SWOV Fact sheet

Cyclists

Summary
Cyclists are vulnerable in traffic. 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 the number of kilometres cycled by these groups, we can see that only cyclists aged 75 and over run 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, often when a cyclist and a car intersect. Infrastructural measures that separate bicycle traffic from motorized traffic as much as possible, improvements to bicycles and the opposing vehicles, as well as educational measures, are aimed at lowering cyclists' crash rates. Other measures that can improve cyclist safety are bicycle helmets, closed side underrun protection for lorries, and Intelligent Transport Systems (ITS).

Background
The Netherlands is a country of cyclists. Practically every Dutch person has a bicycle and uses it regularly. On average, a Dutch person cycles about 850 kilometres a year. In the rest of Europe, only the Danes cycle (a little) more per capita (Lynam et al., 2005). Next to walking, cycling is the most important mode of transport for young children, schoolchildren and older people. Because cyclists mix with other traffic without protection and with a relatively large difference in speed, they are a vulnerable group of road users. By definition, encounters with other road users result in the most serious consequences for cyclists (see SWOV Fact sheet *Vulnerable road users*. This Fact sheet deals with 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?
The Registered Road Crash Database (BRON) of the Dutch Ministry of Transport's Centre for Transport and Navigation (DVS) shows that the number of registered cycling fatalities halved in the period 1987-2008 from 311 to 145 per year (*Figure 1*). According to BRON data, the number of cyclist in-patients registered by the police was reduced by a quarter, from 3,093 in 1987 to 2,335 in 2008. However, if we look at the actual number of in-patients arrived at by comparing police records with hospital records, we can see that the number of in-patients among cyclists has not fallen, but on the contrary, has risen from 6,780 in 1990 to 7,640 in 2004.

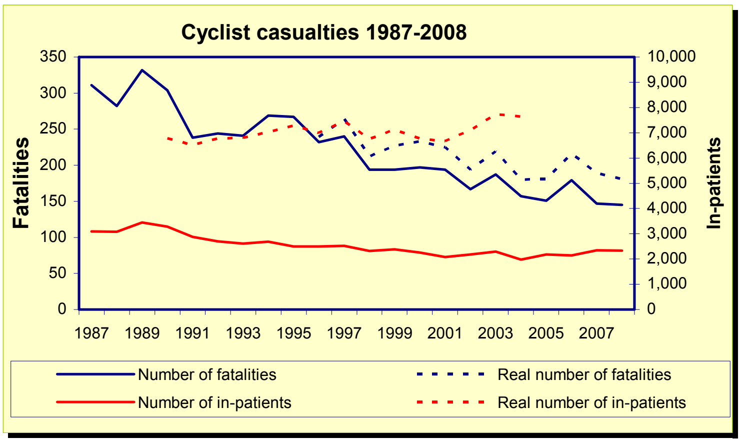

Figure 1. *Sources: Ministry of Transport (BRON); CBS Cause of Death Statistics; National Medical Registration (LMR).*

A more detailed analysis of the data of the National Medical Registration (LMR; see *Figure 2*), shows that this rise in the number of in-patients occurred exclusively in cycling crash casualties where no motor vehicle was involved, i.e. the type of crash that is underreported in the police registrations of

BRON. The number of cycling casualties resulting from crashes with motor vehicles has fallen (slightly) during the last two decades (Van Kampen, 2008).

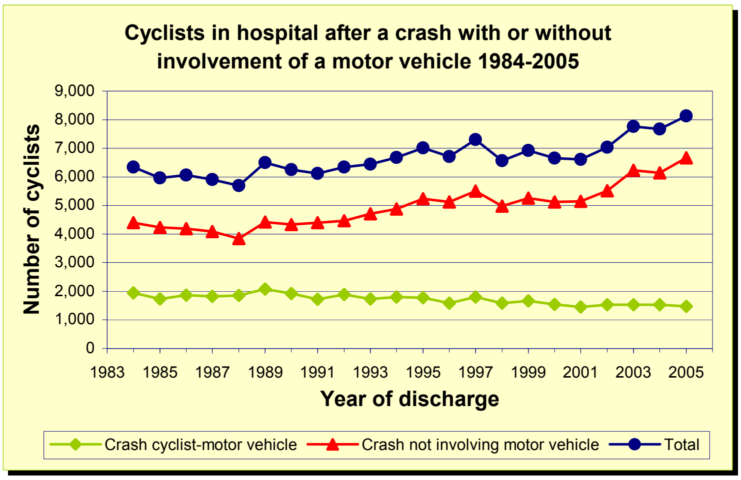

Figure 2. *Source: Van Kampen, 2008; National Medical Registration (LMR)*.

