is why they are popular with young road users. This young age of moped riders, together with the lack of real training and experience with motorised vehicles, means there is a risk that riders lack basic driving skills and are sometimes not able to assess traffic situations adequately (De Ceunynck, Slootmans & Daniels, 2018).

2.2 How do moped riders participate in traffic?

The largest moped markets in Europe are: France, the Netherlands, Germany, Belgium, Italy and Spain. In 2020, about 280,000 mopeds were added to the vehicle population in these countries according to ACEM. The number of moped registrations in these key European markets has halved since 2011. However, an exception to this are the electric mopeds that have seen a real boom in registrations since 2017.

Figure 1. Moped registration in key European markets (Belgium, France, Germany, Italy, Netherlands, and Spain), 2011-2020

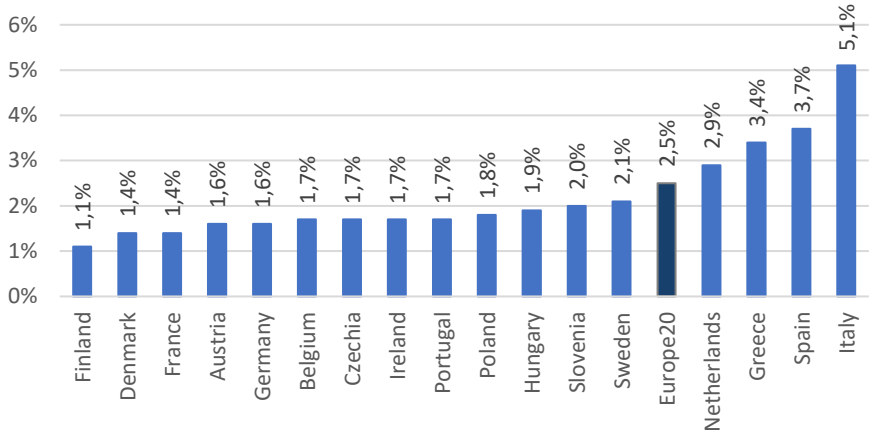


Source: ACEM

There is almost no data on moped mileage. The ESRA survey[1] shows that on average, 2.5% of European respondents use a moped 1 to 3 times a week. This self-reported data shows that mopeds are used most often in Southern countries such as Greece, Spain and Italy, but are also widespread in central Europe and Nordic countries. Respondents from the Netherlands also reported the use of mopeds above the European average, as can be seen in Figure 2 (Yannis et al., 2020).

[1] ESRA (E-Survey of Road users' Attitudes) is coordinated by Vias institute. It is a joint initiative of road safety institutes, research centres, public services, and private sponsors from all over the world. The aim is to collect and analyse comparable data on road safety performance, in particular road safety culture and behaviour of road users. The ESRA data are used as a basis for a large set of road safety indicators. These provide scientific evidence for policy-making at national and international levels. More information on https://www.esranet.eu/en/

Figure 2. Percentage of respondents claiming to ride a moped 1 to 3 days a week



Source: Yannis et al. (2022)

3 Mopeds and road safety

3.1 Crash risk

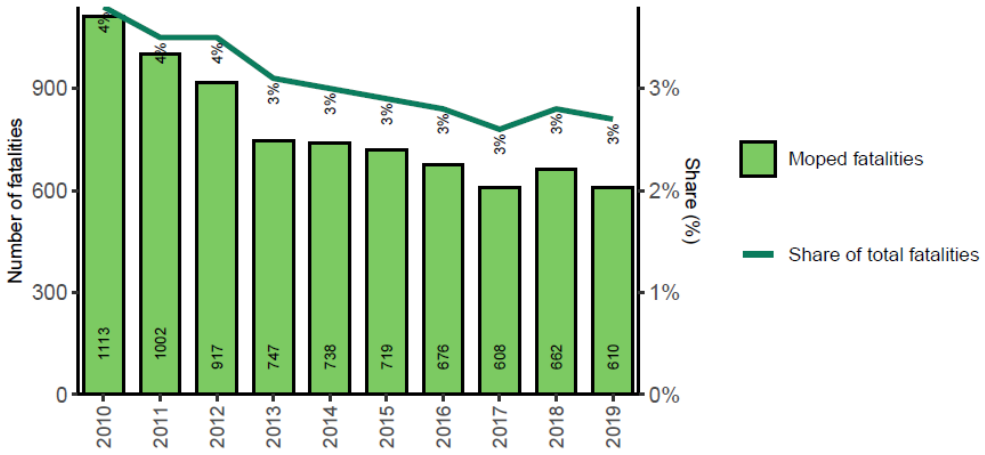
It is difficult to determine crash risk because there is no detailed exposure data. The OECD estimates that PTWs in general are about 20 times riskier compared to cars (OECD/ITF, 2015). The crash rate of a moped is four times greater compared to the crash rate of a motorcycle (Møller & Haustein, 2016).

