Compact accident research

Improving road safety of senior citizens

Unfallforschung der Versicherer

GDV

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Preliminary remarks

People want to remain mobile – and feel safe on the roads – even when they reach an advanced age. The aging of society, which is an increasing trend, will have a considerable influence on mobility and accident statistics. The consequences of road traffic accidents involving senior citizens are already alarming. Since 1996, the number of senior citizens involved in road traffic accidents has been rising disproportionately compared to other road users. Almost a quarter of all road users who are killed, over half of the pedestrians who are killed and half of the cyclists killed are senior citizens.

This brochure summarizes the key results of a study of the UDV (German Insurers Accident Research).

It reveals the problems with which older people are confronted on the roads, compares their subjective assessments of their safety with the reality reflected in the accident statistics and describes measures designed to allow age-appropriate mobility that meets their requirements. In addition, it forecasts that senior citizens will feature increasingly in the accident statistics of the next 20 to 40 years.

It is hoped this brochure will make a contribution toward persuading policymakers to set the right course today, a course that will allow older people to remain mobile in safety in the future.

Content

1 Introduction

In Germany, older people (senior citizens) are generally defined as people of 65 or over. However, this is a somewhat arbitrary definition for statistical purposes. Older people define themselves based on other considerations, chiefly their individual biographies, psychological and physical abilities and lifestyles. Above all, the degeneration process varies from one individual to another, which means that individuals' subjective assessments of their own aging are generally underestimated. The percentage of Germany's population accounted for by senior citizens has risen continuously since the early 1990s. At the turn of the century, it was 16%, and now it is around 19%. This trend will increase in the coming decades on account of falling birth rates. According to current forecasts of the German Office for National Statistics, over a quarter of the population will be 65 or over by 2030, and by 2050 it will be around a third of the population.

People want to remain mobile – even when they are at an advanced age. They want to feel safe on the roads and act in a way that is conducive to safety. If they are mobile, they can lead an independent lifestyle. Essentially, it means they can keep seeing people and attend to their own everyday needs.

However, the consequences of road traffic accidents involving senior citizens are already alarming. Since 1996, the number of senior citizens involved in road traffic accidents has been rising disproportionately compared to other road users. In 2008, around 1,070 older people were killed in road traffic accidents in Germany, while around 11,300 suffered serious injuries and 32,150 minor injuries. Almost a quarter of those who are killed, over half of the pedestrians who are killed and half of the cyclists killed were senior citizens.

As a result of these developments, changes can be expected in the patterns of road traffic accident statistics in Germany. This is why the UDV (German Insurers Accident Research) commissioned a study on how to improve the safety of older road users [1]. It was carried out by Büro für Stadt- und Verkehrsplanung Dr.-Ing. Reinhold Baier GmbH in conjunction with HommerichForschung.

The primary aims of the study were:

- to identify what is actually potentially dangerous and what older people perceive to be dangerous and to compare the two;
- to produce forecasts of the potential dangers on the basis of scenarios representing the expected range of future trends;
- to develop measures and recommendations for age-appropriate mobility that meets the requirements of older people in the areas of transport infrastructure, vehicle safety and road use behaviour.

2 Mobility and age

Mobility is a fundamental requirement for everyone, regardless of their age. In order to be an active road user, however, in addition to an appropriate and affordable means of transport you also need certain psychological and physical abilities.

It can also happen that some individual's capabilities become weaker early and quickly, while others remain relatively strong until quite an advanced age [3]. To some extent, older people compensate for age-related physical deficiencies through their experience and many years of driving – by driving defensively, for example [3].

As a rule, people use the roads less the older they get. The average distance traveled daily

decreases as of about 50 years of age, as shown clearly in Figure 1, which is taken from a study of mobility in Germany [4]. The trend becomes more pronounced as people get older. The main reason for this is that they stop driving to work when they retire.

The representative survey carried out by HommerichForschung for the UDV in the city of Berlin came up with additional findings on the mobility patterns of senior citizens. Taking into account postal codes and parts of the city identified as safe or unsafe, the researchers wrote to an age-weighted random sample of around 6,750 senior citizens. 2,760 people took part in the written survey. The response rate was thus 41%. The key findings about mobility can be summarized as follows:

- Respondents with a high level of activity are younger, more often male, still working, have a higher education entrance qualification or a degree, do not need a walking aid and do have a bicycle.
- Two thirds of the respondents have a driving license, and 80% of those have a car available to them. 52% of the respondents have a bicycle or can use a relation's or friend's bicycle. Women, people living alone and respondents with restricted mobility are less likely to have a car and/or bicycle available to them. Around 16% of the respondents have a license for a two-wheel motor vehicle, but only 8% have such a vehicle. 34% of the respondents have a season ticket for the city's public transport system or can borrow one from relations or friends.
- More than two thirds of the respondents (70%) rely on aids to compensate for physical deficiencies when using the roads. The most common of these deficiencies is poor eyesight (62%), for which they need glasses or contact lenses (Figure 2). A fifth of the respondents have to take regular medication that can have a negative impact on their fitness to drive. Almost one in two of the over-80s (45%) need a walking aid. However, senior citizens who rely on such aids do not take to the roads as often as their peers. A study of the German Federal Highway Research Institute (BASt) [5], which examined the influence of illness and medication on mobility patterns and accident statistics, revealed the following:
  - Both age and illness restrict mobility, age to a greater extent than illness.
  - The relationship between age and driving is generally stronger than that between medication and driving.
  - The risk of becoming involved in a car accident is 2.6 times as high for people with more than one illness than for the healthy.

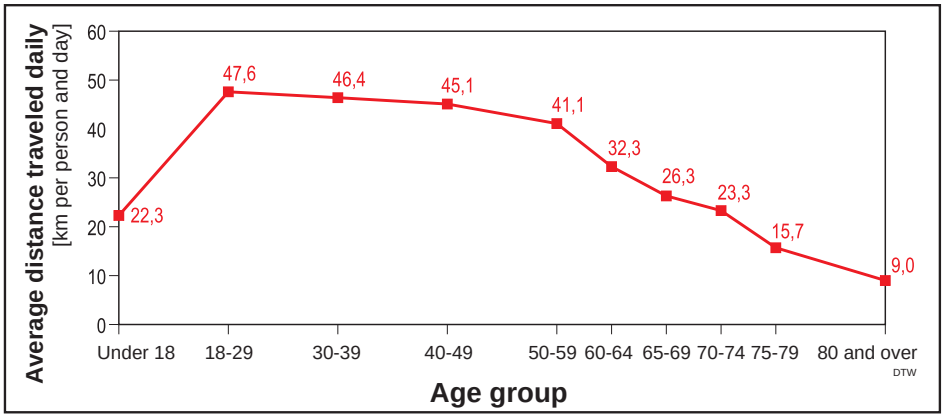


Figure 1:
Average distance travelled by age group (Source: MiD 2002)

- Generally speaking, it can be said that illnesses have a clearly more negative impact on how people of 60 or over cope on the roads compared with younger people. Moreover, men are more strongly affected by this than women.

