TØI report 440/1999
Authors: Fridulv Sagberg, Alf Glad
Oslo 1999, 54 pages Norwegian language

Summary:

Traffic safety for the elderly: Literature study, risk analyses, and assessment of safety measures

The proportion of elderly people in the population is rapidly increasing. In addition, the proportion of license holders among the elderly is also increasing. When considering the fact that several capabilities assumed to be important for safe traffic behaviour show considerable impairment with increasing age, it seems pertinent to raise the question of whether the increased number of elderly road users may imply an over-proportionate increase in the number of road traffic accidents.

Two different aspects of elderly road users' risk are addressed here. First, we consider the question of the *risk of being injured* in traffic among different road user groups (pedestrian, bicyclists, car occupants, public transport patrons, etc). Second, we discuss the *risk of accident involvement among elderly car drivers*, irrespective of their being injured themselves; in other words, to what extent elderly drivers are a hazard to other road users.

The following issues related to the two above-mentioned aspects are discussed in the report:

- How does the accident risk change with increasing age, and how has the risk among elderly road users developed during the last two decades?
- How is the share of accidents among elderly people expected to develop in the future?
- Which age-related changes in perceptual, cognitive, and motor capabilities are important for safe traffic behaviour?
- To what extent do elderly people compensate for their limitations by changing their traffic behaviour?
- What countermeasures can be taken to prevent accidents among elderly pedestrians and car drivers?
- Is there a need for more knowledge about the traffic behaviour and accident risk of elderly people in order to develop more efficient countermeasures?

These issues are elucidated partly on the basis of a comprehensive survey of international research literature, and partly by analyses of Norwegian road traffic accident statistics.

The report can be ordered from:
Institute of Transport Economics, PO Box 6110 Etterstad, N-0602 Oslo, Norway
Telephone: +47 22 57 38 00 Telefax: +47 22 57 02 90

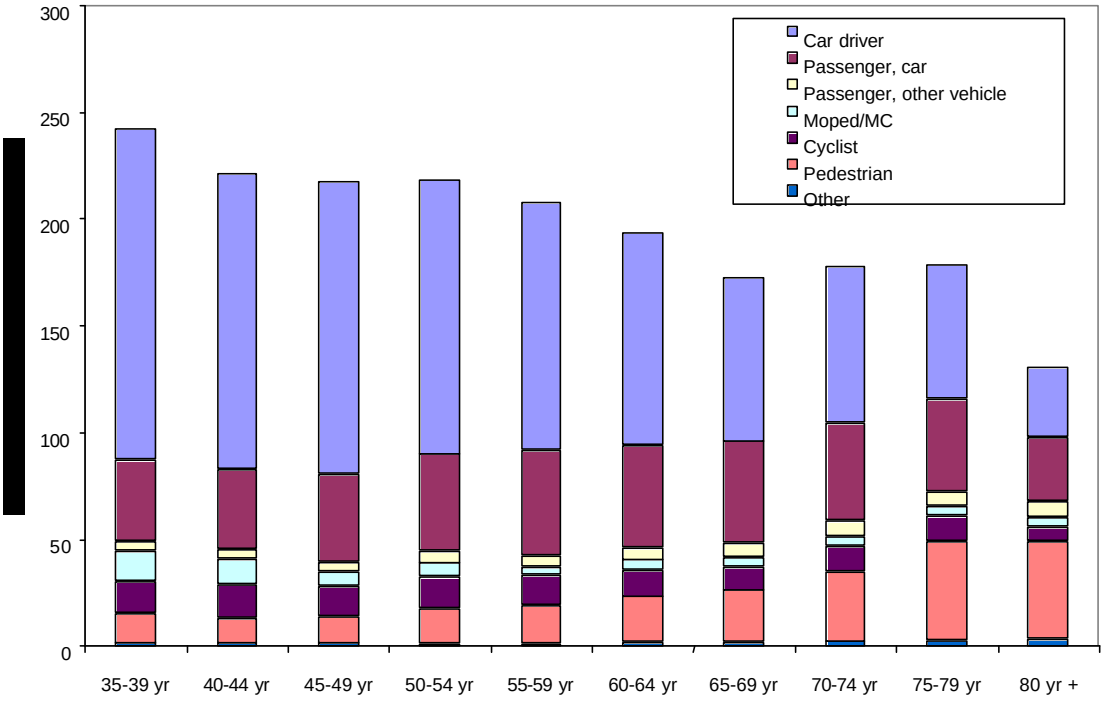
The risk of being injured

In Norway the risk *per capita* of being injured in traffic is lower among the elderly road users, as compared to the middle-aged. This is primarily due to a lower number of injured car drivers among the elderly, which in turn is explained by a lower percentage of persons holding a license and owning a car. In countries with a higher proportion of license holders among the elderly, as for example the USA, the total traffic accident risk *per capita* is higher among the elderly than among the middle-aged.

