SWOV Fact sheet

Risk in traffic

Summary
The most common way of measuring road safety is the number of road crashes and/or the number of casualties in such crashes. To compare the number of crashes in different groups, such as countries, modes of transport, or road types, we can relate the number of casualties to mobility. In this method the casualty rate is determined, which is the number of casualties per distance travelled. The casualty rate not only looks at the number of casualties in a specific group of road users, it also takes the into account the distance travelled by that group. The fatality rate of car occupants has been decreasing in the Netherlands since the 1970s. Moped and light moped riders and motorcyclists have relatively high fatality and injury rates. In addition, young people and especially the elderly are at above-average risk. While casualty rate is the most common measure, other methods of expressing safety are, for example, mortality (fatalities per resident), or number of fatalities per motorized vehicle.

Background
Nearly everyone in the Netherlands participates in traffic virtually on a daily basis. This is one of the reasons that road safety concerns all individuals. The most common measure used to define the level of road safety is the number of road crashes and/or the number of casualties in such crashes. However, mobility is a major factor in the number of road casualties: the longer or more frequently people travel, the more one is exposed to the danger of road crashes. It is therefore necessary to consider the risk in traffic. This fact sheet first defines exactly what we mean by 'risk', before proceeding to a discussion about how the fatality rate and injury rate in traffic have developed in the Netherlands, both overall and for different subgroups (modes of transport, age groups) in traffic. Finally, the fact sheet will briefly discuss some other measures to express road (un)safety.

Why use casualty rate as a measure of road safety?
The number of road crashes or the number of road crash casualties are the most commonly used measures of lack of road safety. However, there are limitations to this method. Imagine, for instance, that every year 500 road crash casualties occur in each of two different countries. If the distance travelled in one of the countries, or its number of residents, is twice that in the other country, the countries' respective levels of traffic safety are not the same per se. The degree to which people participate in traffic is also an important factor. It is therefore necessary to consider not only the number of road crashes or casualties, but also the number of crashes or casualties per distance travelled, in other words the risk of a road crash per part of the road travelled. The concepts fatality and injury rate correct the casualty numbers somewhat for differences in distance travelled. This fact sheet addresses the objective – that is, observed – road safety. In the Netherlands, the subjective factor, the way in which road safety is perceived, is also considered to be of increasing importance; see SWOV Fact sheet *Subjective safety*.

How is risk in traffic defined?
To discuss 'risk' in traffic, it is necessary to define exactly what is meant by the term. A distinction can be for example made between the risk of a crash, the risk of a fatality or the risk of a serious road injury. This fact sheet will focus on the 'risk' of casualties in traffic and will therefore not go into the risk of a crash. One of the reasons for this choice is that more data is available on casualties (fatalities and serious road injuries). Information about the development of the number of road crash casualties and the precise definitions of fatality and serious road injury can be found in the SWOV Fact sheets *Road fatalities in the Netherlands* and *Serious road injuries in the Netherlands*. Furthermore, we must also decide how to relate the number of fatalities or serious road injuries to the distance travelled. In other words, which standard can express the exposure to potentially dangerous traffic? If no mobility data is available, other data – such as vehicle fleet numbers, population size, distance travelled in motor vehicles – can be used to replace mobility. In this case one presumes that the mobility per motor vehicle (when using vehicle numbers) or mobility per person (when using population size) is constant.

When motor vehicle mobility is used, mobility by bicycle or on foot is assumed to be negligible, while this is not always the case. Therefore, these alternatives are not preferable for comparing casualty rates (see for example Hakkert & Braimaister, 2002; Yannis et al., 2005).

We therefore define the casualty rate, as the quotient of the number of fatalities or serious road injuries and the distance travelled; in other words, the casualty rate is the number of casualties per distance travelled. This fact sheet is makes use of not only the registered casualties, but of the estimated real numbers of casualties, both fatalities and serious road injuries (*Figure 1* forms an exception to this, as real numbers of fatalities are only known from 1996 onwards). Since it relates best to casualty numbers, traveller mobility was used as much as possible to determine the distance travelled. Other measures for evaluating road safety are discussed briefly at the end of this fact sheet.