- Walking remains the most important way to get around at an advanced age. Cars and bicycles are used less and less.

These factors have an impact on the mobility patterns of older road users and thus also on their safety.

3 Objective and subjective safety of senior citizens

3.1 Subjective safety

In terms of the risk of an accident, the bicycle is mentioned most often as being somewhat unsafe or very unsafe as a means of transport. 26% of the respondents who use a bicycle feel very or somewhat unsafe when using this means of transport (Figure 3). 14% of the pedestrians surveyed feel somewhat or very unsafe as pedestrians because of the risk of an accident. For pedestrians and bus passengers, there is a clear increase in perceived lack of safety as people get older. Over a quarter of over-80s feel unsafe on foot, and one in seven feel unsafe traveling by bus. In both cases, this is twice the percentage of 65 to 70 year olds who feel unsafe. In the other forms of road use, the percentages of older people feeling unsafe remain about the same. The percentage of car passengers feeling unsafe is halved.

The following relationships exist:

- More women than men stated that they feel unsafe.
- As pedestrians and users of the city's public transport system, respondents with walking aids and those relying on medication feel unsafe more often than other respondents.
- Cyclists feel less unsafe the more they use their bicycles.

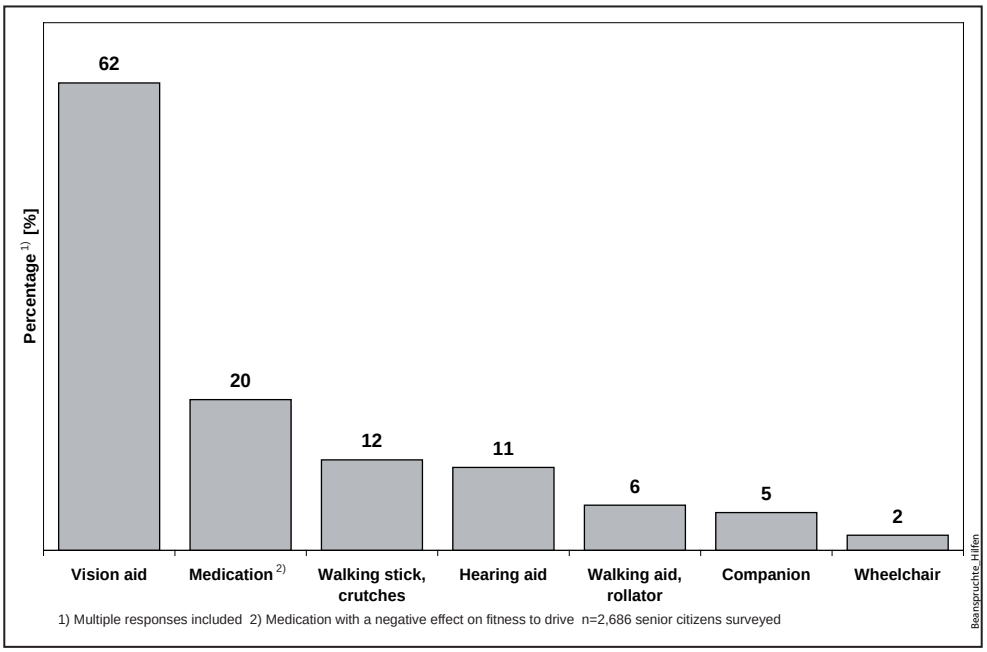


Figure 2:
Use of aids to compensate for physical deficiencies

In addition, users of different means of transport were asked for their assessment of their safety in certain situations on the roads.

The cleansed number of responses in 3.1.1 to 3.1.4 differs from the numbers given in Figure 3 because not all users of each means of transport gave an assessment.

3.1.1 Surveyed cyclists

The surveyed cyclists (n = 800) rate the following situations and scenarios as unsafe:

- main roads without a cycle path or cycle lane (75%);
- turning left (and thus crossing oncoming traffic) to turn into a different road (56%);
- one-way streets where cyclists are allowed to go in the opposite direction to the rest of the traffic (47%);
- junctions with other roads and entrances (46%);
- roundabouts (46%);
- bus lanes that cyclists are allowed to use (43%).

93% of the cyclists surveyed avoid cycling in certain circumstances. These include, in particular:

- slippery surfaces;
- roads used by a high proportion of large trucks;
- uneven or damaged road surfaces;
- poor visibility;
- roads with a speed limit of over 70 km/h for cars.

The women surveyed tend to avoid such situations more than the men surveyed. More of them also stated that they feel unsafe.

3.1.2 Surveyed pedestrians

The pedestrians surveyed (n = 1,950) rate the following situations as somewhat or very unsafe:

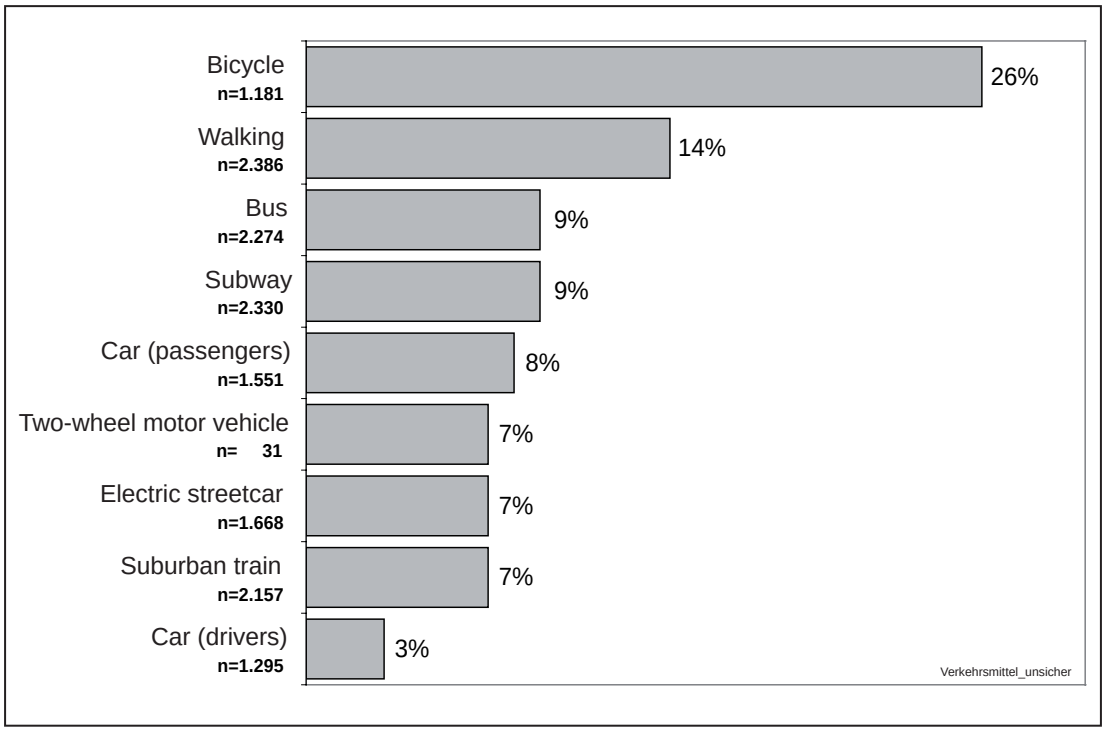


Figure 3:
Assessment of the users of different means of transport as very or somewhat unsafe in terms of the accident risk

- footpaths and sidewalks used by cyclists as well as pedestrians (66%);
- crossing at an intersection without traffic lights (51%);
- crossing roads that have streetcar tracks (49%);
- footpaths and sidewalks on which cars are parked (47%).

