

Cyclists

Summary

Cyclists are vulnerable in traffic. The number of fatalities amongst cyclists is decreasing more slowly than for other modes of transport and the number of serious injuries is increasing. In the Netherlands, many cycling casualties occur in the age groups 12 -17 year olds and the over 60's. When the number of casualties is compared to distance travelled by bicycle by these groups, we can see that only cyclists aged 75 and over have a much higher risk of fatal injury or being admitted to hospital as a result of a cycling crash. Most crashes involving cyclists occur in urban areas. Infrastructural measures that separate bicycle traffic from motorized traffic as much as possible, qualitatively good paths free of obstacles, improvements to bicycles and the opposing vehicles, as well as educational measures, are aimed at lowering the cyclist crash rate. Other measures that can improve cyclist safety are bicycle helmets and closed side underrun protection for lorries.

Background and content

Of all European inhabitants, the Dutch most often say that they use the bicycle as their daily mode of transport (31.2%). The Danes are in second place with 19% (Gallup Organization, 2011). Next to walking, cycling is the most important mode of transport for young children and schoolchildren. Because cyclists mix with other traffic without protection and with a relatively large difference in speed, they are considered to be a vulnerable group of road users (see SWOV Fact sheet [Vulnerable road users](#)). The present Fact sheet will discuss developments in the number of cycling casualties, some of the characteristics of crashes involving cyclists, and measures which could improve the safety of cyclists.

Has traffic become safer for cyclists?

Although the number of fatalities amongst cyclists has been decreasing, it has been decreasing less rapidly than the number of fatalities amongst car occupants (see *Figure 1*). The number of fatalities amongst cyclists and car occupants in the year 2000 has been indexed as 1 in *Figure 1*.

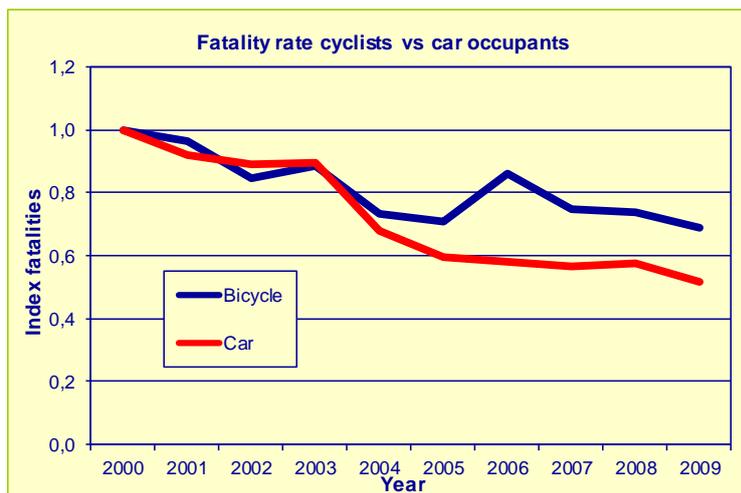


Figure 1. Development in number of fatalities among cyclists and car occupants per distance travelled (index year 2000). Sources: BRON – Infrastructure and the Environment¹; MON – DVS².

¹ The Registered Road Crash Database (BRON) comprises police registered crashes and is administered by the Dutch Ministry of Infrastructure and the Environment.

² The Dutch Mobility Survey (MON) is executed by the Dutch Ministry of Infrastructure's Centre of Transport and Navigation (DVS).

Figure 2 indicates the same as Figure 1, but then for serious injuries (MAIS 2+).