Even though the share of injured persons may be lower among the elderly, the injuries are on the average more severe, probably because of the frailty of older persons in resisting the physical impact of an accident. Looking at *fatalities*, we find that the risk per capita increases with age.

Per distance travelled, both fatality and casualty rates are higher among the elderly; this goes for car drivers, car passengers, pedestrians and bicyclists.

Concerning the question of when the age-related increase in accident starts, the estimates vary somewhat between various studies, and also between different road user groups.



Even though car occupants make up the largest number of injuries and fatalities among the elderly, like they do among the middle-aged, the age-related increase in accident risk is most evident for pedestrians. While pedestrians make up 4 % of the

traffic injuries in the age-group 40 – 49 years, they make up as much as 30 % among those aged 70 years or more.

During the last two decades there has been a considerable decrease in the *per capita* fatality rate among elderly persons, whereas the younger age groups have not shown any corresponding decrease. The reduction in fatalities has been most pronounced among pedestrians, where the present fatality rate among persons 75 years and above is about 1/3 of the level twenty years ago. Also the injury rate among elderly pedestrians has decreased, even though the percentage reduction has been somewhat less than for the fatality rate. Travel survey data from 1984/85, 1991/92 and 1997/98 do, however, not give any clear indications of decreased pedestrian traffic among elderly persons during this period. The decrease in accident risk, therefore, is likely to be explained at least partly by the development of a safer traffic environment during the last two decades, with more traffic separation and better facilities for vulnerable road users in general. It should be noted that in April 1978 a paragraph was added in the Traffic Code, specifically regulating encounters between car drivers and pedestrians, and giving priority to pedestrians at unregulated marked crossings, not only pedestrians who had entered the roadway, but also those who were preparing to enter. This may have resulted in a change in behaviour among drivers, possibly resulting in increased pedestrian safety. The finding of a larger risk decrease among elderly persons than among the middle-aged may imply that a poor traffic environment has more adverse effects on road users with limited resources, like the elderly and the youngest. In spite of this favourable development, however, the accident risk of pedestrians is still, as shown above, considerably increased among the elderly.

The risk of accident involvement among older drivers

The crash involvement risk of older drivers has been the subject of much recent research. Several investigations have given support to the U-shaped relationship between age and involvement risk, indicating elevated risk both among the youngest and the oldest drivers. Although the risk per distance driven appears to increase slightly already from about the age of 60, the most notable risk increase occurs from about the age of 75. Norwegian road accident statistics show the crash involvement risk to be more than twice as high in the age group 75 years and above, compared to the group 35 – 49 years. The increased risk seems to come earlier among females than males, a finding possibly related to less driving experience among females. The following characteristics have been found to be typical for accidents with elderly drivers:

- Elderly drivers are more often found to be at fault for the accident.
- They are over-represented in accidents at intersections and during lane change.
- Failure to stop or yield is more frequent in accidents with elderly drivers.
- The crash involvement risk is higher for elderly females than elderly males, and the gender difference is most pronounced for intersection accidents.
- Accidents involving elderly drivers are on the average more severe (relatively more fatal accidents) than accidents involving younger drivers.

It has further been found that there is a poor correspondence between elderly drivers' self-evaluations of their driving performance on the one hand, and actual driving performance as well as self-reported violations and accident involvement on the other.

Future risk development

It is difficult to make prophecies about the future number of accidents involving elderly road users, because of the uncertainty associated with the various factors that may influence accident risk. We know with high certainty, however, that the proportion of elderly persons in the population will increase. This necessarily implies that their share of accidents will also increase. Several factors may, however, strengthen or weaken this effect. For example, we know that the share of license holders among the elderly will keep on rising for several years, and that their exposure as car drivers therefore will increase. The increase in injuries and fatalities among the elderly can therefore be expected to be particularly notable for car drivers. In addition, it is conceivable that the average elderly driver of to-morrow will drive longer distances than elderly drivers to-day do. In other words, those drivers who are middle-aged now, and drive considerably more than the elderly drivers, may possibly maintain their driving habits when growing older. This may entail more accidents than implied by the sheer increase in the number of license holders. On the other hand, more driving experience among the elderly in the future may result in their having a lower accident risk per distance driven than elderly people to-day. If so, this may counteract the risk increase implied by the other factors mentioned here. Investigations comparing different birth cohorts of elderly drivers indicate that more recent cohorts have lower risk than more distant cohorts at comparable ages.

More knowledge about driving habits in countries with a higher share of license holders among the elderly may provide a better basis for making predictions about expected accident risk in the future. Specific measures taken to influence the number of accidents among the elderly may of course imply that any such predictions will have to be revised.