The extent to which people feel unsafe in terms of the risk of an accident rises with age. Women state that they feel unsafe significantly more than men. This feeling of not being safe increases significantly as activity levels decline.

Crossing a road with streetcar tracks (Figure 4) is rated as unsafe clearly more often by respondents living in western parts of Berlin, where there are no streetcars, than by respondents living in eastern parts, where streetcars are among the most frequently used means of transport.

More than a third of the respondents avoid using the roads as pedestrians in the following circumstances:

- slippery surfaces (snow, black ice, rain);
- uneven or damaged surfaces (cobblestones, potholes);
- poor visibility (poor light, darkness, fog).

These are more often than not older people, women or respondents who need to use a walking aid or have to take medication that can have a negative impact on their ability to cope on the roads.

3.1.3 Surveyed car drivers

Car drivers (n = 1,160) rate the following situations and circumstances, above all, as somewhat or very unsafe:

- construction sites (31%);
- roads used by streetcars (30%);
- overtaking another road user on roads outside built-up areas (28%);
- turning left (and thus crossing oncoming traffic) without traffic lights (20%).

Women feel unsafe significantly more than men. Respondents from western parts of

Figure 4:
Crossing a road with streetcar tracks without any kind of pedestrian crossing

the city rate roads used by streetcars as significantly more unsafe than respondents from the eastern part of the city.

In certain circumstances, up to two thirds of the respondents prefer not to drive their cars. These include, in particular:

- slippery surfaces (snow, black ice, rain);
- poor visibility (poor light, darkness, fog).

Older respondents and women account for a disproportionate number of this group.

Driver assistance systems provide safety

The most widely used systems are systems designed to maintain vehicle stability such as ABS and ESP. These are used by over 80% of the respondents. Half of the vehicles have warning systems such as sensors for measuring the outside temperature or tire pressure monitoring systems. Over 40% have (semi-)automatic transmission, and around a third have a navigation system or parking sensor system. 11% of the vehicles have distance warning and monitoring systems. A clear majority of 80% to 90% of the respondents who have a car with one or more driver assistance systems feel safer as a result. All users of ABS and ESP believe they are relevant to safety, whereas only around two thirds feel the same about distance warning and monitoring systems.

3.1.4 Surveyed public transport users

The circumstances and situations perceived most often to be unsafe by public transport users (n = 1,600) are:

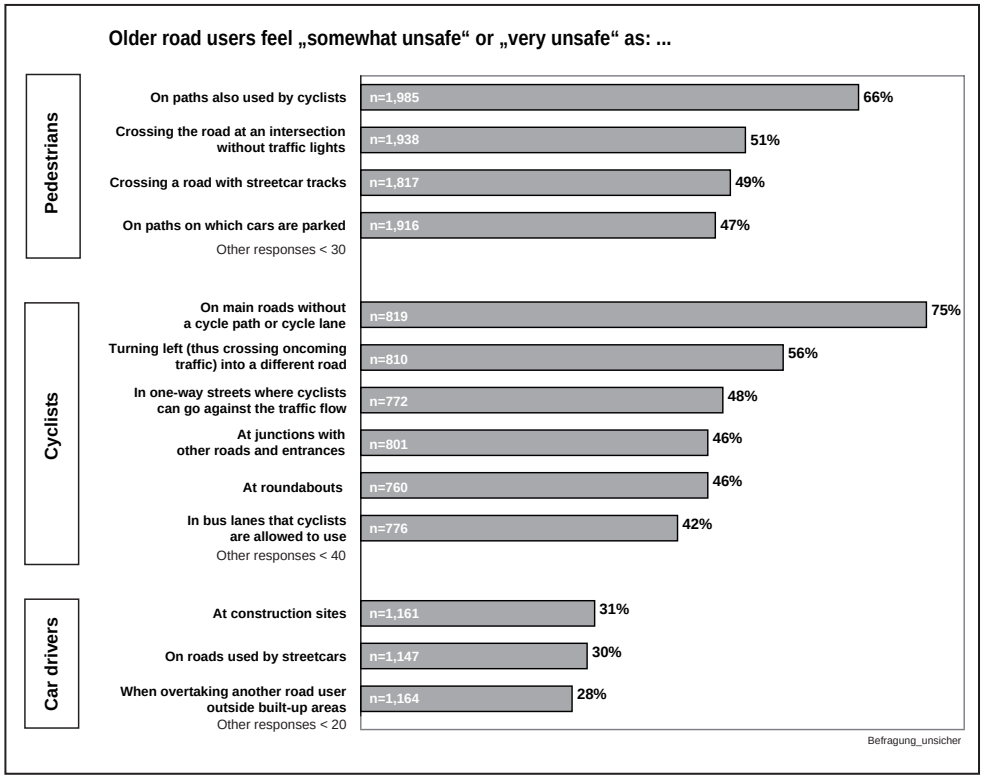


Figure 5:
Circumstances and situations in which older people feel least safe as pedestrians, cyclists and drivers
(Source: own survey of older people in Berlin [1])

- bus or streetcar stops reached by crossing streetcar tracks (49%);
- getting on and off the vehicle (25%).

Considerably more women than men rate bus/streetcar stops reached by crossing streetcar tracks as well as paths leading to bus or streetcar stops or station platforms as somewhat or very unsafe.

3.2 Objective safety as revealed by the accident statistics

As part of the study [1], the UDV commissioned the German Office of National Statistics to carry out a special analysis of all accidents in the period from 2001 to 2006 that were recorded by the German police and involved personal injury or serious damage to property. The analysis was thus based on around 2.1 million accidents involving personal injury and 0.6 million accidents involving serious damage to property. A variety of relationships were analysed, such as those between the age of the person primarily responsible for causing the accident, the number of accidents and their consequences (the accident severity and costs).

There is a long-term rising trend in the number of older people killed or injured in road accidents compared with the average across all age groups.