The vulnerability of the moped rider using a comparatively lightweight vehicle means that a crash can have serious consequences. Moskal et al. (2012) showed that moped riders not wearing a helmet are twice as likely to be involved in an injury crash compared to moped riders wearing a helmet. It was also found that moped riders carrying a passenger had a higher crash rate compared to moped riders without a passenger. Furthermore, the crash risk for leisure-time trips was higher compared to commuting to work or school. Lack of attention during leisure time trips can lead to moped riders not noticing hazards or infrastructural problems (like bad road surfaces) or not noticing them in time.

3.2 General trend in number of fatalities

The proportion of moped fatalities within the total number of road fatalities in the EU in 2019 was 3%. Between 2010 and 2019, the number of moped fatalities almost halved, while the total number of fatalities for all road users decreased by 23%. No other mode of transport shows a greater reduction in fatalities than mopeds (European Commission, 2021).

Figure 3. Annual number of moped fatalities, and their share in the total number of fatalities in the EU27 (2010-2019)



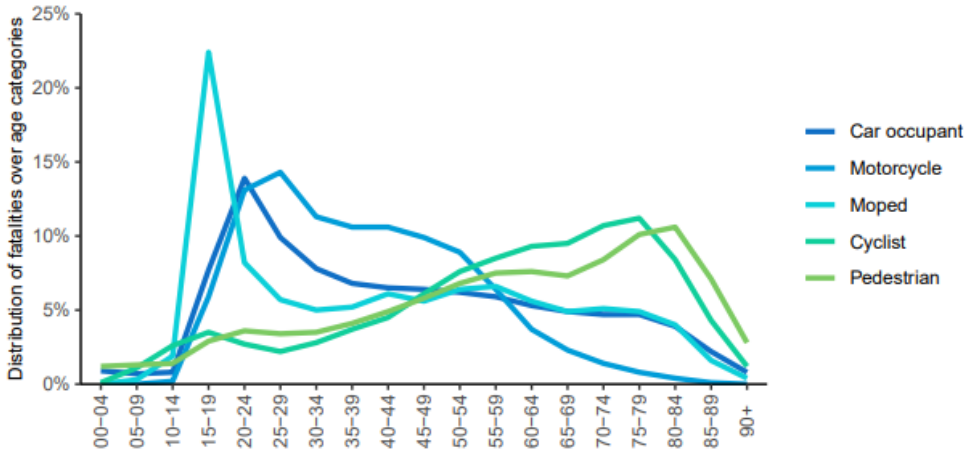
Source: European Commission (2021)

The moped mortality rate (number of fatalities per million inhabitants) is generally higher in Southern Europe compared to other parts of the EU. The popularity of this transport mode in these countries needs to be considered when interpreting risk levels. The Netherlands also has a high moped mortality rate compared to the EU average. The number of moped fatalities as a proportion of total fatalities also appears to be higher in the southern EU Member States (European Commission, 2021).

3.3 Crash characteristics

Moped fatalities are mainly male: more than 9 out of 10 fatally injured moped riders were male (compared with 7 out of 10 for all road fatalities). Half of fatally injured moped riders were between 25 and 64 years old. The proportion of over-65s has increased while the proportion of young people up to 24 has decreased in the last decade. With moped riders, a high peak in the number of fatalities occurs among 15–19-year-olds, as can be seen in Figure 4. Only a small minority of fatalities were passengers of mopeds (European Commission, 2021).