Capacities and limitations of elderly road users

Safe travel on one's own depends on both perceptual, cognitive and motor capacities. Consequently, impairments affecting such functions may probably explain the increased accident risk sustained by elderly road users. Although research efforts concerning relationships between accident risk and age-related decrements have mostly focused on car drivers, the findings may be relevant for explaining problems among other groups of road users as well.

Visual perception plays a most important part in receiving information from the traffic environment. However, only weak relationships have been observed between accident risk and performance on traditional vision screening tests, like visual acuity and visual field. Several possible explanations for this weak relationship have been suggested:

- Traffic accidents have many causes, and visual impairment is only one of several contributing factors. It is therefore not possible to document clear effects between visual ability and accident risk.
- There are minimum legal requirements regarding the visual functions of drivers. This implies a restriction of the range of visual capacity, precluding the detection of relationships with accidents. In line with this, one usually finds stronger relationships between visual functions and accidents among elderly drivers than among the younger. The range in functions is likely to be wider among the elderly.
- In many studies equipment with low reliability has been used. This may result in erroneous measurements, which are likely to attenuate any relationships with other variables.
- Drivers with impaired vision may compensate by less driving and by avoiding difficult driving conditions.
- Visual functions that on theoretical grounds can be assumed relevant to driving performance (e.g., contrast sensitivity) have not been included in the largest studies of the relationship between vision and accidents.

The cognitive functions comprise among other things attention functions, memory, and the conscious processing of information. The research on cognition as related to driver behaviour has mostly been concerned with attention functions, and various tests of attention have shown relatively clear associations with accident risk. One measure that has received considerable interest during the recent years is the so-called "useful field of view" (UFOV). This is a test of the utilisation of information in the visual field. UFOV consists of three subtests: divided attention, selective attention, and perceptual speed. Several studies of older drivers have demonstrated significant relationships between these measures and accident risk. A particularly intriguing finding is that UFOV appears to be amenable to special training procedures. More research is needed, however, in order to determine whether increases in UFOV obtained by training may result in decreased accident risk.

Several age-related changes may affect motor functions. For example, movements are slower and more restricted, and the reaction time increases. For drivers such changes may conceivably cause problems regarding head movements to receive information from the sides, or problems with quick and precise handling of pedals, steering-wheel, gear, and other equipment in the car. For pedestrians these changes imply that they need more time for crossing streets, and that they may have problems with turning to see other traffic. There is, however, little research to document the assumed relationships between motor functions and accidents.

Certain diseases that affect both sensory, cognitive and motor functions are more prevalent among elderly people. In particular, research interest has focused on dementia and related states, which affect many elderly persons, primarily after the age of 80. Several studies show that dementia negatively influences driving behaviour and safety.

Along with the age-related increase in morbidity goes the use of medicines, some of which may adversely affect driving performance and accident risk. In addition to effects of an increased use of medicines comes the possibility that the behavioural effects of certain drugs (e.g., benzodiazepines) are stronger among elderly persons.

In sum, the sensory, cognitive and motor impairments seem very likely explanations of elderly persons' high traffic accident risk. The cognitive functions appear more important explanations than the perceptual and motor functions.

Do elderly road users compensate for their limitations?

Provided that all elderly persons were sufficiently aware of their own limitations and adjusted their behaviour accordingly, high age might not necessarily result in higher accident risk. Concerning drivers, several studies show that many of them in fact adjust their behaviour considerably when growing older. Several of them voluntarily give up driving, even if not counselled by their doctor to do so. It has further been shown that many elderly persons tend to avoid driving under potentially adverse driving conditions, such as snowy or icy roads, darkness, or heavy traffic. There may, however, be certain subgroups of elderly drivers who are not sufficiently aware of their impairments. It has for example been shown that many elderly drivers have unrealistic views of their own driving skills. And concerning drivers with dementia, it is uncertain to what extent they acknowledge the possible risk they represent in traffic, both to themselves and to other road users.

As for pedestrians, there is less research results on the issue of compensation. They probably restrict their exposure more or less by necessity as the motor functions deteriorate, and also become more careful. But it is more uncertain to what extent they change to safer walking behaviour as a consequence of sensory or cognitive impairment.

From the available research evidence one can conclude that elderly road users to some extent compensate for their limitations by changing to safer ways of travelling. Since, however, the risk of accident involvement increases with age, the compensation is not sufficient to balance the impaired capacities.

Countermeasures

The high accident risk of elderly road users may be seen as a discrepancy between the demands of the traffic system and the road users' capacity. This discrepancy can be reduced either by traffic technology (changing the demands of the system), training and education (improving the elderly road users' skills in traffic), or selection (preventing persons with high risk from using the traffic system). The latter measure is relevant only for drivers, who are the only group whose use of the traffic system is regulated by a license.

