

## Motorcycle and moped helmets

### Summary

Wearing a crash helmet is an important contribution to road safety. If a helmet is worn, the risk of being killed in a motorcycle crash decreases by about 42%. In the Netherlands, compulsory crash helmet wearing for motorcyclists was introduced in 1972, and the obligation for moped riders followed in 1975. Compulsory helmet wearing became generally accepted after its introduction. In spite of this, about 25% of moped riders and 13% of motorcyclists admitted to hospital after a crash still have severe head/skull injuries. This may partly be caused by the helmet not being fastened properly. Especially the percentage of moped riders *properly* wearing the helmet has not increased, despite intensified police enforcement. SWOV recommends a more targeted enforcement and more public information.

### Background and content

Before World War II many motorcyclists wore leather jackets and a leather hood helmet with ear flaps. A pair of goggles helped to protect the eyes. In those days it was more a matter of protection against the weather than a matter of safety. Safety was no issue then, and helmets were practically only worn during races. Not until after the war, when there was a lot more traffic and many more crashes happened, road safety gained importance. From the 1960s onwards, voluntary helmet use increased. This was also the case for the new light motorcycle that came to be known as the 'moped' and rapidly became popular. This fact sheet will discuss the use and necessity of crash helmets for motorized two-wheelers. For more information about helmets for bicycles, we refer to the SWOV factsheet [Bicycle helmets](#).

### What is the road safety problem?

During the past five years, about 60 moped riders and 80 motorcyclists per year were killed on the road in the Netherlands, and there is a downward trend. The annual number of inpatients is about 1,800 and 1,100 respectively. Most of the moped rider casualties are 15-19 years old and the majority is male. The age dispersion of casualties among the motorcyclists is much broader, 20-54 years old, with a peak at 25-34 year olds. Here too there are more male than female casualties. The proportion of inpatients among moped riders is larger than among motorcyclists, irrespective of age. Due to the lower driving speed a moped crash can easily develop into one involving severe injury, but not easily into a fatal crash.

### Which injuries do moped riders and motorcyclists incur?

We can use the data from the hospital inpatient registration (LMR) to answer this question, because it is practically complete and therefore is representative for the whole of the Netherlands. A disadvantage is that the LMR makes no distinction between moped riders and light-moped riders. The registered police data shows the percentage of light-moped riders among in-patients to have been approximately 20% during the past years.

*Figure 1* shows several differences in the distribution of the most frequent injuries by body part and their severity between the group of moped and light moped riders, from now on referred to as '(light-)moped riders', and motorcyclists. There are far fewer head/skull injuries among motorcyclists (13%) than among (light-)moped riders (27%). Part of this difference is explained by the fact that the crash helmet is not compulsory for light-moped riders, who thus inevitably increase the percentage. A more detailed crash analysis shows that light-moped riders indeed incur head/skull injury more frequently (approx. 40%) than moped riders (approx. 25%). That is still considerably more frequently than among motorcyclists (13%). An explanation may be that moped riders do not always wear a helmet or do not always fasten the chin strap, which means that the helmet has little or no effect in collisions.

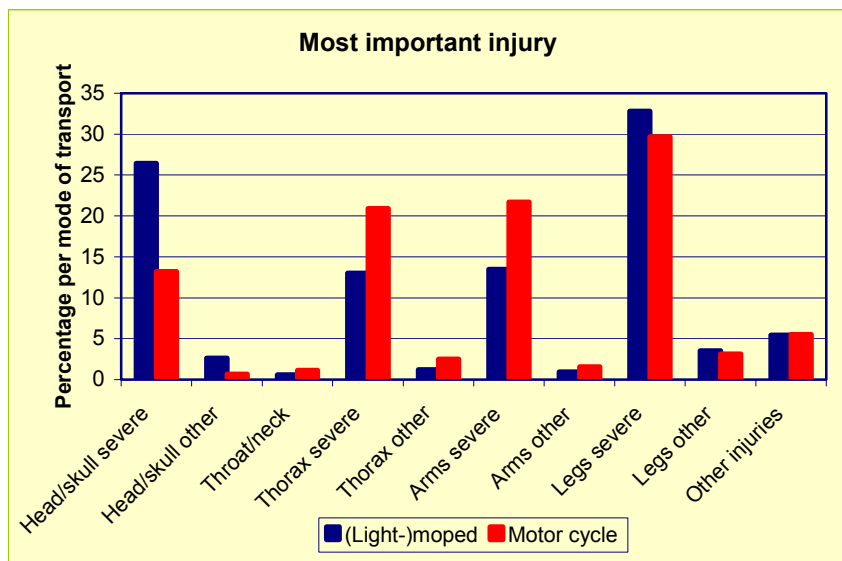


Figure 1. Injuries of (light-)moped rider and motorcyclist inpatients. (Source: LMR 2001-2005).

### How does a crash helmet work?

A helmet prevents or reduces head injury and a well-fitting one makes riding a motorized two-wheeler more comfortable, particularly at high speeds. This is also important for safety. A helmet consists of four basic components: outer shell, inner shell, protective padding, and chin strap. Furthermore, most types of helmet also have a visor. The task of the hard outer shell, usually made of fibre reinforced composites or thermoplastic fibres, is to prevent objects to penetrate, and to absorb and spread energy. The task of the soft inner shell, usually made of polystyrene foam in various densities, is to absorb the collision energy slowly and to spread it over a large area of the head. The protective padding, often made of polyurethane, ensures comfort of wear. The chin strap ensures that the helmet remains on the head no matter what happens. The helmet wearer's vision is guaranteed by the hinged visor. The shape of the helmet reduces wind noise to acceptable proportions, although turbulence can still raise the sound level.