Figure 4. Distribution of fatalities over 5-year age categories, by transport mode, in the EU27 (2010-2019)

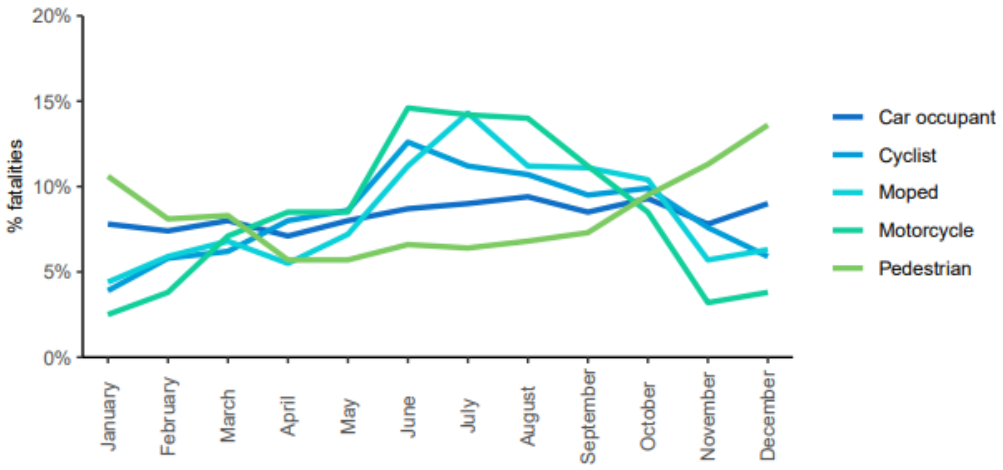


Source: European Commission (2021)

Up to 94% of all fatalities in road crashes involving moped riders were moped riders themselves. 31% of moped riders died in a unilateral crash (i.e. a crash in which only one vehicle is involved) (European Commission, 2021).

The distribution of moped fatalities over the week hardly differs from the distribution of all fatalities, but – as can be seen in Figure 5 – moped fatalities show a pronounced seasonal variation, with far fewer fatalities during the winter months and more during the spring and summer months (European Commission, 2021). One explanation is the fact that road users are less inclined to travel using a moped in wintery weather conditions (Delhaye & Vandael Schreurs, 2022).

Figure 5. Monthly distribution of fatalities by transport mode, in the EU27 (2019)



Source: European Commission (2021)

Regarding location, we see an increase of the share of moped fatalities on rural roads and therefore a decrease of the share on urban roads in the last decade (European Commission, 2021).

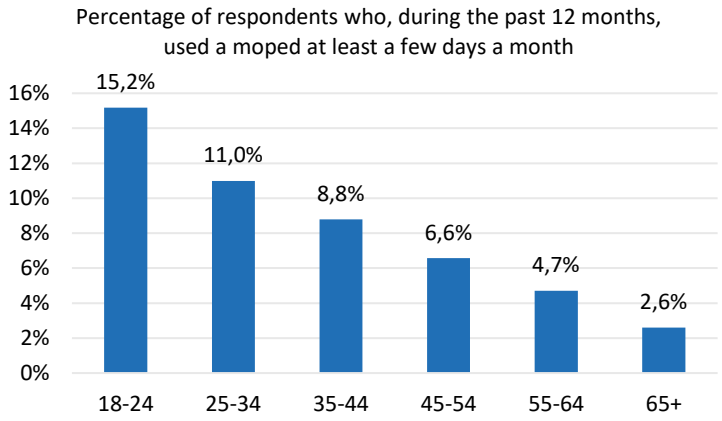
A couple of studies have looked at the type of moped crashes, based on in-depth analysis of crashes. These studies can give insights about a specific type of crash, but they involve a very limited number of crashes in a specific region. Therefore, they are not applicable to Europe as a whole, but they nevertheless give some useful insights. Crashes often happen at intersections, where either another road user does not notice the moped rider or where one of the road users involved exhibits risky behaviour at the intersection. Overtaking is also mentioned in all studies: crashes happen while overtaking cyclists or while overtaking another road user. Manoeuvers by other road users also cause moped crashes. The moped rider did not expect the manoeuver, misinterpreted the manoeuver or could not see the other road user and therefore did not know about the manoeuver. Other important factors in moped crashes are: loss of control, infrastructural problems, driving with insufficient attention to the driving task, and risky behaviour (De Ceunynck, Slootmans & Daniels, 2017; Davidse et al., 2017; Møller and Haustein, 2016; Van Elslande & Marechal, 2008).