At a national level, road safety can therefore be expressed by using the casualty rate which is calculated by dividing the total number of road casualties in a given period by the total mobility on Dutch roads in the same period. However, there may be considerable differences in casualty rate between various subgroups in traffic, for instance between different age groups or between different modes of transport. To make these differences visible, we will also give the casualty rate per subgroup, for instance (for mopeds) the number of moped casualties divided by the associated moped mobility.

What is the casualty rate in traffic in the Netherlands?

According to the definition provided in the previous section, the casualty rate in the Netherlands is determined by the number of road casualties and their mobility. More information about the number of casualties and mobility can be found in the SWOV Fact sheets *Road fatalities in the Netherlands*, *Serious road injuries in the Netherlands*, and *Mobility on Dutch roads*.

First an overall picture will be provided of the casualty rate in Dutch traffic from 1950. Only the number of fatalities has been reliably recorded for this extended period. For the years prior to 1985, only data on motor vehicle mobility is available. Data on non-motorized traffic is not available (see also the SWOV Fact sheet *Mobility on Dutch roads*). In addition, it must be remembered that, certainly in the 1950s, traffic was not yet dominated by the car as is the case today. The quotient of the total number of road casualties and total motor vehicle mobility would therefore present an inaccurate picture of the casualty rate. For this reason, only the fatality rate for car occupants is presented to illustrate the fatality rate development in traffic since 1950 (see *Figure 1*).

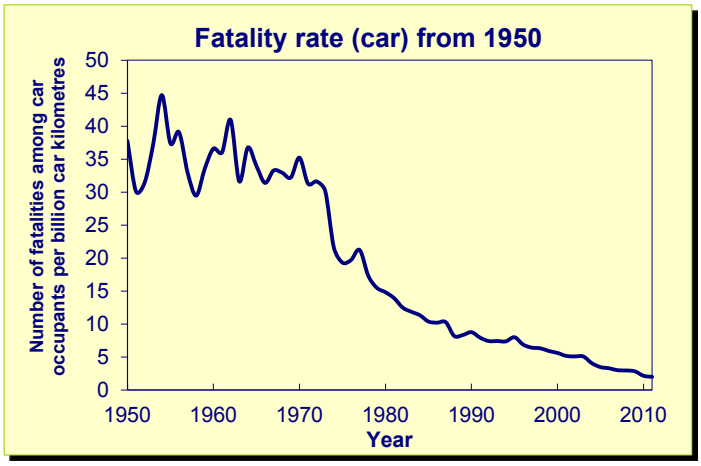

Figure 1. *The fatality rate for car occupants (number of fatalities among car occupants per billion car km) in the Netherlands for the period 1950-2011. Sources: mobility: Statistics Netherlands (CBS); fatalities: Ministry of Infrastructure and the Environment (IenM), based on registration by police.*

Although the number of fatalities increased sharply in the period 1950-1970 (see SWOV Fact sheet *Road fatalities in the Netherlands*), *Figure 1* indicates that the fatality rate for car occupants – with some fluctuations – remained more or less constant during this period. It is also apparent that the fatality rate has been decreasing virtually continuously since the 1970s. This decrease is approximately 5.8% per on average and is the result of, among other things, measures concerning

infrastructure, vehicle safety and law enforcement. Increasing driver experience from 1970, following an explosive growth of car traffic until 1970, may also have contributed to the decrease in the fatality rate (Vlakveld, 2011). However, this decrease exhibits considerable variation between successive years. This may be the result of both irregular shifts in mobility and changes in risk. Statistical variance in both the number of fatalities and mobility also plays a role in risk variation between the years.