Are there differences between age groups?

In the Netherlands, in the period 2005-2007 the majority of cyclist fatalities occurred amongst cyclists aged 75 and older (see *Figure 3*). The largest number of in-patients was amongst cyclists aged 12 - 17 and cyclists aged 64 - 74. The number of casualties increases in both categories of severity from the age group 25 – 29 onward. These figures are based on the police registration (BRON). Real numbers, as shown in *Figure 1*, are not available for the combination of age group and mode of transport. It is therefore possible that in reality the relations between the age groups are different than is shown here. For example, under-registration of fatalities is particularly marked amongst older cyclists. This concerns cyclists who are taken to hospital after a fall from their bicycle and who later die from the consequences of the fall. Such cyclist-only crashes are often not registered by the police and are therefore under-represented in *Figure 3*.

When the registered number of fatalities and in-patients from 2005-2007 are compared with the number of kilometres cycled by the various age groups during that period, we gain a better picture of cycling safety with regard to the various age groups. This shows us the casualty rate (see *Figure 4*). From this we can see that the fatality rate for cyclists aged 75 and older is by far the highest and they also have the highest risk of being admitted to hospital following a cycling crash. The risk of a fatal crash is more than seventeen times higher for cyclists aged 75 and older than for younger cyclists (0 - 74 years old), and the hospital admission rate is more than four times as high as for younger cyclists. One explanation for the high casualty rate for older people is their physical vulnerability. Because their bones are more brittle and their soft tissues less elastic, they have a greater chance of more serious injury than younger people do, even when the crashes are of equal seriousness (Davidse, 2007; Evans, 2004; see also the SWOV Fact sheet *The elderly in traffic*.

Although young people (aged 12 - 17) account for a large part of bicycle crashes in absolute terms, it can be seen that the casualty rate is not extremely high for this group. On average, young people cycle more often than adults do and their bicycles form a larger proportion of their transportation (Wegman & Aarts, 2006). This can be explained by the fact that there are fewer alternatives for young people. As soon as they reach an age when alternatives such as mopeds and cars are available to them, they use their bicycles less often. This is also borne out by the number of cycling casualties – the number of cycling casualties amongst 18 - 24 year-olds is much lower.

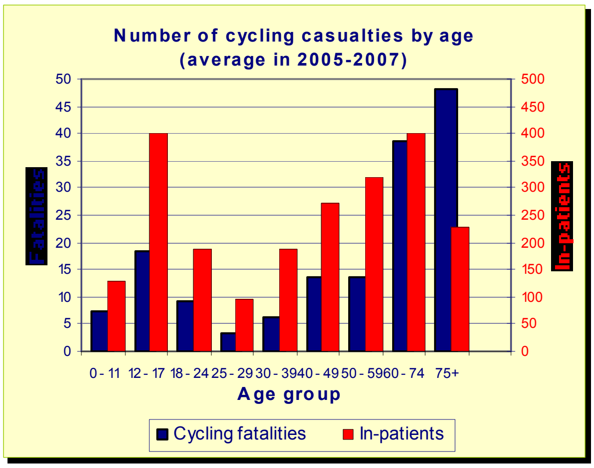

Figure 3. *Source: Ministry of Transport, Public Works and Water Management, BRON.*

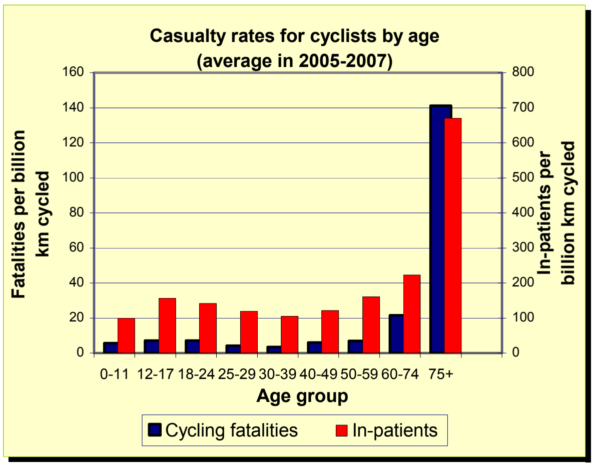

Figure 4. *Source: Ministry of Transport, Public Works and Water Management, BRON; MobiliteitsOnderzoek Nederland MON (Netherlands Mobility Research).*

