

## Fatigue in traffic: causes and effects

### Summary

The role of fatigue must not be underestimated when studying the causes of crashes. Driver fatigue crashes are not only a matter of having spent too long behind the wheel; fatigue can also be caused by too little sleep, stress, or time of the day. According to a conservative estimate based on studies abroad, driver fatigue is involved in 10-15% of all severe crashes.

Although technical aids that prevent fatigue crashes are being developed, they are not yet ready for use. In the road haulage industry, the only means that are presently available to combat fatigue crashes are a) consistently applying (and enforcing) the driving and resting hours and b) a safety culture. Information campaigns should make non-professional car drivers aware of the risks of fatigue. This fact sheet will discuss the factors that play a role in driver fatigue.

### What is fatigue?

There is no clear definition of fatigue. The term is attributed with various meanings: physical (e.g. as a result of heavy and protracted physical labour) and neurobiological (biologically determined sleep-awake rhythms). In addition, it also has a mental/psychological meaning: not having the energy to do something, and a subjectively experienced reluctance to continue with a task.

### What causes fatigue?

Fatigue has many causes. It used to be directly and almost exclusively associated with the amount of time that one has been carrying out a particular task (time-on-task). It is still seen as one of the most important causes. However, research has shown other factors that are equally important.

1. In the first place, fatigue is a lack of sleep. This can be *chronic* or *acute*.
  - A *chronic lack of sleep* is the result of not having enough sleep during a long period. The average person needs 8 hours of sleep in every 24-hour cycle. The quality of the sleep is also of great importance, besides the quantity. If sleep is regularly interrupted, this leads to a chronic lack of sleep, just as too little sleep does. The quality of sleep is influenced by, among other things, sleep disorders like sleep apnoea (a temporary breathing stoppage while sleeping) or narcolepsy (the tendency to suddenly fall asleep). But it can also be a side effect of chronic diseases and/or medication or the result of external factors such as a noisy or unpleasant sleeping environment.
  - An *acute lack of sleep* is also the result of too little sleep, but is less structural than chronic lack of sleep. An acute lack of sleep can occur after just *one* bad or short night. If there has been too little sleep during a 24-hour period, we refer to it as a partial, acute lack of sleep. There is a complete, acute lack of sleep if there has been no sleep at all in a period of 24 hours.
2. Fatigue or sleepiness can also occur without lack of sleep. This type of fatigue is usually linked to the daily sleep cycle or the biorhythm. This means that at certain times in the 24-hour cycle the human body has a greater need for sleep than at other times. This happens most and lasts longest early in the morning (approximately between midnight and 4 a.m.) and, to a lesser extent, about 12 hours later (approximately between 2 p.m. and 4 p.m.). At these moments, there is a natural tendency to sleep and, if this cannot be given in to, a sleepy feeling occurs.
3. The following factors have indirect influence: age, physical condition, the use of alcohol, drugs and/or medicine, external factors such as temperature, noise, vibrations, and also the routine of a task. For example, driving alone on a boring road for a long time may not itself cause fatigue or sleepiness, but it can cause the consequences to manifest sooner.

### **How often does fatigue occur?**

As fatigue has many causes, it seems valid to conclude that everybody is very tired once in a while. The questionnaire and interview survey show that about 30% of the population is very tired regularly. The estimation is that about 10% of the population suffers from a serious type of sleeplessness. About 3% of the population suffers from a sleep disorder, of which sleep apnoea is the most common.

Many studies have shown that fatigue while driving a car is also a very frequent phenomenon. Approximately 25% of all drivers, professional as well as non-professional drivers, say that they have at least once fallen asleep behind the wheel; about 50% say they have sometimes been very tired while driving or to have nearly fallen asleep.

### **What in general are the effects?**

Fatigue leads to a reduction in alertness, longer reaction times, memory problems, poorer psychometric coordination, and less efficient information processing. Fatigue also has an effect on the frame of mind. The motivation to carry out a task diminishes, the communication and interaction with the surroundings deteriorates, and one gets irritated quicker and reacts more aggressively towards people and things. In other words, fatigue leads to diminished action capability and action preparedness.