In Norway, there is a certain selection implied by the requirement of a health certificate for all drivers above the age of 70 years. At the discretion of the issuing physician, the certificate may be issued for a period of up to 5 years. This fact, as

well as the rather superficial medical investigation required, implies that very few drivers are selected out of traffic by this measure.

A comparison between Finland, where drivers above 45 years undergo a health examination every 5 years, and Sweden, where no medical examination is required for drivers, showed that the Finnish system of health examinations did not have any effect on the safety of car occupants. It was also found that the risk among elderly pedestrians and bicyclists was higher in Finland, a finding tentatively explained by the health examination forcing former drivers over to less safe modes of transport

Several investigations have indicated that tests of perceptual and cognitive functions as well as dementia symptoms bear the largest promise as selection instruments. In the Norwegian health examination tests to diagnose dementia are sometimes used, but scarcely tests specifically directed towards perceptual and cognitive functions.

Both with dementia and with normal ageing there is a gradual reduction in the functions that are important for safe driving. Consequently, a gradual restriction of where and when to drive might be one possible kind of selection.

To achieve a selection procedure with sufficient sensitivity and selectivity it must be carried out by personnel with special competence, including experience with the most relevant tests. Routine measurement of “useful field of view” can be relevant if the administration of the test can be simplified for use with a standard PC (the current version requires special equipment). General practitioners will neither have the necessary competence nor the required tests. One solution might be to limit all medical examinations of drivers to specialists who are given special training in the use of driver selection procedures.

Education and training of drivers can be targeted both at counteracting the age-related impairments and at updating the drivers regarding driving techniques as well as their knowledge of relevant laws and regulations. Research results indicate that physical, perceptual and cognitive training may improve the functioning of elderly drivers and make their driving safer.

An evaluation of a practical and theoretical driving course for elderly drivers in Norway showed that drivers having attended the course had more knowledge about traffic rules and signs, drove more under difficult conditions, and had fewer accidents than drivers without the course.

Changes in the traffic system probably make elderly drivers uncertain about how to drive correctly. Thus they are required to use more mental resources on conscious information processing and decision-making when driving than younger drivers, with increased risk of errors as a result. Education and training should aim at providing suitable rules for driving behaviour, reducing the cognitive load of driving, and freeing more resources for handling unexpected or complex situations.

In the research literature there are several suggestions regarding traffic technological measures to improve the situation of elderly drivers. These measures fall in two general categories. The first kind of measures aim at increasing the readability, legibility and attention-capturing characteristics of signs, signals and markings. The second category comprises measures to facilitate the information process by simplifying traffic situations. Examples include separate left-turn lanes combined with a protected left-turn signal phase, the replacement of X junctions by

two displaced T junctions, increasing the sight distances at crossings, and the use of early warning signs of choice situations or other possible difficulties.

The implementation of new road traffic information systems – both in-car and road-side systems – may possibly increase the information processing load on elderly drivers. The cognitive capacity of this group of drivers should therefore be taken into due consideration in establishing design criteria for such systems.

The largest problems for elderly pedestrians are related to crossing at sites without marked crossings, whereas crossing at signalised crossings appear to be easier. Many elderly pedestrians look at traffic only from one direction before they start crossing a road with two-way traffic. These differences in observing behaviour are not found for crossing of streets with one-way traffic. A relatively larger proportion of accidents among the elderly pedestrians occur during the final part of the crossing, a finding possibly related to their poor ability to observe traffic in both directions, combined with their reduced speed of locomotion.

These studies of behaviour and risk of elderly pedestrians have resulted in a series of suggestions for countermeasures:

- More pedestrian crossings, and particularly signalised crossings.
- Increased length of the pedestrian green phase in signalised crossings, and the use of systems that can detect pedestrians in the crossing and prolong the green phase if needed.
- Extended use of traffic islands, reducing the demand on pedestrians to observe traffic in both directions simultaneously.
- Extension of the sidewalk at pedestrian crossings, so that pedestrians standing at the kerb are in line with the roadway side of parked cars. This results both in shorter crossing distance and improved mutual visibility between pedestrians and motorists.
- Better pavements maintenance in crossing areas, reducing the need of pedestrians to watch out for potholes and other irregularities.

Further research

There is a need for more focused research on specific issues as a basis for targeted safety efforts. Some of the pertinent topics include:

- The provision of better exposure data for drivers, as a basis for the assessment of risk variations in time and space.
- Behavioural studies to assess what driving situations are particularly problematic for elderly drivers.
- Evaluations of training and education for elderly drivers, and assessment of the importance of driving experience for accident risk.
- Validity studies of new selection procedures.
- Assessment of the importance of traffic and vehicle technologies for the risk of elderly drivers.

- The provision of better exposure data for other road users as well, particularly pedestrians and public transport patrons.
- Behavioural studies of elderly pedestrians, and the evaluation of various traffic technology solutions.