The number of older people killed or injured in road accidents in Germany rose continuously from 1991 to 2006 by a total of 27% (almost 43,000 in 2006). The number of fatalities decreased by around a third to 1,154, the number of seriously injured stagnated at around 11,000, but the number suffering minor injuries increased by around half to over 30,000 (Figure 6). The overall increase is thus accounted for exclusively by the number of people suffering minor injuries. Over the same period, there was a continuous decline in the total number of people killed or suffering serious or minor injuries on the roads.

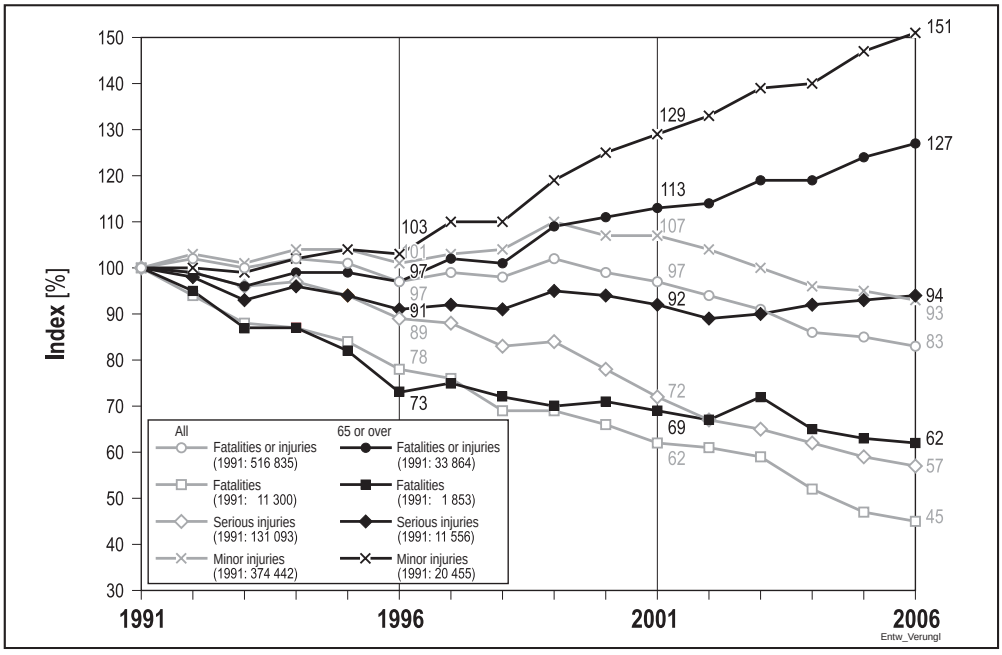


Figure 6:
Trends of injuries and fatalities on the roads
(Source: German Office for National Statistics; own representation)

When the demographic trend is taken into account, the picture with regard to fatalities and injuries is not as bad as it first appears, but it is still more unfavourable for older people.

The total number of people killed or injured in road traffic accidents for every 100,000 people in a particular age group of the population shows, that there has been a long-term decline in the number of older people killed or injured except for people suffering minor injuries (Figure 7). The long-term trends for older people and killed are roughly in line with the average for all age groups, but the long-term trends for serious injuries and minor injuries suffered by older people, and thus also for all fatalities and injuries, are less favourable than the average trends for all age groups.

The relationship remains valid in the context of the proportion of the population killed or injured: the more serious the injury, the greater the proportion of older people appearing in the statistics.

Given their percentage of the population, older people cause fewer accidents than the population as a whole, and the resulting accident costs are lower.

The average accident rate for older people in the years from 2001 to 2006 was around 2.6 accidents per 1,000 head of population belonging to this age group (Figure 8) and thus about half of the average accident rate for the population as a whole (5.5 accidents per 1,000 head of population). The same applies to accident costs per head of population. Figure 8 illustrates how this effect becomes stronger at more advanced ages.

When compared with the distance travelled as well, the accident rate and accident costs per head of population were both around 20% under the average values for the population as a whole during the period studied.

The more serious the injury, the greater the proportion of older people appearing in the statistics. Older people have a considerably

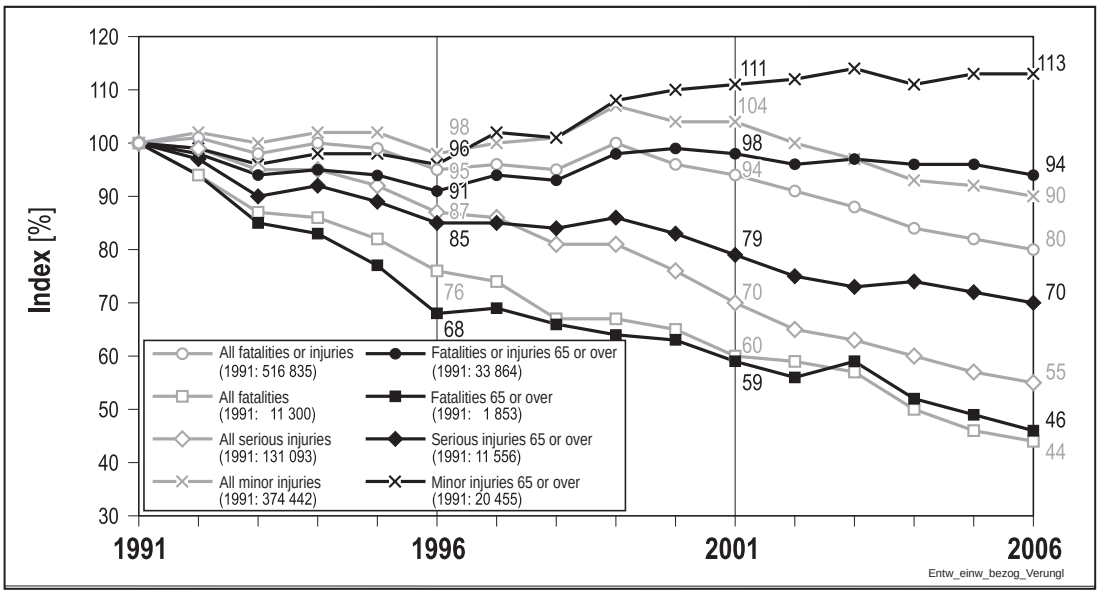


Figure 7:
Trends of injuries and fatalities on the roads
(Source: German Office for National Statistics; own representation)

higher risk than other age groups of being killed or seriously injured in road traffic accidents.
Around 10% of the people killed and injured in road traffic accidents in 2006 were 65 or older. Older people accounted for 15% of the people seriously injured in road traffic accidents in 2006 (around 10,800 people). And they made up 23% of all road traffic fatalities (1,154 people). There is also a long-term negative trend here: The percentages in 2001 were almost 8% for all fatalities and injuries, 11% for serious injuries and around 18% for fatalities – considerably lower than the current values (Figure 9).