All the above-mentioned functions are important for carrying out the driving task accurately and safely. It can, therefore, be expected that fatigue also leads to a worsening of carrying out the driving task. Various studies have indeed shown this to be the case. Such research generally involves a driving simulator in which subjects either drive a long distance or are not allowed to sleep for a long time. The results of this type of study are reasonably uniform. In the first place it was found that tired people have more problems in keeping their lane, more often cross or nearly cross the side marking, and make greater steering adjustments and do so more abruptly. The drivers also react less accurately to deceleration by the driver in front.

In spite of this, the car driver appears to be capable of adjusting to the circumstances. For example, it has been found that the task performance deteriorates less when the task gets more difficult or more dangerous, for example in road bends, when an oncoming vehicle approaches, or when a vehicle in front suddenly brakes. In addition, there are also indications that a driver compensates fatigue. Initially, this is done by increasing the task demands by, for example, driving faster. Next, as fatigue increases, the task demands are decreased by driving slower and keeping a longer distance to the vehicle ahead. It must however be observed that people in a hurry use compensation in the form of lower task demands much less frequently.

### **What is the role of fatigue in road crashes?**

The next question is whether fatigue also plays a role in the occurrence of road crashes. The answer is an unambiguous 'yes'. However, the question of to what extent this is the case, is much more difficult to answer. As opposed to, for example, the use of alcohol, drugs and/or medicines, it is by no means simple to determine the extent of fatigue in an objective way and it must be estimated in a much less direct way. The police crash reports indicate that 1-4% of all registered crashes are sleep-related. In the Netherlands, the police give sleep/fatigue as the primary cause in approximately 0.3% of all registered serious crashes. However, it is highly likely that these police reports greatly underestimate the problem. In most countries, police are not (yet) very alert to fatigue as the crash cause. Besides, most normal healthy drivers will not simply admit that they were very tired or had fallen asleep at the time of the crash. In addition, the crash itself will have caused most of the symptoms of fatigue to disappear.

The questionnaire study and in-depth crash analyses have led to completely different conclusions about fatigue's role in road crashes. Based on these methods, estimates of the percentage of sleep-related crashes vary greatly, but are 10-25% higher than can be concluded from police reports. The higher percentages have particularly been found in studies that examined lorry crashes and/or fatal crashes. All these estimates are from studies outside the Netherlands. As far as we know, no such estimates of the size of the problem have yet been made for the Dutch situation. However, if we extrapolate the above estimates for the Netherlands, and start of from a conservative estimate of 10-15%, there are 700-1000 registered, severe crashes a year that are (partly) related to fatigue or falling asleep behind the wheel. These are fatal or in-patient crashes not involving alcohol.

A limited number of studies has also examined whether fatigue leads to a greater chance of being involved in a crash. These show that people with a sleep disorder and people with an acute lack of sleep have a considerably larger (3-8x) risk of being involved in an injury crash.

### **Which road users have the highest risk?**

Most of the fatigue crashes occur on trunk roads and motorways, during the late evening and early morning under good circumstances, when the driver has spent a considerable length of time on the road. The result is that one either goes off the road or has a frontal collision with an oncoming vehicle. The consequences are usually very severe: one brakes too late so that the collision speed is fast. Some road user categories are relatively often involved in fatigue-related crashes. These are:

- people younger than 25 years old;
- people with sleep disorders;
- people who drive at night;
- long distance drivers;
- professional drivers;
- people who work in shifts.

### **What are the possible measures?**

Until now, contrary to, for example, alcohol, it has been impossible to fix a legal limit of the extent of fatigue that permits further traffic participation that can be enforced by the police. This makes it difficult to determine measures that can be taken in the short term. This is certainly the case for the ordinary, non-professional driver. There are slightly more possibilities for professional drivers because they can be dealt with by laws and regulations, often via haulage companies.

#### *Haulage companies*

- First of all, they offer the possibility to use rules to set maximum driving and minimum resting hours that take the human need for rest and sufficient night time sleep adequately into account.
- Then, of course, the haulage companies have to plan the work in such a way that chauffeurs can really adhere to the rules. Compliance control of these rules remains important. In addition, haulage companies should also take their responsibility of informing their drivers about the causes and results of fatigue.
- With regard to the occurrence of fatigue, the influence of personal living circumstances (life style) of individual drivers and their own responsibility should not be forgotten.
- Also screening drivers chauffeurs for sleep disorders, especially sleep apnoea, may be considered a task of the haulage companies.
- The so-called Fatigue Management programmes, especially in Australia and the United States, are based on these starting points, but also the ideas about a Safety Culture for haulage companies fit into this. This concept is gradually getting more attention in the Netherlands.