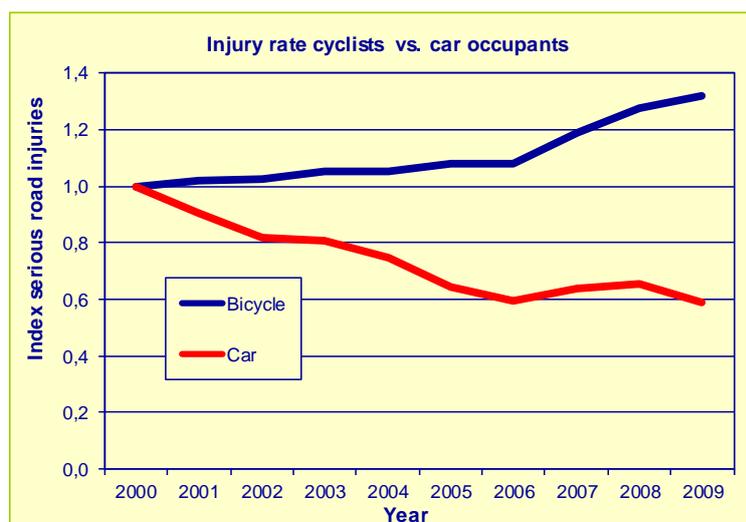


Figure 2. Development in the number of serious injuries among cyclists and car occupants per distance travelled (index year 2000). Sources: LMR – DHD³; MON – DVS.

Figure 2 even shows an increase in the number of seriously injured cyclists, while the number of seriously injured car occupants has decreased. A cyclist can get seriously injured through collision with a motor vehicle, but this can also happen without any involvement of a motor vehicle. Those cases may involve crashing into a pole or a crash with another cyclist. These are called cyclist-only crashes. 75% of cyclist fatalities are the result of crashes involving a motor vehicle, and 90% of cyclist injuries are the result of crashes *not* involving a motor vehicle. In recent years, the number of seriously injured cyclists caused by crashes involving a motor vehicle has decreased slightly, while that number has increased for cyclist-only crashes.

Are there differences between age groups and genders?

Figure 3 shows the number of registered fatalities per 100,000 inhabitants over the period 2005-2009, by age category and gender. Figure 4 shows the same information, but then for serious injuries.

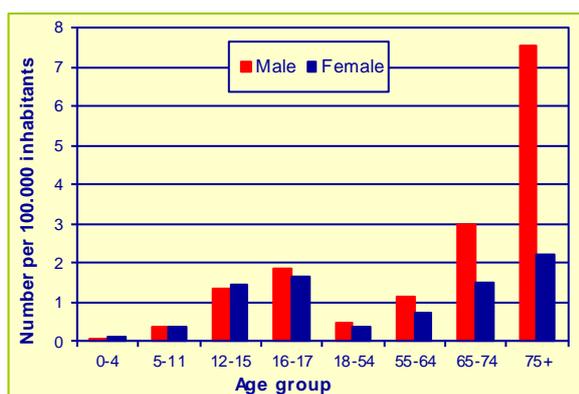


Figure 3. The number of cyclist fatalities per 100,000 inhabitants by gender and age group for the years 2005-2009 (Registered Crashes in the Netherlands BRON – Ministry of Infrastructure and the Environment; Statistics Netherlands).

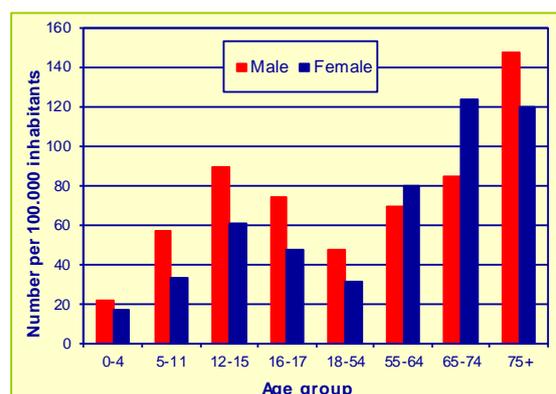


Figure 4. The number of seriously injured cyclists per 100,000 inhabitants, by gender and age group for the years 2005-2009 (LMR – DHV; Statistics Netherlands).

Figure 3 and Figure 4 show that, corrected for the number of inhabitants, most cycling casualties, fatalities as well as serious injuries, occur amongst teenagers and the group of elderly (65 and older). Amongst elderly cyclists (65 years and older), fatalities occur more often for men than for women.

³ The National Medical Register (LMR) consists of injuries registered by hospitals and the injury level (expressed in MAIS) and is maintained by Dutch Hospital Data (DHD).