Where do cycling crashes occur and what type of crash opponents are involved?
The majority (79%) of seriously injured casualties amongst Dutch cyclists during the period 2005-2007 resulted from a crash in an urban area; 67% of these occurred at intersections and 33% on road sections. The opposite is true for crashes on rural roads – most of the casualties (57%) occurred on road segments, and 43% of the casualties occurred at intersections. The most important crash opponents were cars (58%). The manoeuvre that most frequently precedes crashes between cyclists and cars is when both road users are going straight ahead and intersect without turning off (Schoon, 2003). Thus cyclists crossing at intersections is a dominant manoeuvre in cycling crashes. The SWOV Fact sheet *Crossing facilities for cyclists and pedestrians* deals with this in more detail.

Encounters between cyclists and lorries – which account for 4% of seriously injured cyclists – are of a different kind. They are often blind spot crashes, where the cyclist is in the lorry's blind spot and the driver cannot see him. The 'classic' blind spot crash occurs when a lorry driver executes a right-hand turn and does not notice the cyclist who is going straight ahead. Recent research has brought a second type of blind spot crash to light. This occurs when a lorry crosses a bicycle path (where cyclists have priority) at right angles and the lorry driver does not notice the cyclist. This situation occurs at priority intersections and when entering a roundabout. Both cases have occurred more frequently in recent years, possibly due to the increase in the number of two-way bicycle paths and the increase in the number of roundabouts in the Netherlands (Schoon, Doumen & De Bruin, 2008; see also the Fact sheet *Blind spot crashes*).

Schoon & Blokpoel (2000) examined the causes of bicycle crashes in which no other road users were involved. They identified the most frequent causes of cyclist-only crashes (e.g. where cyclists overturn or drive into a ditch) as the result of doing stunts (27%), catching a foot between the spokes (18%), and bicycle defects (13%). Where crashing into obstacles is concerned, these consist of hitting the kerb (36%) and posts (18%).

The limited visibility of cyclists due to bicycle lights not working (or being absent) is another possible cause of cycling crashes. Insufficient lighting or no lighting at all in twilight or darkness – 20% of cycling casualties result from crashes during twilight or darkness – means that motorists have difficulty in seeing cyclists. Figures provided by the former Transport Research Centre AVV show that 38% of cyclists have insufficient lighting or no lighting (AVV, 2007).

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 bicycle traffic. 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 concrete example of a measure which separates bicycle traffic from fast(er) traffic is called *Mopeds on the carriageway*. From 15 December 1999, in the Netherlands, mopeds have been moved from bicycle paths onto the carriageways in urban areas where the speed limit is 50 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 the positive expectations of this move (AVV, 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 undertaken in the past were aimed at stimulating the use of bicycles and improving the travelling speed and comfort of cyclists. Examples of this are the bicycle demonstration routes that were constructed in the Tilburg and The Hague municipalities in the 1980s. Priority regulations at intersections were adapted, and the routes were made recognizable for both cyclists and other road users. Other features of these bicycle routes are separate bicycle paths or service roads, asphalt or concrete surface, short waiting times/high priority at traffic lights, and street lighting. A so-called 'cycle street' can also be part of such a cycle route. A cycle street is a street in a residential area that functions as an important bicycle link, with the important feature that the car is subordinate to the bicycle (Andriesse & Ligtermoet, 2005; Fietsberaad 2004). The road safety benefit of a cycle route has yet to be demonstrated. If cycle routes are constructed according to Sustainable Safety principles, for instance by using separate bicycle paths, and if cyclists are 'bundled' (i.e. not spread over alternative routes), a positive road safety effect is to be expected. In practice many municipalities are in fact planning to construct cycle routes. Here it is important that they take measures at route level (a sequence of road sections and intersections), rather than at individual road section/intersection level.

Vehicles

Since 1 November 1979, approved red rear reflectors and (amber) reflectors on the pedals have been compulsory for bicycles in the Netherlands. From 1 January 1987, it also became compulsory to have white or yellow side reflectors on the wheels of bicycles. In the dark, Dutch cyclists must also display a white headlight and a red rear light.

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 more convex wide-angle mirror are compulsory for lorries in Europe. In 2002 and 2003 there were far fewer blind spot crashes than in previous years. In hindsight it would appear that this reduction in the number of crashes was not due to the effect of the blind spot mirror, but to the amount of attention given to lorry crashes at the time these mirrors were introduced (Schoon, Doumen & De Bruin, 2008).