### What types of helmets are there?

There are various types of crash helmets. This fact sheet will only discuss those types which meet the requirements of regulation ECE R22-05:

- the integral helmet; this is a helmet that completely encloses the entire head and is equipped with a fixed jaw guard;
- the jet helmet; this helmet does not have a jaw guard but only a usually hinged visor in front;
- the system helmet; this is an integral helmet with a hinged jaw guard.

### What are the legal requirements?

Since June 1<sup>st</sup> 1972, wearing an approved crash helmet has been compulsory in the Netherlands for riders and passengers of motorcycles. This law has been extended to include moped riders from February 1<sup>st</sup> 1975. The helmet approval requirements are the same for both categories of transport mode, and they have been laid down in the above-mentioned ECE R22-05. However, these requirements only apply to newly bought helmets. ECE R22-05 sets minimum requirements for shock absorbance, penetration resistance, stiffness, protruding parts, surface friction, chin strap, and falling off.

### How effective is a helmet?

Wearing a helmet reduces the risk of head injury in a crash considerably. An international review of 61 studies on the use of a moped helmet shows that the risk of severe head injury decreases by about 69% when wearing a helmet (Liu et al., 2007). The risk of being killed in a motorcycle crash decreases by about 42%.

Research has also been done on whether wearing a helmet can have negative consequences for the incurrance of head and neck injury. In Switzerland, Konrad et al. (1996) found that wearing a helmet of 1500 grams or more was to be discouraged because of an increased risk of a skull base fracture.

Furthermore, studies have been carried out on possible differences in effectiveness between the various helmet types, particularly the integral helmet and the jet helmet. It is clear that an integral helmet with a fixed jaw guard considerably reduces the risk of chin and facial injury. The jet helmet lacks this protection. Studies carried out in Taiwan and Australia also find no difference between the integral and the jet helmet in causing spinal cord injuries (Lin et al., 2004; O'Connor, 2005)..

According to Wells et al. (2004), the colour of the helmet can be important in preventing crashes. Wearers of a white helmet even have a 24% lower crash rate than those wearing a black helmet. The cause of this difference would be a better visibility of motorcyclists wearing a white helmet. However, a personality difference between riders choosing a black and those choosing a white helmet, such as a greater safety awareness, cannot be ruled out.

### **How many motorcyclists and moped riders wear a helmet?**

After wearing a crash helmet had been made compulsory for motorcyclists in 1972, wearing one was generally accepted by riders and passengers. It is, however, uncertain whether motorcyclists always wear an approved helmet. The study of Huijbers (1988) showed that at that time 13% of the helmets worn in the Netherlands had no approval hallmark.

Compulsory crash helmet wearing for moped riders, which was introduced in 1975, initially was also generally accepted. In 1984 about 100% of the Dutch moped riders and passengers wore one, but in 1996 this had dropped to 99% for riders and 86% for passengers. This decline continued for a long time; in 2002 the wearing percentages were 91% for riders and 74% for passengers; it is striking that young riders wore the helmet less than the older riders. The decline in wearing helmets and the frequent involvement of young moped riders in crashes were reason to intensify the police enforcement of helmet use by moped riders. Since then the percentages of helmet wearing increased to 96% for riders and 84% for passengers in 2008, probably also because of the intensified police enforcement (Henkens & Hijkoop, 2008).

When a helmet is worn without a fastened chin strap, the effectiveness of protection in a crash is limited. Therefore it is important to keep the chin strap well fastened, allowing no slack. Studies have shown that this is often not the case, among moped riders more so than among motorcyclists. The most recent data on motorcyclists in the Netherlands is from the 1980s (Huijbers, 1988). It showed that 2% of helmet wearers did not have their chin strap fastened and that 13% wore it too loose. In 2008, 90% of moped riders in the Netherlands had their chin strap fastened and 87% wore the helmet properly on the forehead. 60% of the moped riders wore the helmet allowing no slack (Henkens & Hijkoop, 2008). Unfortunately, these percentages of properly wearing the helmet and chin strap have not increased much since 2002, despite the intensified police enforcement.

### **Which developments are to be expected?**

The helmet will remain the most important source of protection against injury for both motorcyclists and moped riders. However, this can still be improved by, for instance, using better absorption materials and stronger outer shells. In a study by Eindhoven University of Technology (Van den Bosch, 2006) the rotational acceleration and deforming of the head in crashes was investigated. For this type of test a more natural flexible test head needs to be developed. A rotation test could be included in ECE R22-05, in addition to the existing acceleration requirements.

### **Conclusions**

A helmet that meets the requirements of the ECE R22-05 guideline offers good protection for moped riders and motorcyclists. A crash helmet prevents or reduces the severity of head and neck injury in a crash. An international survey of 61 studies shows that wearing a motorcycle helmet decreases the number of fatal crashes by about 42% and the risk of severe head injury by about 69% (Liu et al., 2007).

### **Recommendations**

There are indications that the protective effect of the helmet can still be improved. Perhaps this requires adapting the test procedure requirements so that advanced materials and constructions can contribute optimally.

The compulsory helmet can be regarded as socially accepted and prevents a considerable number of fatalities and inpatients due to head injury. However, this requires correct wearing of the helmet. Police enforcement together with public information can make an important contribution to this. There is every reason for concern about helmet wearing habits of moped riders. Since 2002 the percentage of helmet wearers has risen from 91% to 96% among moped riders, but the percentage of riders wearing the helmet *properly* has hardly risen at all since 2002. We recommend a more targeted enforcement and more public information.

Finally, the data used in this fact sheet indicates that light-moped riders would also benefit from head protection, because their percentage of crashes with severe head/skull injury is higher than that of moped riders.

### **Publications and sources [SWOV reports in Dutch have a summary in English]**

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