However, when it comes to seriously injured cyclists, clearly more women than men in the age of 65 up to 74 are seriously injured. Because not every inhabitant cycles and because not every age group cycles equally often, *Figure 5* shows the number of fatalities per kilometre travelled by bicycle; *Figure 6* shows the same information for seriously injured cyclists.

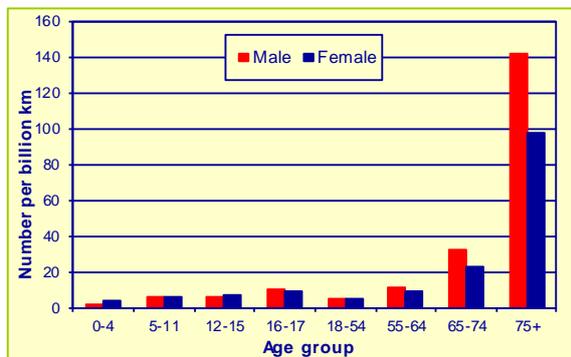


Figure 5. Number of cyclist fatalities by gender and age, divided by distance travelled by bicycle (in billions of kilometres) in 2005-2009 (BRON – Ministry of Infrastructure; MON – DVS).

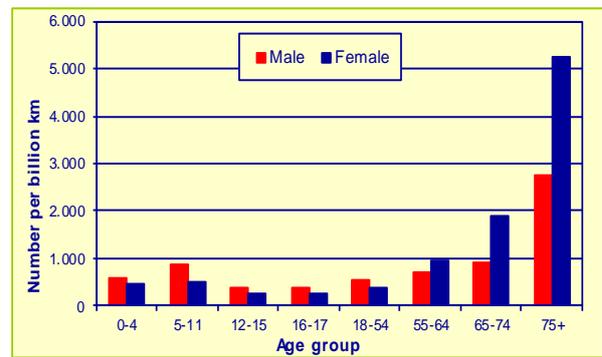


Figure 6. Number of seriously injured cyclists by gender and age, divided by distance travelled by bicycle (in billions of kilometres) in 2005-2009 (LMR – DHD; MON – DVS).

Noticeably, when corrected for the annual number of kilometres cycled, more bicycle fatalities occur among men than among women of 75 years and older in traffic in that age group, while more serious injuries occur more amongst female than amongst male cyclists of 75 years and older. It is not clear why this is so. The difference could be related to differences in the nature of the crashes (collisions versus falls), the model of the bicycles used (men's or women's bicycle), or differences in frailty (on average, women live longer than men). Furthermore, it is noticeable that, corrected for distance travelled, there is no longer a clear increased risk for teenage cyclists. The fatality rate of 16- and 17-year-olds is somewhat higher than that of the ages 12 to 15 and cyclists of 18 to 54 years old, but the serious injury rate at the age of 16 and 17 is not higher than that in the two other age groups mentioned. This is noticeable because young moped riders and young drivers do have an increased injury rate (see SWOV Fact sheets [Moped and light-moped riders](#) and [Young novice drivers](#)),

The high mortality rate amongst elderly can partly be explained by their age. With the increase of age, functions such as eyesight, reaction speed, and the speed of information processing decrease. Physical strength and the ability to turn one's head also decrease; see also the SWOV fact sheet [The elderly in traffic](#). Elderly cyclists can partly compensate these disabilities by cycling more cautiously and avoiding busy traffic. It is unknown how well elderly cyclists can balance the decrease in their abilities with their tasks as cyclists in traffic. Crashes amongst elderly cyclist more often have serious outcomes because of frailty, which increases with age (Zeegers, 2010). Whereas at a young age one might have an abrasion after a fall, at an elderly age the risk of having a fracture after a fall as well is high. Besides wearing a helmet, which few elderly cyclists do, there is hardly anything they can do to compensate for the increasing frailty with age.

What are the causes of cycling crashes?