Man

On 1 May 2001, the measure *Priority for cyclists and moped riders coming from the right* came into force. This meant the exception of cyclists, moped and light-moped riders, and other slow traffic regarding the general rule that 'traffic coming from the right has right of way' was abolished for junctions without any designated priorities. The introduction of the new priority rule was widely publicized in the *Pass it on, right has priority* campaign. A study by Van Loon (2003) has shown that this priority rule has had hardly any effect on traffic safety – there were fears beforehand that the number of crashes would increase. The number of priority crashes with injury has remained approximately the same, and the number of casualties amongst slow traffic (cyclists, and moped and light-moped drivers) has increased slightly.

The national campaign *Lights on – that'll get you home* of the Dutch Ministry of Transport was run in 2003 and 2004. Its aim was to maintain the positive attitude towards bicycle lights and reflectors, to increase the subjective chance of being caught riding without bicycle lights, to promote the use of bicycle lights, and to stimulate people to acquire or repair lights and reflectors in time. Behavioural measurements showed that between the first measurement at the beginning of 2003 and the last one in January 2007, the proportion of cyclists with working rear lights increased from 52% to 62%. The use of front lights increased from 57% to 74% (AVV, 2007).

The *Safe on the Way* project, a joint project of Transport and Logistics Netherlands and the Dutch Traffic Safety Organisation has been running since 1997. Primary school children are given theory and practical lessons on how to deal safely with lorries in traffic. Explicit attention is also paid to the blind spot.

The *Schools have just begun again* campaign asks road users to pay attention and be alert for cyclists in traffic after the summer holidays. Banners and posters call on motorists and other road users to take children returning to primary and secondary school into account.

What gains can still be achieved?
Many roads and streets have not yet been laid out in accordance with 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 (Berends & Stipdonk, 2009). 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*.

Any cyclist involved in a cycling crash, or who has a fall whilst cycling, runs the risk of head or skull injury; 30% of serious injuries to cyclists are head or skull injuries. Wearing a *bicycle helmet* reduces the severity of the injury. As serious head or skull injuries are the most frequent injuries amongst young casualties, the use of bicycle helmets is promoted in particular for children in the Netherlands. For more information see SWOV Fact sheet *Bicycle helmets*).

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. Cyclists land on a different part of the vehicle: whilst pedestrians mainly land on the bonnet, cyclists usually hit the windscreen. A sharpening of the test requirements is therefore desirable. One of the measures that would lessen serious and fatal injuries to cyclists considerably is an *airbag on the windscreen* (Rodarius, Mordaka & Versmissen, 2008; Schoon, 2003). This is particularly important for the Netherlands, because the large numbers of cyclists mean that many more vulnerable road users are involved in crashes with cars than in most other EU countries.

The application of Intelligent Transport Systems (ITS) can also contribute to the safety of cyclists. As cyclists are often involved in crashes with cars, they may also benefit from the introduction of ITS systems in cars, such as the Intelligent Speed Assistant (ISA), and night vision systems which improve vision in the dark and therefore ensure that cyclists are seen (more) quickly (Van Kampen, Krop & Schoon, 2005).

A sharpening of the guidelines for improved field-of-vision systems is required to reduce the number of blind spot crashes even further. The new front-view system that has been compulsory in Europe for new lorries since 2007 should also be made compulsory for lorries manufactured prior to 2007. Infrastructural and behavioural measures are also necessary to reduce the number of blind spot crashes. For instance, cyclists and lorries must be separated at locations where lorries can turn right. In the long term, there should be a structural division between heavy and light traffic. This can be achieved by only allowing heavy goods traffic on main road networks where, for instance, distribution centres are situated (Schoon, Doumen & De Bruin, 2008). Behavioural measures are desirable for both cyclists and the lorry drivers. For more information see the SWOV Fact sheet *Blind spot crashes*.

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.

Conclusion

In the Netherlands, most in-patients occur amongst cyclists aged 12-17 and cyclists aged 60-74. The crash rate per kilometre cycled is highest amongst over-75s. In the past, many measures were implemented, each of which has contributed to reducing the danger to cyclists. In order to further reduce the danger to cyclists, it is important to make the infrastructure safer for bicycle traffic, to stimulate the use of correct bicycle lights and bicycle helmets, and to introduce measures that are related to cyclists' potential crash opponents, such as closed side underrun protection (for lorries), safer car fronts, and the application of ITS systems.

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