SWOV Fact sheet

Cyclists

Summary
Cyclists are vulnerable in traffic. Relatively many 12-17 year olds and the 50 year olds and older are casualties. Most of the crashes involving cyclists occur on urban roads, often when a cyclist and car cross each other. Infrastructural measures that separate cyclists as much as possible from motorized traffic, vehicle improvements such as reflectors on bicycles and field of vision improving systems for lorries, and educational measures are aimed at lowering the cyclists' crash rates. Measures that can also improve cyclist safety are the cyclist helmet, closed side underrun protection for lorries, and Intelligent Transport Systems (ITS).

Background
The Netherlands is a country of cyclists. Practically every Dutchman has a bicycle and uses it regularly. An average Dutchman cycles about 850 kilometres a year; in Europe only the Danes cycle more. Besides walking, cycling is the most important mode of transport for young children, school children, and the elderly. Together with moped riders and light-moped riders, cyclists are a vulnerable group of road users because they are unprotected and mix with other traffic which drives much fast than they do. Collisions with other road users usually have the severest consequences for cyclists. This fact sheet deals with the cyclists' traffic problems and the effects of existing and several new measures.

How unsafe are cyclists in traffic?
The Registered Road Crash Database BRON of the Ministry of Transport's Transport Research Centre (TRC) shows that the number of registered cyclist deaths halved during the 1987-2005 period, i.e. from 311 to 151 a year (*Figure 1*). The annual number of in-patients also decreased during this period by almost a third, i.e. from 3093 in 1987 to 2186 in 2005. The number of cyclist casualties, just as the total number of casualties, also had a downward trend. During the 1987-2005 period the proportion of cyclist casualties varied between 17% and 23%. It is striking that the share of cyclist casualties has increased since 2002; this was caused by the fact that the decrease in the total number of casualties was larger than that of the cyclists. Seeing as about 7.5% of all kilometres travelled are travelled by bicycle, the proportion of cyclist casualties is relatively large.

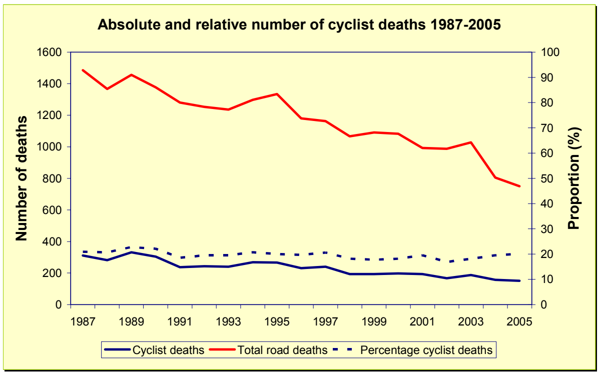

Figure 1. *Source: BRON (TRC).*

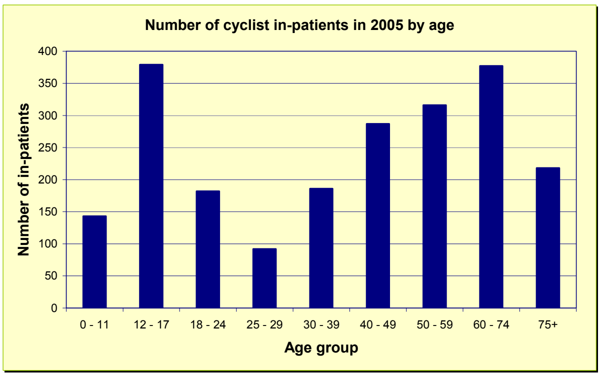

Figure 2. *Source: BRON (TRC).*

In 2005 the largest numbers of cyclist road deaths were those of 50 years old and older: 91 of the 151 deaths. The 12-17 year olds also have a relatively large number of deaths. Beginning with the age group 25-29 years old, in which the fewest deaths occur, the number of deaths per age group increases. With regard to the number of in-patients (*Figure 2*) the 12-17 year olds and the 60-74 year olds have the most.

Casualty rates
Casualty rates for 2005 were calculated by adding up the numbers of deaths and in-patients (the sum of which is called casualties) and dividing this sum by the number of kilometres cycled. This is expressed in casualties per billion kilometres cycled (*Figure 3*). The elderly cyclists, in particular the 75 years old and older, clearly constitute a high casualty rate group. Their rates are about six times greater than the average. An explanation for this is their physical vulnerability. Because their bones are getting more brittle and their soft tissues less elastic, they have a greater chance than the young of severe injury from a collision that is just as violent (Wegman & Aarts, 2005). Although in absolute numbers the 12-17 year olds are involved in many crashes, their casualty rate is not exceptionally great. On average the young cycle more often than adults and they use the bicycle for a large proportion of their exposure. This can be explained by the fact that there are fewer alternatives for the young. As soon as they reach the age of alternatives, such as mopeds and cars, their bicycle use decreases.