What are the differences in fatality and injury rate for the different modes of transport?

There are considerable differences in fatality and injury rates between the different modes of transport. *Figure 2* shows the number of fatalities and the number of serious road injuries per distance travelled for the different modes of transport. At present, data of more than 20 years is available for the number of fatalities. However, due to a decreased quality of crash registration by the police, data on injuries are no longer available from 2010 onwards.

The fatality rate has declined for all modes of transport. This is not the case for the serious injury rate; in recent years this has increased for cyclists, moped riders and motorcyclists. However, there turns out to be a clear difference in rates between cyclists in crashes involving a motor vehicle and cyclists in crashes not involving a motor vehicle (not shown in the figure); the injury rate among cyclists is higher for crashes not involving a motor vehicle. Furthermore, there is also a difference in the development of these rates. Since 2000, the injury rate among cyclists in crashes involving motor vehicles has remained approximately the same, whereas since that year the injury rate for crashes not involving motor vehicles has seen a considerable increase with a factor of 1.5.

The fatality and injury rates for road users riding motorized two-wheelers, motorcycles as well as mopeds, are high compared to the rates for car occupants; the fatality rate is higher by a factor of about 25. The serious injury rate for motorcyclists is more than 50 times higher than the rate for car occupants, whereas the serious injury rate for moped riders is even more than 100 times higher.

In 2011, there were 2 fatalities per billion km travelled among car occupants. In 1990s, there still were 5 fatalities per billion km. During the past ten years, a decrease in the fatality and injury rates can also be seen for pedestrians. With less than two serious road injuries per billion km travelled, public transport by bus, tram and underground, (not included in *Figure 2*) has the lowest fatality and injury rates.

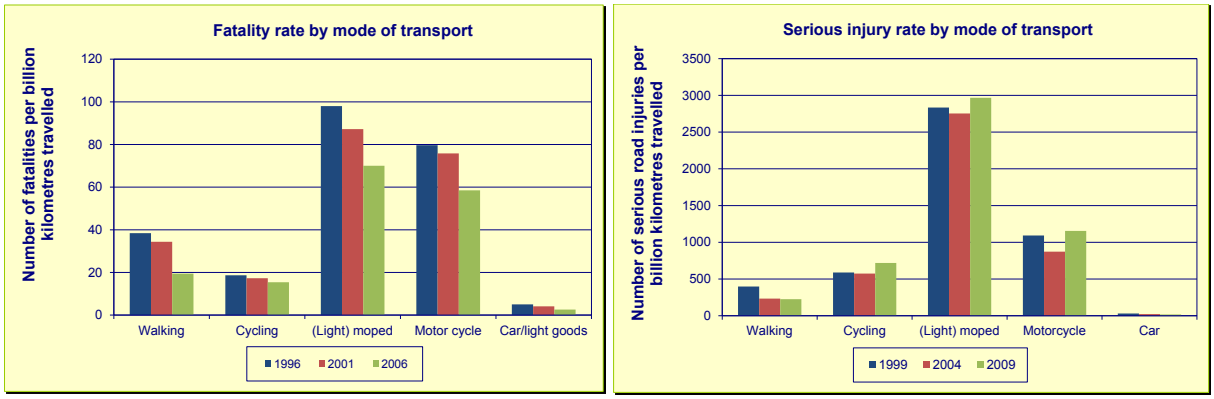

Figure 2. *Numbers of fatalities and number of serious road injuries per billion km travelled in the Netherlands for different modes of transport. Sources: Statistics Netherlands (CBS), Ministry of Infrastructure and the Environment (IenM), Dutch Hospital Data (DHD) and SWOV.*

For more information about road users with specific modes of transport, please see the SWOV Fact sheets *Pedestrian safety*, *Cyclists*, *Moped and light-moped riders* and *Motorcyclists*.

What are the differences in fatality and injury rate for different age groups?