#### *Ordinary, non-professional drivers*

At this moment in time, the possibilities of measures aimed at drivers in general concentrate mainly on giving information about causes, effects, fatigue symptoms, and advice about possibilities of limiting (if only temporarily) the effects of fatigue. This can at least increase the awareness of the role of fatigue in road safety, which is a precondition for changing behaviour. In itself, however, it is too small a step. An example is the Dutch information campaign 'Don't become a sleepdriver' which was launched in 2008.

#### *Infrastructural measures*

With regard to infrastructure, rumble strips in the longitudinal direction are already being used to warn drivers audibly and kinetically if their vehicle is about to go off the road. Experiments are being carried out with Lane Departure Warning Systems, a technologically more advanced system, but with the same purpose. In addition, roadside barriers and obstacle-free zones beside the road are also very important for limiting the consequences of the typical fatigue crash, viz. going off the road (see also the SWOV fact sheet [Safe road shoulders](#)).

#### *New developments: automatic fatigue detection systems*

Various national and international studies are working on the development of intelligent detection and warning systems. Such a system automatically detects whether a driver is tired. The idea is then that the system makes the driver aware of the tiredness, possibly advises him what to do, and undertakes action to keep the driver awake, or even make further driving impossible. These are promising

developments, but will not lead to large-scale use in the short term. A number of technical problems (how can fatigue best be detected) and matters of principle (when and how should such a system intervene) need to be solved first. It is important to follow the developments and, if possible, facilitate them. We should already now be thinking about the way in which such systems can be implemented in due time.

## Conclusion

Based on the data in the literature it can be concluded that fatigue has many causes and that everybody is bound to drive occasionally while very tired. Another conclusion is that fatigue has a negative effect on the driving skill and road safety. Therefore, fatigue in traffic is not just a safety problem for 'large' countries and not just a problem for professional drivers. Presently, there are few possibilities of preventing fatigue related crashes. Both ordinary drivers, as well as professional drivers and their employers, should be aware of the causes of fatigue and its road safety effects. The haulage companies can make this part of a Fatigue Management programme, for example within the pursuit of a Safety Culture. Automatic in-vehicle detection and warning systems may be possibilities for the future.

## Publications and sources (the Dutch SWOV report contains an English summary)

AVV (2006). [Naar een nieuwe aanpak van vermoeidheid in het verkeer](#). Adviesdienst Verkeer en Vervoer AVV, Directoraat-Generaal Rijkswaterstaat, Rotterdam.

Brookhuis, K.A. (2001). [Vermoeidheid in het Europese goederen en personenvervoer: initiatieven in Europa](#). Experimentele & Arbeids Psychologie, Rijksuniversiteit Groningen, Groningen.

ETSC (2001). [The role of driver fatigue in commercial road transport](#). European Transport Safety Council ETSC, Brussels.

Hoekstra, E. & Zutphen, R. van (2005). [Quick scan vrachtauto-ongevallen op het hoofdwegennet](#). Verkeerscentrum Nederland, Utrecht.

Jettinghoff, K., Starren, A., Houtman, I. & Henstra, D. (2005). [I love uitgerust achter het stuur!? Vermoeidheid in het verkeer: maatregelen in het buitenland en hun toepasbaarheid in Nederland](#). Twijnstra Gudde, Amersfoort.

NHTSA (2001). [Drowsy driving and automobile crashes](#). National Highway Traffic Safety Administration NHTSA, Washington DC.

Nordbakke, S. & Sagberg, F. (2007). [Sleepy at the wheel: Knowledge, symptoms and behaviour among car drivers](#). In: Transportation Research Part F, vol. 10, nr. 1, p. 1-10.

Schagen, I.N.L.G. van (2003). [Vermoeidheid achter het stuur; Een inventarisatie van oorzaken, gevolgen en maatregelen](#). R-2003-16. SWOV, Leidschendam.

Vanlaar, W., Simpson, H., Mayhew, D. & Robertson, R. (2007). [Fatigued and drowsy driving: A survey of attitudes, opinions and behaviors](#). In: Journal of Safety Research, vol. 39, nr. 3, p. 303-309.