3.4 Causation factors

Several factors play a role in moped crashes including the road infrastructure, the setting of appropriate speeds, speeding, the behaviour of the moped rider and other road users involved in the crash, and the vehicles involved. It is important to keep in mind that a crash is seldom caused by just one factor.

Information on ownership per age group per country is not generally available, but in many European countries mopeds are the only means of motorised transportation for young people (up to 16 years old) (European Commission, 2018). Data from the ESRA survey shows that young people do use mopeds more often compared to older age groups, as can be seen in Figure 6.

Figure 6. Percentage of respondents who used a moped at least a few days a month during the past 12 months (2022)



Source: Meesmann et al. (2022)

As younger people often lack the necessary basic skills to drive a vehicle and poorly assess traffic situations correctly, this can be an explanation for an increased crash risk for this group. In addition to the lack of experience, young people pursue independence and like to push their limits (Slootmans et al., 2017). Research suggests that the crash risk is highest for the "extreme" age groups (in other words, for both the youngest and the oldest moped riders) (Martensen & Roynard, 2013; Moskal et al., 2012).

Another factor could be the lack of training of young moped riders, who only need a theory test to obtain a driver's license. In most European countries, this is complemented by some practical training and/or an exam (European Commission, 2018). However, research shows that young riders have insufficient experience with certain traffic situations. In addition, they are more likely than other age-groups to have insufficient control of the vehicle (Slootmans et al., 2017). The share of young riders in fatalities is decreasing (see 3.3), which seems to be a training effect.

As with motorcycles, there is an issue with detection by other road users. Research suggests that in crashes between a powered two-wheeler and another motor vehicle, the driver of the other motor vehicle is at fault in the majority of cases (Haworth, 2012). Moped riders are not always noticed by other road users, partly because there are relatively

few moped riders on European roads and partly because a smaller vehicle is more difficult to detect, and their speed more difficult to estimate. Another possibility is that the other party is aware of the approaching moped, but the moped arrives faster than expected, creating small safety margins (Slootmans et al., 2017; Møller and Haustein, 2016; Van Elslande & Marechal, 2008; Stelling-Konczak et al., 2021).

Speeding, which may be excessive speed and/or inappropriate speed, is one of the most influential factors in crashes involving PTWs (Møller and Haustein, 2016), although this can equally be the other vehicles involved in the crash as the PTW itself. Mopeds are already one of the most vulnerable vehicles on the road, and evidence shows the higher the speed, the heavier the impact in a crash, and the more serious the crash (Slootmans et al., 2017). The tuning of the moped engine, which makes the moped go faster than the maximum design speed or type-approved speed, could also play a role in moped crashes. However, there are few official figures on this, and more insight is needed.

4 Countermeasures

Countermeasures should take into account the implementation of a rigorous safe system approach, which implies improving infrastructure, enhancing vehicle safety, the setting of appropriate speeds and behaviour of all road users and adequate enforcement.

4.1 Helmets

PTWs provide little protection against injury in the case of a crash. Injuries to the head are the most severe. It is known that helmets are very effective in reducing head injuries and indeed fatal injuries by 44%. There are, greatly simplified, two types of helmets: open face helmets and full-face helmets. Research is inconclusive as to which type of helmet is better (European Commission, 2018).

While helmets are mandatory for moped riders in EU countries, it's important to promote improvements in the quality of helmets sold through the enforcement of standards (IRAP, 2022a).

4.2 Learning, testing, and licensing

Learning, testing, and licensing of PTW riders are inter-related. They ensure that moped riders have an acceptable level of competency, both in terms of vehicle control and in terms of safe interaction with other road users (European Commission, 2018).

Even though there are no graduated driver licensing (GDL) systems in place for moped riders, it is estimated that introducing such a system would have a positive impact on crashes involving PTWs. Research on car drivers shows that this system gradually provides learning with driving experience in low-risk environments. Drivers start in a protected environment, and gradually progress to driving in the "normal" environment. They usually pass through three phases: a learner's permit; a (restricted) provisional license; and finally a full driver's license. Testing is an important component of the system. The learning period has to be long enough to ensure drivers acquire enough experience. GDL

programs have been proven to be effective in reducing the crash rate for 16- and 17-year old car drivers. The stricter the GDL - based on the duration of the period of the learner permit, night-time driving restrictions, and passenger restrictions - the more the crash rate is reduced (Hay, Etienne & Paire-Ficout, 2017). A drawback of this system is the increase in cost for obtaining a driving license. Mopeds are often chosen because they are an affordable mode of transport. Making a moped license more expensive could induce mobility poverty.