In addition to subdividing according to mode of transport, subdivision according to age group can also give insight into the fatality and injury rates for different groups of road users. *Figure 3* shows the numbers of fatalities and serious road injuries per billion km travelled for the different age groups up to and including 2009. For later years, no data by age group is available of serious injuries. The first thing to note in the figure is that the fatality rate in road crashes is approximately four times higher for those

aged 75 and over, than the average of all age groups together. The injury rate due to road crashes is approximately three times higher for both those aged 75 and over, than that of the average road user. For young people (aged 12-17), this rate is approximately double the average.

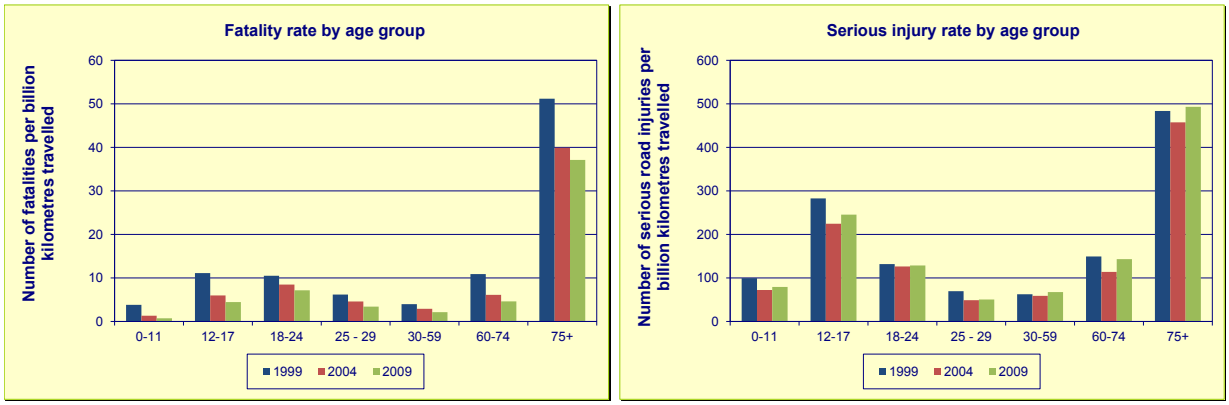

Figure 3. *Numbers of fatalities and serious road injuries in the Netherlands per billion km travelled for different age groups and for 1999, 2004, and 2009. Sources: Statistics Netherlands (CBS), Ministry of Infrastructure and the Environment (IenM), Dutch Hospital Data (DHD), and SWOV.*

The higher rates for the elderly (aged 75 and over) stem mainly from their greater physical vulnerability and functional disorders (more information can be found in SWOV Fact sheet *The elderly in traffic*). The higher rate for younger people is strongly linked to the start of their independent participation in motorized traffic. Relative to other age groups, young people aged 16 and 17 frequently use mopeds, a high-risk mode of transport in comparison with other modes.

As we saw in the previous section, the differences in fatality and injury rates between the various modes of transport are fairly large. Moreover, the distribution over different modes of transport may vary per age group. It would therefore be useful to also categorize the rates according to mode of transport when categorizing on the basis of age group. *Figures 4* and *5* show the fatality and injury rates for car occupants and cyclists categorized by age group. After 2009, too little data on injury crashes has been registered by the police to make reliable estimations.

Car occupants aged 18-24 and 75 and over have higher fatality and injury rates than other age groups (*Figure 4*). The higher rates for the 18-24 age group coincides with their novice driver participation in traffic. Furthermore, a decrease in the fatality and serious injury rates for car occupants can be seen for all age groups.