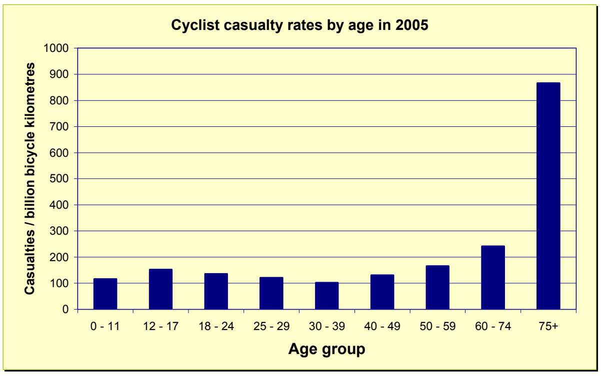

Figure 3. *Source: BRON (TRC); National Travel Survey (Statistics Netherlands).*

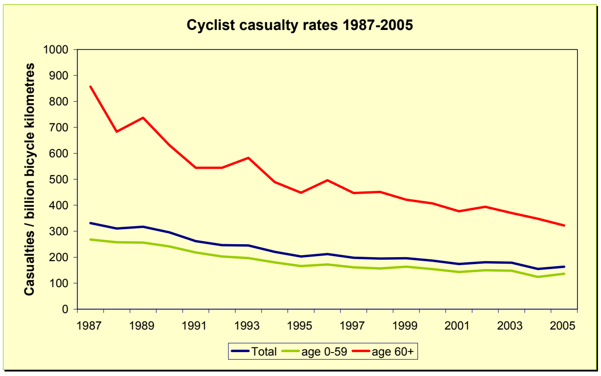

Figure 4. *Source: BRON (TRC); National Travel Survey (Statistics Netherlands).*

Figure 4 shows that the casualty rate gradually halved during the 1987-2005 period to 164 casualties per billion kilometres cycled. There has been a relatively large decrease in the casualty rate for older cyclists. Besides the casualty rate, Van Boggelen & Everaars (2006) use a collision opponent rate, defined as the chance of other road users being injured. For cyclists the casualty rate is more than three times greater than that of car occupants, but for the collision partner it is exactly the opposite; that of car occupants is more than three times greater than that of cyclists. If the casualty rate and the collision opponent rate are added up, a 'total rate' can be obtained. In order to obtain insight into the road safety consequences of a shift from car kilometres to bicycle kilometres in a particular municipality, Van Boggelen & Everaard (2006) compared the total rate of the car with the total rate of the bicycle. For those municipalities with a more or less equal balance between the total rates of car and bicycle, the road safety does not change. For those municipalities where the total rate for cars is larger than that for bicycles, a shift from car to bicycle kilometres leads to fewer casualties. This is the opposite of municipalities where the total rate for cars is smaller than that for bicycles: a shift from car to bicycle kilometres leads to more casualties.

Where and when do cyclist crashes occur?

The majority (78%) of cyclist casualties occurs in urban areas; 65% of these occurs on intersections and 35% on road sections. The opposite is true for crashes on rural roads: 58% occurs on road sections and 42% on intersections. Only 6% of the severely injured cyclist casualties occur in 30 km/hour zones, whereas 73% occur on 50 km/hour roads (Wegman & Aarts, 2005). In a year, the months of December to March have on average fewer cyclist crashes, and May/June and September/October have on average more. This reflects weather conditions which lead to fewer bicycle kilometres in the winter period.
Most of the cyclist crashes occur on weekdays (16% on each weekday), 11% on Saturdays and 8% on Sundays. With regard to the time of day, there are more 0-11 year olds at 14.00-19.00 crashes and fewer during the 7.00-10.00 morning rush hour. There are more young adults at 7.00-10.00 and 16.00-19.00 crashes. Crashes involving adults (25-64 years old) are more equally divided over the whole day. Those older than 60 years are more often involved during daytime, with a peak during 10.00-14.00.