Bicycle-only crashes are caused by cyclists colliding with objects such as bollards and kerbs, skidding or losing balance. Skidding does not only take place due to snow or ice on the road surface, but also because of materials such as tram rails and metal panels (for a temporary road surface) which are slippery when wet, or because of blocking brakes and so on. Losing balance is caused by unevenness of the road surface, objects such as branches of trees or (the sides of) metal panels on the road surface, luggage that comes between the spikes, bicycle defects, etcetera. Elderly people often lose balance when they get on and off the bicycle, which is related to the low speed during these manoeuvres (Ormel, Klein Wolt & Den Hertog, 2008; Schepers 2013). In terms of infrastructure, the presence of obstacles, the quality of the surface and the road shoulder, and level of maintenance play a role in the occurrence of bicycle-only crashes. Other infrastructural factors are the visibility of obstacles and the alignment and the width of bicycle tracks and bicycle lanes (Schepers, 2013). The above information on the circumstances of bicycle-only crashes is mainly derived from a survey amongst lightly injured cyclists, in some cases supplemented by inspection of crash locations.

When cyclists collide with other vehicles, these are mostly other cyclists (Ormel, Klein Wolt & Den Hertog, 2008). On average, bicycle-bicycle collisions are equally serious as bicycle-only crashes and often occur when people cycle together, for example when someone hits a bicycle in front or when steering wheels hook together (Schepers, 2010). An observational research indicates that too small bicycle tracks increase the risk of bicycle-bicycle crashes (Van der Horst et al., 2013). Passenger cars are the second most important crash vehicle for bicycles (Schoon & Blokpoel, 2000). The more serious the outcome of a bicycle crash, the more likely it is that a motor vehicle was involved in the crash. Almost 75% of all fatal crashes are a crash between bicycle and motor vehicle. Crashes involving a bicycle and a motor vehicle are often 'transverse crashes', because of cyclists crossing over or because of bicycle traffic intersecting motor vehicles at crossings. In 78% of fatal crashes between a motor vehicle and a bicycle, the manoeuvres 'intersecting' or 'crossing over' are involved (see SWOV fact sheet [Crossing facilities for cyclists and pedestrians](#)).

The degree of exposure to motorized traffic and its speed are related collisions with cyclists. Speed namely determines the kinetic energy released in a crash. Therefore, larger residential areas decrease the rate of serious crashes in various ways: not only the speed is limited in those areas, but also the exposure to fast moving motor vehicles, because motor vehicles only use residential areas for the smallest possible part of their route due to speed reductions and traffic circulation measures (such as road closures and one-way traffic). Research that compared Dutch cities shows that fewer fatalities and serious injuries occur as cyclists use residential areas for a larger part of their route (instead of cycling along distributor roads) and as more distributor roads have split-level intersections. In cities such as Houten, this separation of cyclists and motor vehicles has been implemented to a large extent (Schepers, 2013).

More research has been done on two types of crashes involving a cyclist and a motor vehicle; blind spot crashes, and crashes involving a bicycle and a passenger car in which the car comes from an unexpected angle for the cyclist. The causes of blind spot crashes are described in the SWOV fact sheet [Blind spot crashes](#). Considering the second crash type, we know that motorists, when exiting a side street, often overlook cyclists that are coming from the right when they are crossing a two-way cycling lane before they can turn left or right onto the through road (Ränsänen & Summala, 1998; Schepers, 2013; Summala et al., 1996).

Cycling crashes also develop due to behaviours of the cyclists themselves, such as cycling without lights, after using alcohol, cycling on the wrong side of the road (against the driving direction), through red lights, with baggage on the steering wheel, etcetera. Little research has been done into the risk and background of ignoring red traffic lights, but some information is known about cycling without lights, the use of alcohol and distraction in combination with cycling.

In darkness, 25% of cyclists do not use head lights and 30% do not use rear lights (Boxum & Broeks, 2010). The effect of using bicycle light was not looked into for a long time, because in crashes there was no registration of using or not having used bicycle lights (Reurings, 2010). Because of that, the use of bicycle lights according to measurements of the Dutch Ministry of Transport (Boxum & Broeks, 2010) has been related to the development of the number of registered bicycle crashes involving motor vehicles in darkness (in the cities where the measurements took place). The analysis seems to indicate that the risk of these crashes is lower as the use of bicycle lights is greater (Kuiken & Stoop, 2012). On the basis of an experiment in Denmark, the conclusion was that using bicycle lights during daytime adds to cyclist's road safety (Madsen et al., 2012). Kuiken & Stoop (2012) point out that the current cycling lights do probably not contribute to preventing bicycle-only crashes.