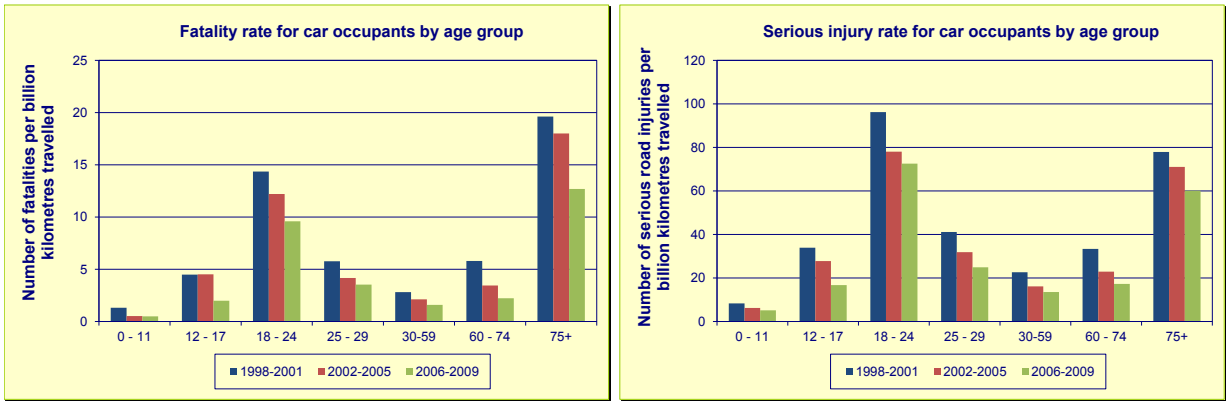

Figure 4. *Numbers of fatalities and serious road injuries among car occupants per billion km travelled by car in the Netherlands for different age groups. Sources: Statistics Netherlands (CBS), Ministry of Infrastructure and the Environment (IenM), Dutch Hospital Data (DHD), and SWOV.*

Among cyclists, the over-75s in particular have higher fatality and injury rates (*Figure 5*). To a lesser extent the age group 60-74 also have increased fatality and injury rates. The high rates can be explained by the increased vulnerability of elderly road users.

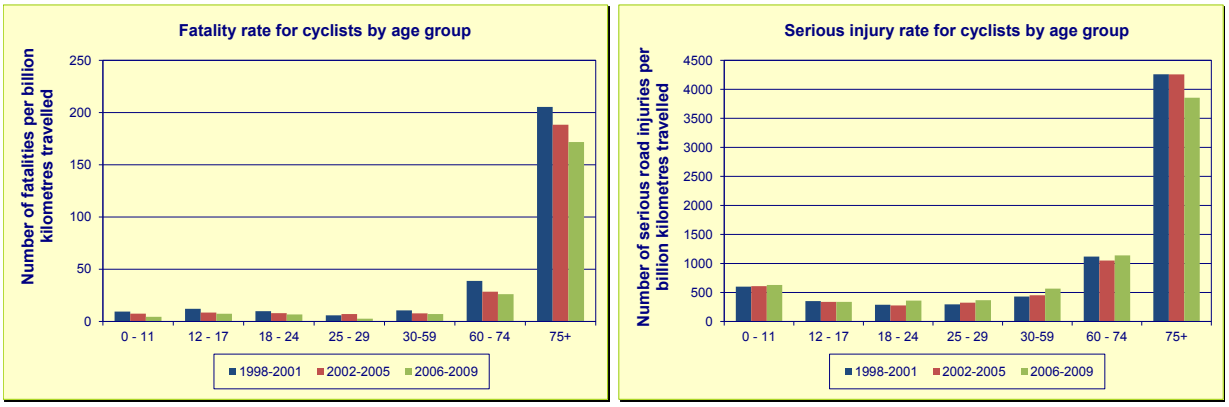

Figure 5. *Numbers of fatalities and serious road injuries among cyclists per billion km cycled in the Netherlands for different age groups. Sources: Statistics Netherlands (CBS), Ministry of Infrastructure and the Environment (IenM), Dutch Hospital Data (DHD), and SWOV.*

For more details about fatality and injury rates by mode of transport and age, see SWOV (2007).