What are the causes of cyclist crashes?
Of all injured cyclists 55% occurs in crashes with cars. The most common crash is one in which both car and bicycle are driving straight ahead and cross each other's path (Schoon, 2003). Cyclists crossing over is thus a dominant manoeuvre in the various crash types. The SWOV Fact sheet *Crossing facilities for cyclists and pedestrians* (SWOV, 2005) goes into greater detail. Many cyclists are also involved in side collisions when turning off. Schoon & Blokpoel (2000) conclude that the most common causes of bicycle crashes not involving any other road user (e.g. rollovers and landing in a ditch) are: stunting (27%), foot caught between the spokes (18%) and bicycle defects (13%); 36% consists of collisions with obstacles and 18% of collisions against poles. Van Kampen (1993) studied bicycles parked in racks and showed that they often have technical defects. For example, 30% did not have lights that worked well, 10% had poor brakes and 10% had a defect frame. It is difficult to objectively determine how much such defects contribute to crashes. The limited visibility of bicycles is possibly another cause of cyclist crashes. By not having good lights on a bicycle during sunrise and sunset (when 20% of cyclist casualties occur) it makes it difficult for motorists to see them. Crash data further show that red light running causes 7.5% of cyclist crashes.

What are the effects of measures in the Netherlands?
Road
An important way to lower the casualty rate of cyclists is to make the infrastructure safer for them. These infrastructural measures aim at separating cyclists as much as possible from motorized traffic, and at controlling the speed of motorized traffic in situations where they meet cyclists.

In 1990 the Minister of Transport presented the national *Bicycle Master Plan* to stimulate (safer) cycling. For 1995 two intermediate goals had been formulated: the number of injured cyclists had to be 10% and the number of killed cyclists had to be 15% less than in 1986. These intermediate goals were reached (VenW, 1998).

In the 1980s the municipalities of Tilburg and The Hague laid out bicycle demonstration routes. Adjustments in the priority ruling at intersections were made and the routes were made recognizable for both cyclists and other road users. Other features of these routes were: separate bicycle lanes or service roads, closed road asphalting, short waiting times and/or high priority at traffic lights and street lights. What is known as a 'cycle street' can also be part of such a cycle route. A cycle street is a street within a residential area that functions as an important bicycle link, with as important feature that the car is subordinate to the bicycle (Andriesse & Ligtermoet, 2005; Fietsberaad 2004). What has been studied is the road safety influence of bicycle demonstration routes in Tilburg and The Hague (Goudappel Coffeng, 1981; TNO, 1982). These studies showed that installing such a bicycle route had no road safety effect. What did happen was a shift in the crash types occurring: an increase in injury crashes only involving mopeds, bicycles and pedestrians and single vehicle crashes involving mopeds or bicycles, and a decrease in injury crashes between motorized vehicles and single motorized vehicle crashes. An assessment of a bicycle network in the municipality of Deft (Louisse, Ten Grotenhuis & Van Vliet, 1994) showed that neither bicycle use nor road safety had increased. The road safety benefit of a bicycle route has yet to be explained. If bicycle routes are laid out according to Sustainable Safety principles, e.g. by using separate bicycle lanes, and if cyclists are 'bundled' (i.e. not split along alternative routes) a positive road safety effect is to be expected. In practice, many municipalities have planned a bicycle route. To do this it is important to take measures at the route level (a connected number of road stretches and intersections), instead of at the road section-intersection level.

Vehicle
Since 1 November 1979 an approved rear mudguard reflector and (amber) reflectors on the pedals are obligatory. Since 1 January 1987 the white or yellow reflectors on wheels were added. Besides this, during the hours of darkness it's obligatory to have a white front light and a red rear light. Blokpoel (1990) calculated that bicycle *side reflection* resulted in a 4% casualty reduction among cyclists at twilight and darkness.
Schoon (2006) concluded that after the *introduction* of *field of vision improvement systems* on all lorries in the Netherlands per 1January 2003, there was a short-lived reduction of 30-50% in the number of cyclist casualties resulting from collisions in which the cyclist was positioned in the blind area of a lorry turning right.

Human
On 1 May 2001 the measure of *Priority cyclist from the right* was introduced. This meant the exception for cyclists, light-moped riders, moped riders and other slow traffic to the general rule that 'right has right-of-way' at equivalent intersections was repealed. The introduction of this new priority regulation was widely publicized by the *Pass it on, right has priority* campaign. A study of Van Loon (2003) showed that this measure has had hardly any road safety influence. The number of injury priority crashes has remained about the same and the number of casualties among cyclists, light-moped riders and moped riders has increased slightly.