The type of road use plays a considerable role: In 2006, around 51% of pedestrians killed, 28% of pedestrians seriously injured, 48% of cyclists killed and 22% of cyclists seriously injured were 65 or older. On the other hand, "only" 17% of car drivers or passengers killed and 12% of car drivers or passengers seriously injured were 65 or older. All of these percentages have increased over the years, as shown in Figure 9.

The accidents in which older people are involved are of above-average severity.
Compared to the average across all age groups, senior citizens cause more accidents on roads in built-up areas and about half as many on freeways (Autobahnen). The latter correlates with the distances traveled by older people. The severity of the accidents caused by senior citizens and involving personal injury, as measured by the number of fatalities, is 28 fatalities for every 1,000 accidents involving personal injury. It is thus around 63% higher than the average accident severity (Figure 10).

In built-up areas, the severity of accidents in which the person primarily responsible is 65 or over is 16 fatalities for every 1,000 accidents involving personal injury, which is about 2.3 times the average severity across all age groups. On roads outside built-up areas, the severity of accidents in which the main party responsible is an older person is 1.5 times the average across all age groups. The severity of accidents increases significantly as senior citizens get older. People of 80 or over who

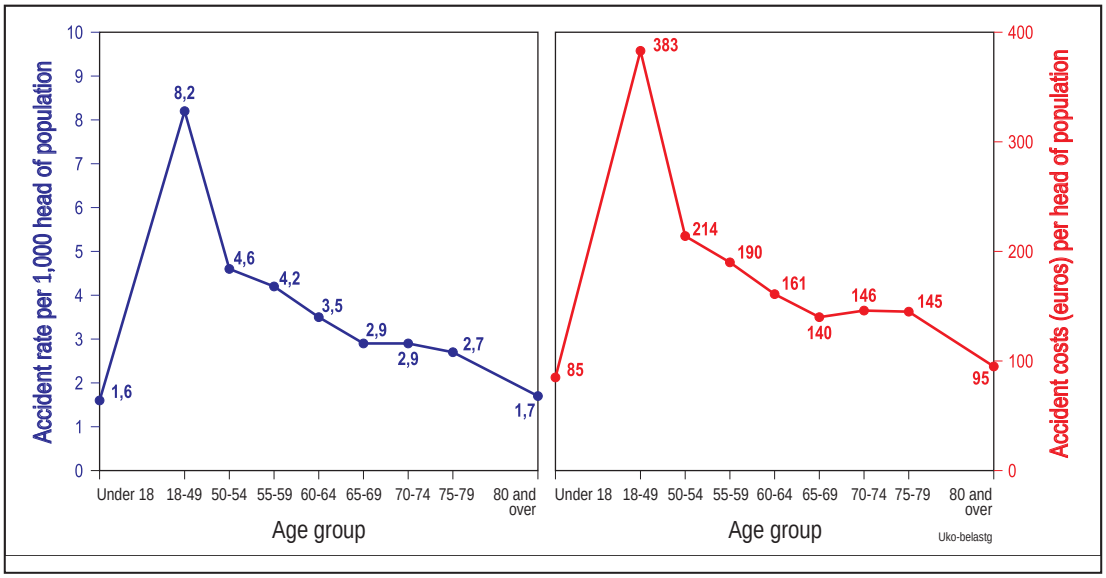


Figure 8:
Average accident rate and accident costs per head of population by age group (from 2001 to 2006)
(Source: Special analysis of the German Office for National Statistics; own representation)

are primarily responsible for accidents cause about 43 fatalities for every 1,000 accidents involving personal injury, while younger senior citizens aged 65 to 69 and younger road users cause about half or less than half this number of fatalities (Figure 11).

Certain situations on the roads carry a greater risk for older people than for younger road users. In particular, complex situations carry an increased risk for older people:

- On roads in built-up areas, the percentage of crossing-over accidents (accident type 4) is

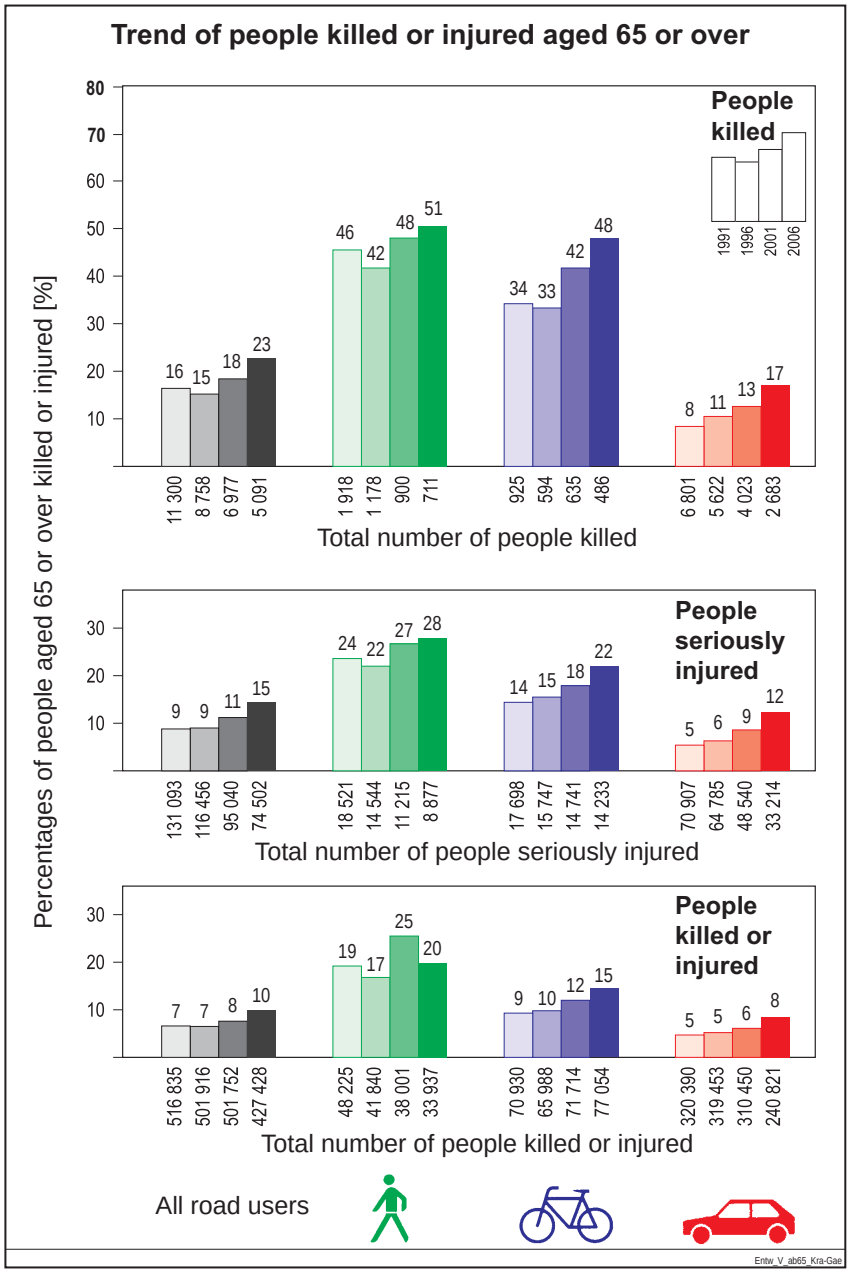


Figure 9:
Percentages of older people among those killed or injured in accidents by type of road use
(Source: German Office for National Statistics; own representation)