What are the differences in fatality and injury rate according to road type?
Unfortunately, due to insufficient data on traveller mobility on different road types, it is not possible to determine differences in rates according to road type (see SWOV Fact sheet *Mobility on Dutch roads*). There are estimates, but these are considered to be insufficiently reliable. Data that is available indicates, among other things, that, in 1986, the number of fatalities per distance travelled by motor vehicles on motorways and trunk roads was around four times lower than it was on roads with a speed limit of 80 km/h (Koornstra, 1998).

Do fatality and injury rate also depend on the type of crash opponent?
In two-vehicle crashes the fatality and injury rates also depend on the opponent's mobility. After all, if the passenger car mobility increases, cyclists will encounter more cars and there will be an increase in cyclist casualties in bicycle-car crashes. Furthermore, there may be considerable differences in casualty rate between different conflict categories, such as differences in the risk of being a cyclist in a bicycle-car crash or in a bicycle-bicycle crash. A car occupant, for example, has a greater risk of dying in a single-vehicle crash than in a collision with another car (SWOV, 2007). Taking the characteristics of a (potential) opponent into account in addition to those of casualties can therefore be worthwhile in road safety studies. For more detailed information per type of conflict, see, for example, Stipdonk & Reurings (2010).

Are there other ways to express road safety?
For a variety of reasons, however, it can be meaningful to consider alternative measures of distance travelled (Hakkert & Braimaister, 2002; Yannis et al., 2005). To begin with, insufficient mobility data may be available, thus necessitating the use of an alternative. Fairly sound data on mobility has been available in the Netherlands since the 1980s. However, this is unfortunately not the case in many other countries. Therefore, alternatives are generally used for comparisons between different countries (see also the SWOV Fact sheet *International comparability of road safety data*).

Furthermore, for specific issues, mobility may not be the best choice of measure to relate the number of crashes to. This is, for example, the case if one, as a tourist, wants to compare the a priori fatality rate in different countries, or if one wants to compare the various causes of death (criminality, traffic, sports). The fatality risk (mortality) per person will then be a better measure.

In the case of insufficient reliable figures on mobility, the number of vehicles and sales figures for fuel can be used as alternative measures of mobility (see also SWOV Fact sheet *Mobility on Dutch roads*). These alternatives can therefore also be used as an alternative for distance travelled in the calculation

of fatality and injury rate in traffic. A disadvantage of these alternatives is that they cannot account for slow traffic such as pedestrians and cyclists.

Furthermore, the number of casualties per road length is used as a road safety measure. This is also referred to as the casualty density. This measure is mainly used on a local level; that is, for a certain road or road section. Finally, the total time spent in traffic rather than distance travelled can be used to measure the level of exposure to risk. Comparisons using number of casualties per unit of time can be especially relevant when comparing with activities other than traffic participation (see also ETSC, 1999).

Mortality rate as an alternative for fatality and injury rate
The number of fatalities per inhabitant is also referred to as the (traffic) mortality. In addition to international comparisons, this measure is also used to make comparisons between developments in the rates of various causes of death. *Figure 6* shows the traffic mortality rate in the 27 EU countries, of course if data was available on this. In recent years, the mortality rate appears to vary between a little more than 20 fatalities per million inhabitants to around 100 per million in recent years. The number of injuries per inhabitant is called the morbidity.