Higher order skills training, such as hazard perception training is any educational programme or training which aims to enhance the higher order riding skills. These types of training are mainly aimed at young novice (car) drivers. Hazard perception training enhances the ability of moped riders to detect road hazards. A number of studies have shown that hazard perception training reduces the risk of collision and driving speeds (Katrakazas, 2017). Moped training in the Netherlands showed that moped training which actively engages participants in the evaluation of their own behaviour is important in achieving a safety impact of training, although the long-term effect is limited (Goldenbeld et al., 2004). Post-licence training for those who already obtained a car license, could have a positive effect on this group of riders who start riding a moped without any practical experience.

Other road users also need training, considering how errors in observation – such as "looked but failed to see" errors – by motorised vehicle drivers are a common causal factor in moped crashes. This driver training should include elements to improve the understanding and expectations that drivers have towards mopeds (Morris et al., 2018).

4.3 Enforcement

Police enforcement should focus on the behaviour of all road users including speeding and distraction, and the engine tuning of mopeds. A study found that in the majority of crashes, involving a moped ridden by a 16 or 17 year old in Denmark, were caused by violation of traffic laws by the moped rider, preventive measures "should aim to eliminate violations and increase anticipatory skills among moped riders and awareness of mopeds among other road users." (Møller and Haustein, 2016).

4.4 Infrastructure

Roads should be forgiving: errors are inevitable in the road transport system and should be accommodated by design. In the first place, the road design should allow adequate room for rectification of any errors (IRAP, 2022b).

The quality of the road surface is very important for moped riders. The choice of materials for the road surface, the choice of road markings, and road maintenance and repair are essential for the comfort and safety of moped riders. An irregularity in the road surface can be an obstacle and lead to a fall. Road markings, sewer covers, etc. can be slippery in rainy weather (European Commission, 2018; Slootmans et al., 2017). Furthermore, a forgiving road environment can help to protect (young) moped riders from the consequences of risky behaviours such as speeding (Møller and Haustein, 2016).

Crashes involving a moped often happen at intersections, which is why infrastructure-based technologies have the capacity to prevent collisions. Co-operative Intelligent Transport Systems (ITS) should be developed, to enable road users to become aware of the presence of mopeds and other PTWs (Morris et al., 2018). Most innovations in the ITS sector target motorised transport. However, avoiding/mitigating visibility problems (adverse lighting or weather conditions) and counteracting critical infrastructure are ideal applications for ITS (Bell & Risser, 2017). The Connected Motorcycle Consortium[2] is currently working on this.

Research shows that the number of crashes and fatalities decreases when mopeds drive on the roadway rather than on cycle paths. There were fewer collisions between mopeds and cyclists, and also fewer conflicts between a moped and a car turning off at an intersection (AVV, 2011). It is important to ensure that the speed of the moped is as close as possible to the speed of the other road users using the same section of the road. This benefits both homogeneity of speed and predictability of road users (SWOV, 2014). The most beneficial option is a general speed limit of 30 km/h in urban areas on roads where vulnerable road users share the road with motorised vehicles (Stelling, Vlakveld & Twisk, 2021).

4.5 Vehicle safety

The new EU General Safety Regulation 2019/2144 which has introduced as of July 2022 state-of-the-art safety technologies as standard vehicle equipment should help improve the safety of vulnerable road users including moped riders. For example:

- Advanced emergency braking systems capable of detecting motor vehicles and vulnerable road users in front of them
- Enlarged head-impact protection zones capable of mitigating injuries in collisions with vulnerable road users.
- Cars and vans must be constructed in such a way that will help to reduce blind spots in front of and to the side of the driver.

4.6 Research needs

It is clear that there is a lack of data concerning mopeds. There is almost no exposure data available, which makes it hard to calculate risks. Most studies on crash causes focus on a limited number of studies, making it hard to extrapolate these results for the whole of Europe. There is also a need for mobility research – which should look at moped use, riding models, etc. – and for naturalistic studies to chart risk patterns, skills, attitudes, behaviors, and so on.

[2] https://www.cmc-info.net/

5 Further reading

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