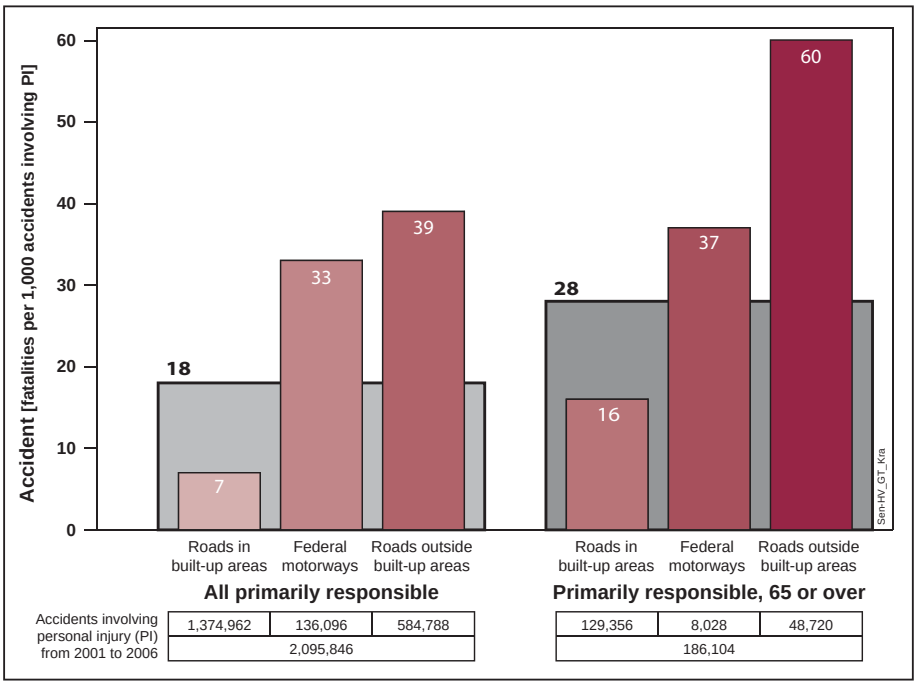


Figure 10:
The severity of accidents caused primarily by senior citizens compared with all accidents regardless of who caused them primarily and by location
(Source: Special analysis of the German Office for National Statistics; own representation)

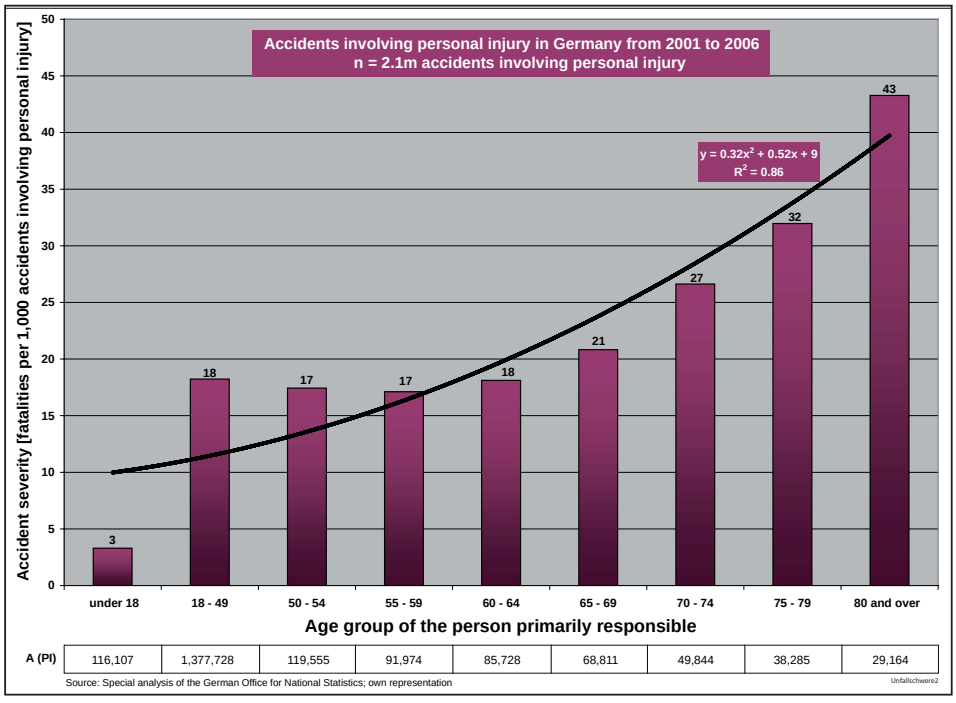


Figure 11:
Accident severity by age of the person primarily responsible
(Source: Special analysis of the German Office for National Statistics; own representation)