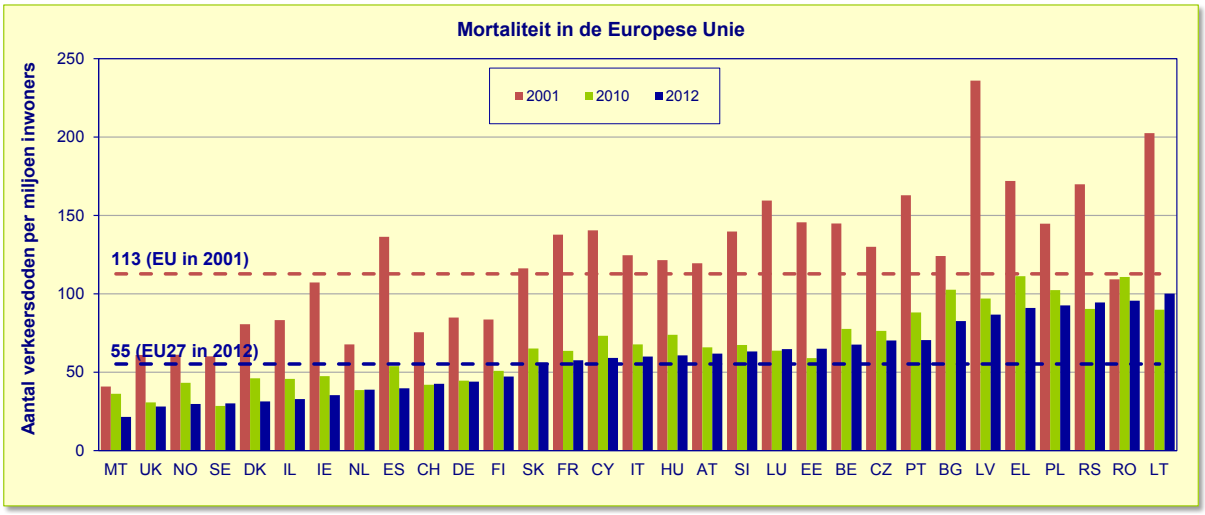

Figure 6. *Traffic mortality rate (number of fatalities per million inhabitants) in the EU27 (ETSC, 2013).*

Developments in the mortality rate of different age groups in the Netherlands are shown in *Figure 7*. The traffic mortality rate decreased for all age groups in the last twenty years. This rate was lowest throughout that period for children aged 0-11. Like the fatality and injury rates in traffic, the mortality rate is highest in the 18-24 and the over-75s age groups. In specific cases it is also possible to consider the segment of the population with driving licences rather than the total population.

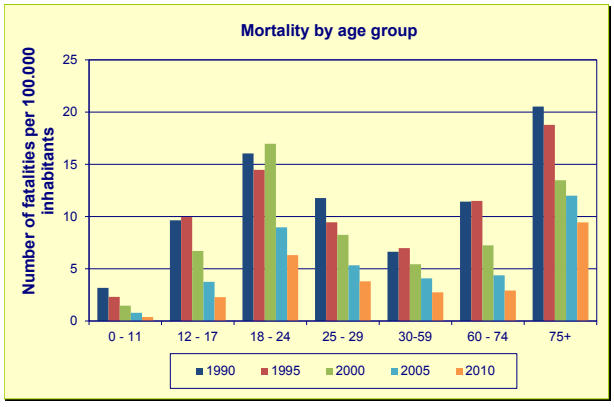

Figure 7. *Traffic mortality rate (number of fatalities per 100,000 inhabitants) in the Netherlands for different age groups and for five different years since 1990. Sources: Statistics Netherlands (CBS), Ministry of Infrastructure and the Environment (IenM).*

Conclusion

Road safety can be expressed in terms of numbers of crashes or casualties as well as in terms of risk expressed in fatality and injury rate. In addition to the number of casualties, risk also takes the distance travelled in traffic into account. Risk is defined as the casualty rate: the number of road casualties (fatalities and serious road injuries) per km travelled. For car occupants, the fatality rate in traffic has been decreasing in the Netherlands since the 1970s. The fatality rate and injury rate according to mode of transport are relatively high for moped/light moped riders and motorcyclists in particular. In addition, both the elderly, due to their greater vulnerability and functional disorders, and young people, as novice participants in motorized traffic, have above-average rates. In recent years, the injury rate has increased considerably for bicycle crashes in which no motor vehicle is involved.

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