The Ministry of Transport's national *Lights on, that'll get you home* campaign in 2003 and 2004 had as goal to maintain the positive attitude to bicycle lights and reflection, to increase the subjective chance of getting caught without bicycle lights, to promote the use of bicycle lights and to stimulate reparation or purchase of lights and reflectors in time. Observations showed that between the first observation in early 2003 and the last one in January 2006, the proportion of cyclists with rear lights that worked, had increased from 52% via 61% to 69%. Using front lights increased from 57% via 66% and 73% to 74% (Brink, 2006).

The *Safe on the Way* project, a joint project of Transport and Logistics Netherlands and the Traffic Safety Association, has been running since 1997. Primary School children get theory and practical lessons about the way in which they can deal safely with lorries. Children are inexperienced and can not yet judge certain situations. They also often do unexpected things that can be very life threatening in the vicinity of lorries. The goal of the project is to teach all primary school children unambiguously to act safely around lorries and other large vehicles.

The *Schools have just begun again* campaign also contributes to paying attention to cyclists in traffic at the end of the summer holidays. Banners and posters call on motorists and other road users to look out for children going back to primary school or secondary school. These campaigns have not been assessed. The current project *Effects of Traffic Education* (EVEO) provides insight in the effects of education as it does the related costs and benefits. A literature study of the effects of educative measures (Dragutinovic & Twisk, forthcoming) shows that effects are mainly measured in knowledge, attitudes, and self-reported behaviour, and rarely in the number of crashes. It is here assumed that safer behaviour leads to fewer crashes.

What benefits can still be gained?
Those who are involved in a crash or fall from a bicycle can incur skull or brain damage. Especially young children fall now and again from their bicycles without there having been a collision with another road user. Wearing a *bicycle helmet* lessens the injury severity. The helmet can also contribute to a bicyclist's visibility. Education should make parents more aware of the helmet's importance (Bloks et al., 2006). According to Lammar (2005) education linked to a bicycle helmet subsidy leads to a significant increase in helmet wearing. Together with education, a bicycle helmet law will have greater success in increasing its use and will provide the quickest and best results. Vijgen et al. (2005) describe the cost-effectiveness of the bicycle helmet and a number of studies that suggest that interventions can increase helmet use among the 3-15 year olds can be 40% or more cost-effective.

In the Netherlands the *front reflector* on a bicycle is not obligatory. A front reflector ensures that approaching bicycles are more conspicuous when it's dark. Using an accident analysis, Schoon & Polak (1998) determined that if all bicycles were equipped with a front reflector, about two deaths and a year could be saved. The number of casualties saved at this moment in time will not be greater because more cyclists have lighting that works in 2006 than in 1998. According to Schoon & Polak (1998) there is a negative cost-benefit of áll bicycles being fitted with front reflectors; installation of front reflection on néw bicycles has a positive cost-benefit.

A decrease of 8% in the number of bicycle casualties during the hours of darkness is to be expected if all cyclists were to carry both front and back light (Schoon, 2003). A measuring of lighting carried by cyclists (Brink, 2006) shows that 64% of the cyclists carries both front and back light. The effect percentage of 8% can be used to calculate that in 2005 one road death and ten in-patients would have been saved if all cyclists had carried lights.

Since 1 January 1995 it is obligatory for new lorries, trailers and semi trailers to be equipped with open *side underrun protection*. Such side protection prevents vulnerable road users from ending up under the wheels of a lorry. Closed side underrun protection reaches down lower (to the road surface) and this makes it more effective than open side protection. Van Kampen & Schoon (1999) estimate the effect of open side protection to be 25% fewer deaths and injured, and of closed side protection 35%.

For cyclists it is important that *car fronts* are constructed safer. This measure ensures that crashes are less severe. Since late 2003 the European Union (EU) regulations govern this apply. This is extra important for the Netherlands because, due to so many cyclists, 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 towards cyclist safety. Because cars are involved in most crashes with cyclists, it is therefore to be expected that introducing in-car ITS, such as Intelligent Speed Assistance (ISA), Collision Avoidance Systems (CAS), and night vision systems that ensure drivers can see cyclists in time, will improve also cyclist safety (Van Kampen, Krop & Schoon, 2005).

Conclusion

Cyclists are vulnerable in traffic. Relatively speaking, most of the cyclist casualties are 50 years old and older. In the past many measures were taken which each contributed to improving cyclist safety. To make it even safer, it is necessary to make the infrastructure safer for cyclists, to stimulate the front reflector, correct bicycle lighting and helmet wearing, and to introduce measures regarding the potential collision opponents of cyclists such as closed side underrun protection for lorries, safer car fronts and ITS applications.

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