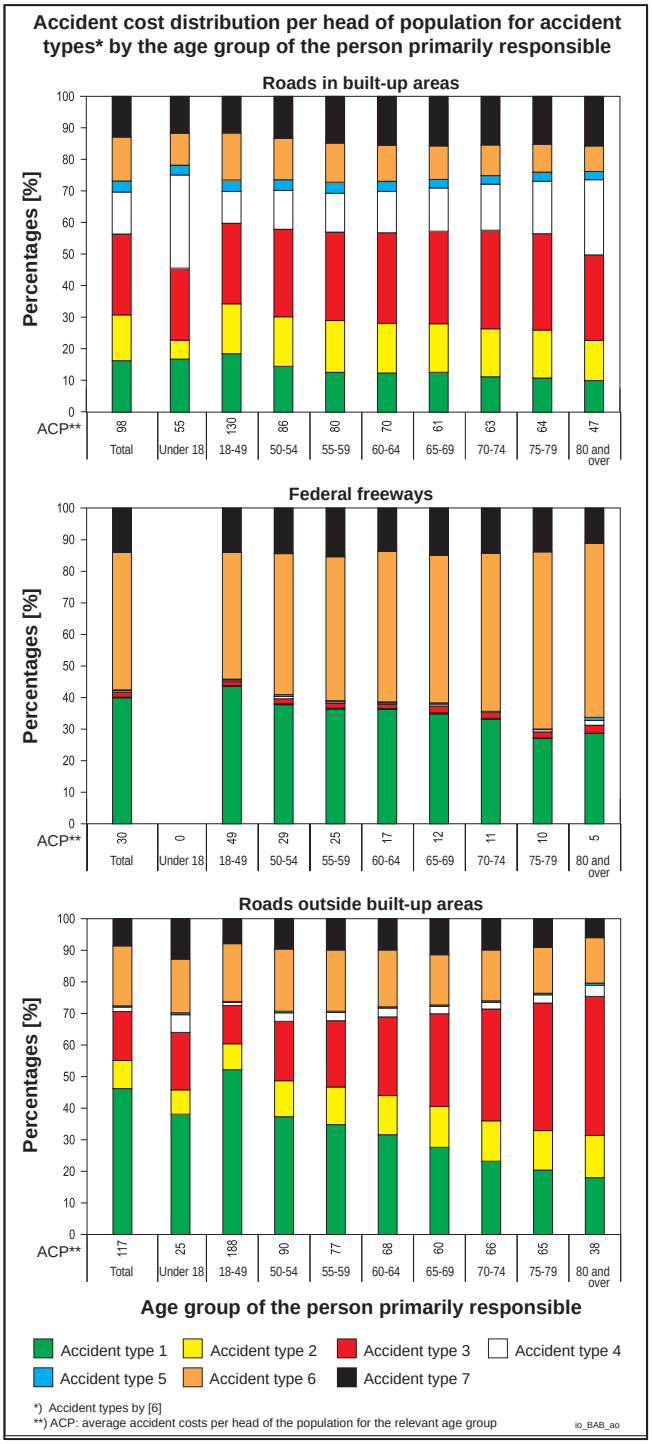


Figure 12:
Distribution of population-related accident costs by location, accident type and age group averaged across the years 2001 to 2006
(Source: Special analysis of the German Office for National Statistics; own representation)

higher among older people, particularly for accidents with fatalities. At the same time, there is an age-specific increase in accident costs per head of population for this accident type [6] (Figure 12).

- On freeways (Autobahnen), the percentage of accidents in longitudinal traffic (accident type 6) and the associated accident costs per head of population are higher for older people. On the other hand, older people have fewer driving accidents (accident type 1) (Figure 12).
- On roads outside built-up areas, on the other hand, the percentage of turning-into/crossing accidents (accident type 3) is considerably higher for older people, whereas the percentage of turning-off accidents (accident type 2) remains largely constant across all age groups, and the percentage of driving accidents (accident type 1) decreases. Here too, the relationships with regard to accident costs per head of population are comparable (Figure 12).

The problems of older people in complex situations on the roads are also evident from the characteristics of the accident locations:

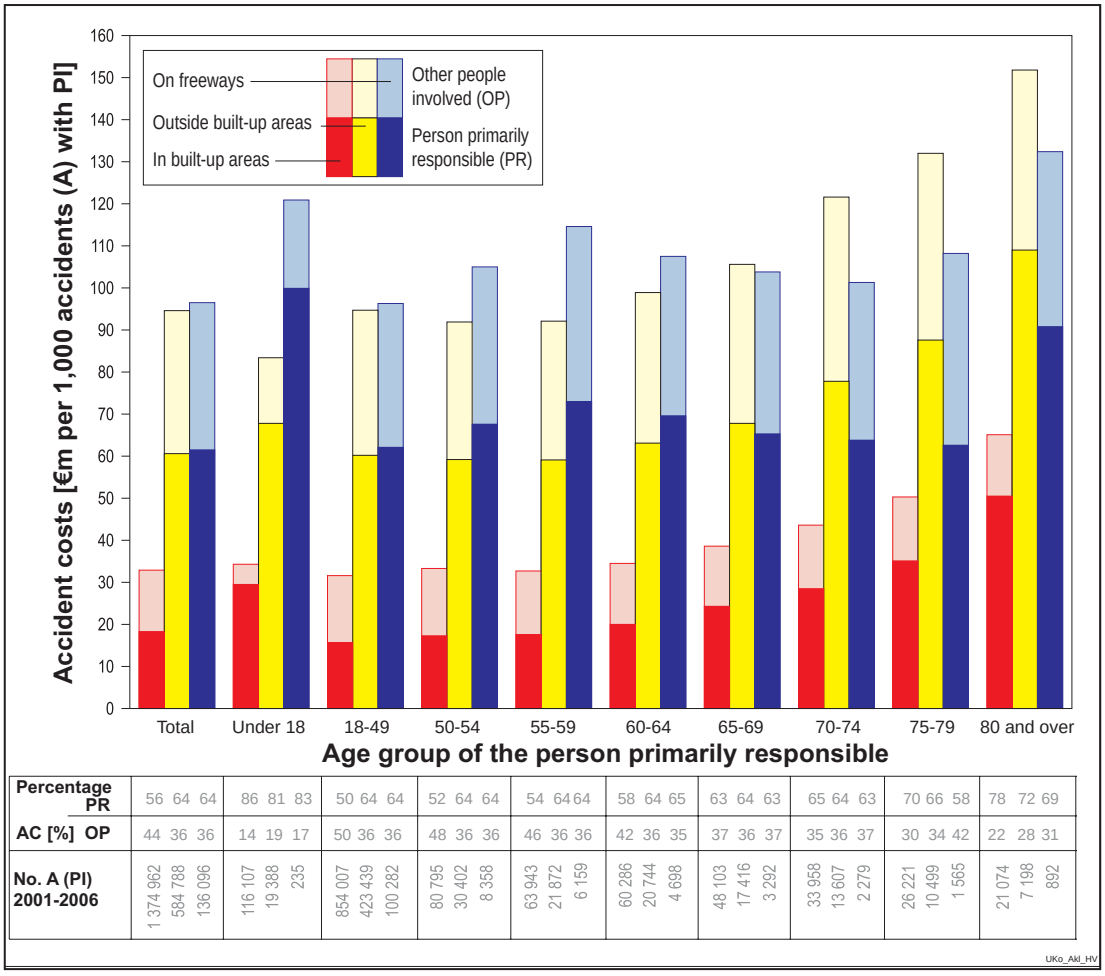
- Both in built-up areas and on roads outside built-up areas, the percentage of accidents occurring at intersections and junctions is higher for older people, whereas the percentage of accidents they have on gradients or in bends decreases. This effect is more pronounced outside built-up areas.
- On freeways, the percentage of accidents occurring on slip roads and at interchanges is higher for older people, whereas the percentage of accidents they have on the freeway itself decreases.
- Older people have more accidents at zebra crossings and pedestrian crossings with signals.
- On freeways, the incidence of accidents at sites where work is being carried out increases among older people.

As drivers get older, they make more mistakes. A mistake is the cause of the accident for 69% of drivers aged 18 to 65, 71% of drivers aged 65 to 75 and 88% of drivers aged over 75. From the age of 75, drivers thus make considerably more mistakes.

Older people primarily responsible for causing accidents are themselves more likely to be killed or injured, particularly on roads in built-up areas.