In cycling crashes in which no motor vehicle was involved and which caused serious injury, alcohol was used by almost 5% of cyclists (Ormel, Klein Wolt & Den Hertog, 2008). Especially in weekend nights, a lot of cyclists are under the influence of alcohol. Nearly 60% of injured cyclists in weekend nights in the age group of 18 to 24 years old, was under the influence of alcohol in 2008 (Ormel, Klein Wolt & Den Hertog, 2008).

A relatively new phenomenon is the use of media devices while cycling and the distraction and lowered perception that leads to. Not only do cyclists listen to music, they also make calls, send text messages and use internet services. Analysis of self-reported data on the use of devices and bicycle crashes shows that when devices are used while cycling, the crash rate is 1.3 times as high as when

no devices are used. For this topic, see SWOV fact sheet [Use of media devices by cyclists and pedestrians](#).

What measures have been undertaken in the Netherlands to improve the safety of cyclists?

Roads

An important way to lower the casualty rate of cyclists is to make the infrastructure safer for cyclists. These infrastructural measures aim to separate bicycle traffic from fast traffic as much as possible, and to control the speed of fast traffic in situations where bicycles and fast traffic have to mix. A first example of this is the abovementioned separation of cyclists and motor vehicles. The degree of separation reached in the Dutch city of Houten is difficult to establish in existing city networks, but there are cities that show it is possible to increase the degree of separation on the long term. A second example is the measure *Mopeds on the carriageway*. From 15 December 1999, in the Netherlands, mopeds have been moved from bicycle paths onto the carriageways where the speed limit is lower than 70 km/h. This move was suggested, amongst others, to improve the safety of cyclists on the bicycle paths. An initial evaluation of the traffic safety effects of this measure one year after it came into force confirmed that fewer bicycle-moped crashes took place (Van Loon, 2001). An example of speed control in situations where bicycle and fast traffic mix is the creation of 30 and 60 km/h areas. The SWOV Fact sheet [Zone 30: urban residential areas](#) explains this in detail. Other infrastructural measures can be found in the SWOV fact sheet [Bicycle facilities on distributor roads](#).

The bicycle and bicycle attributes

Bicycles have not changed in their essence since the end of the 19th century. However, in recent years electrical bicycles have come into existence, which are mostly popular amongst elderly cyclists. Little is yet known about the crash rate of electrical bicycles. However, it has appeared that crashes involving electrical bicycles are mostly the same as other bicycle crashes as to the ratio of single vehicle, bicycle-bicycle or bicycle-motor vehicle crashes (Kruijer et al., 2013). Bicycles hardly offer any protection, which makes cyclists vulnerable on a bicycle. The only means of protection is a bicycle helmet; see for more information the SWOV fact sheet [Bicycle helmets](#).

Vehicles

Measures for vehicles regarding potential crash opponents can also reduce the number of cycling casualties. For instance, *side underrun protection* can prevent cyclists and other vulnerable road users from sliding under the wheels of lorries. Since 1 January 1995, it is compulsory for new lorries, semi-trailers and trailers to be equipped with open side underrun protection. *Field of vision improvement systems* can lessen the blind spot of lorries, thereby reducing the risk of blind spot crashes. Since 1 January 2003, all lorries with a Dutch registration number must have a blind spot mirror. Since 2007, a front-view mirror and a wide-angle mirror are compulsory for new lorries in Europe. Since 2002, the so-called 'bull bars' have been prohibited in Europe, and since 2006 cars receive stars at Euro NCAP for their crashworthiness for cyclists and pedestrians. The best way to avoid collision of a car with a cyclist at the last moment, or to at least absorb the blow as much as possible, is an automatic brake system that detects cyclists and activates an airbag on the bonnet. Such a system is currently being developed by TNO and it is expected that the first prototype of the airbag for cyclists will be ready in 2012.

What gains can still be achieved?

Many roads and streets have not yet been laid out in accordance with the principles of Sustainable Safety. For instance, many of the 'Zones 30' have a low-cost design which means that people do not take the speed limits seriously (Weijermars & Van Schagen, 2009; Berends & Stipdonk, 2009). Next to that, further gains can be achieved by further separating cyclists from fast traffic. This can be done on the one hand by creating large residential areas with attractive cycling routes, and by creating split-level intersections of distributor roads and cycling tunnels or cycling bridges. It can also help to not invest too much in the attractiveness of routes next to distributor roads. For example, changing one-way cycle tracks into two-way cycle tracks along these roads makes it more attractive and at the same time more dangerous to cycle along these routes (Scheppers, 2013). Not all distributor roads have yet been fitted with adjoining or separate bicycle paths, which means that an effective separation of motor vehicles and other road traffic is not guaranteed (see also SWOV Fact sheet [Bicycle facilities on road segments and intersections of distributor roads](#)).

Wearing a helmet greatly reduces the risk of brain injuries (see the SWOV fact sheet [Bicycle helmets](#)). Despite the beneficial effects of bicycle helmets, there is a lot of resistance against a compulsory use

of helmets because it may prevent people from cycling. It is unknown whether this would actually be the case in the Dutch situation. However, the voluntary use of helmets can of course be stimulated as is already being done for racing cyclists. This could especially be done for the use of bicycle helmets by children.

Elderly cyclists fall relatively often while getting on and off the bicycle (Ormel, Klein Wolt & Den Hertog, 2008). Perhaps these falls amongst elderly cyclists could partly be prevented through the type of bicycle they ride. One may think of tricycles or bicycles on which one can place both feet on the ground when standing still. Whether this would really prevent crashes needs, however, to be investigated further. The mobility scooter, for example, meets these demands, but the number of single vehicle crashes with this vehicle is around equally high as that of the bicycle (Hoofwijk & Draisma, 2011).

Infrastructure plays a part in around half of all single vehicle cycling crashes (mostly in combination with other factors; Schepers, 2013). Over the coming years, removing and improving visibility of obstacles, a better quality of road surface and road shoulder (level and free of slippery materials), sufficient road width, maintenance, adequate measures against slippery road conditions in winter, amongst others, could contribute to the prevention of single-vehicle crashes.

In order to reduce the number of seriously injured cycling casualties due to bicycle and head-on car crashes, it is important that the *car fronts* are made safer. Since the end of 2005, EU regulations have come into force, which are based on collisions with pedestrians. However, cyclists also benefit from this measure, albeit to a lesser degree than pedestrians. By stimulating the use of a special airbag for cyclists (which is being developed; see above), serious and fatal injuries will most likely be greatly lessened (Rodarius, Mordaka & Versmissen, 2008).

Since 1 January 1995, it is compulsory for new lorries, semi-trailers and trailers to be fitted with *open side underrun protection*. However, *closed side underrun protection* is more effective for moped drivers, cyclists and pedestrians, as it reaches lower (to the surface of the road). Van Kampen & Schoon (1999) estimate that open side underrun protection results in 25% fewer fatalities and injuries, and closed side underrun protection results in 35% fewer.

Drivers often do not perceive cyclists timely when these come from unusual directions (for the drivers) or when they do other unexpected things. By hazard anticipation training, drivers can learn, amongst other things, to better detect hazards involving cyclists and be more aware of the risks. Drivers' scanning behaviour can strongly improve by this type of training (Vlakveld, 2011).

Conclusion

Compared to the road safety of car occupants, which is developing favourably, the development of road safety for cyclists can be described as bad in the Netherlands. Often, cyclists are involved in fatal crashes with a motor vehicle and often they get wounded by a fall without involvement of a motor vehicle. The crash risk of cyclists increases fast after the age of 65. Increasing frailty with the increase in age plays an important role in that. The preferred method to improve cycling safety is to deal with the underlying causes, without implementing measures that would lead to detrimental effects. For example, the infrastructure can be made safer for bicycle traffic and be better maintained, the use of correct bicycle lights and bicycle helmets can be stimulated, and measures can be introduced that are related to cyclists' potential crash opponents, such as closed side underrun protection (for lorries) and safer car fronts.

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