Accident costs per 1,000 accidents involving personal injury increase with the age of the person primarily responsible for causing the accident. Regardless of location (roads in built-up areas, roads outside built-up areas or freeways), this is mainly due to the severity of the injury suffered by the person primarily responsible for the accident (Figure 13).

The accident costs of the people primarily responsible for causing accidents increase considerably the older these people are, particularly on normal roads outside built-up areas and roads in built-up areas. In built-up areas, the percentage of total accident costs accounted for by the person primarily responsible for causing the accident increases the older



	Total	Under 18	18-49	50-54	55-59	60-64	65-69	70-74	75-79	80 and over
Percentage PR	56 64 64	86 81 83	50 64 64	52 64 64	54 64 64	58 64 65	63 64 63	65 64 63	70 66 58	78 72 69
AC [%] OP	44 36 36	14 19 17	50 36 36	48 36 36	46 36 36	42 36 35	37 36 37	35 36 37	30 34 42	22 28 31
No. A (PI) 2001-2006	1 374 962 584 788 136 096	116 107 19 388 235	854 007 423 439 100 282	80 795 30 402 8 358	63 943 21 872 6 159	60 286 20 744 4 698	48 103 17 416 3 292	33 958 13 607 2 279	26 221 10 499 1 565	21 074 7 198 892

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Figure 13:
Average accident costs of the person primarily responsible for the accident and the other people involved in the years from 2001 to 2006
(Source: Special analysis of the German Office for National Statistics; own representation)

the person is. For people aged 80 or over, these percentages increase in all road categories.

The times of day at which accidents occur reflect the mobility patterns of older people. The times of day at which fatalities and injuries occur are a reflection of the mobility patterns of older people at different times of the day [4].

In contrast to other age groups, where there are clear peaks in fatalities and injuries between 3 p.m and 6 p.m., the peaks of older road users in terms of fatalities and injuries are shallow. There is a slight peak in the latter part of the morning (from 9 a.m. to midday) outside the rush hour, and the level of fatalities and injuries then remains roughly the same until the latter part of the afternoon (3 p.m to 6 p.m.).

The percentage of accidents caused when the light is fading, after dark or when the roads are in a poor condition (wet or icy surface in the winter) declines continuously as people get older. Survey results in Berlin confirm that older people avoid using the roads actively when weather conditions are bad, and that applies to all means of transport. As shown in Figure 14, the objective risk correlates only partially with subjective assessments of the risk. Above all, the high risk of having an accident in a car compared to other means of transport and of being killed or seriously injured, or of being killed as a pedestrian, is evidently not appreciated.

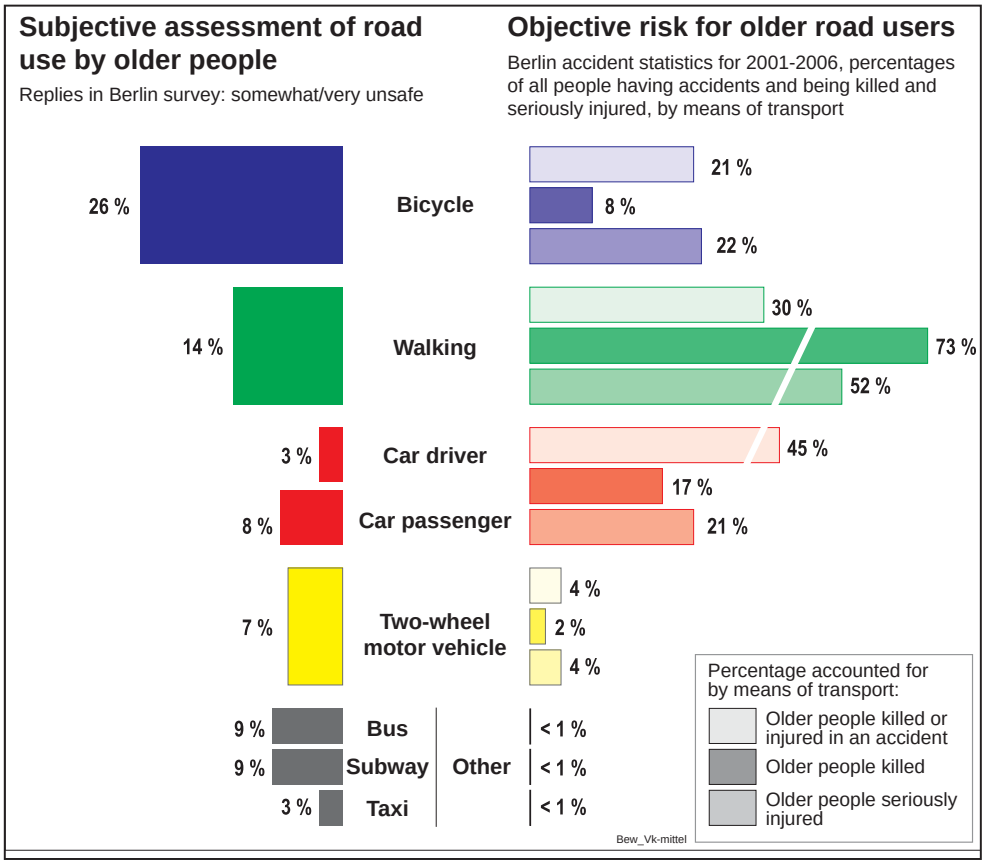

Figure 14:
Subjective assessment of the safety of different means of transport compared to the objective accident statistics for older people
(Source: Survey of older people in Berlin and accident statistics for Berlin; own representation)

3.3 Subjective and objective safety compared

The comparison uses findings from:

- the survey of senior citizens in Berlin (subjective safety);
- the analysis of the accident statistics in Berlin and throughout Germany as well as the literature (objective safety).

On the basis of location-based statements from the written survey, a local inspection was carried out of selected stretches of road, and the statements were compared with the actual accidents that occurred using the accident type maps of all accidents (one-year maps) and of accidents involving personal injury (three-year maps), as shown in Figure 15.

In addition, the specified unsafe or improved situations/circumstances together with respondents' subjective assessments of their safety on the roads were compared with the findings from the official road traffic accident statistics and from previous investigations. Non-motorized road users (cyclists and pedestrians) and car drivers have very different perceptions about road safety (see 3.3.1 and 3.3.2).

3.3.1 Non-motorized road users

The traffic accident data (2000 to 2006) for Berlin shows that slightly higher percentages of older cyclists than younger cyclists are primarily responsible for driving accidents (accident type 1), turning-off accidents (accident type 2) and turning-into/crossing accidents (accident type 3). Accident type 3 alone accounts for about a third of all recorded accidents, and accidents at intersections and junctions (accident types 2 and 3 together) account for about 43% of all recorded accidents. This corresponds to the subjective assessments of cyclists. They feel that turning into a road or turning off a road when you have to cross oncoming traffic (i.e. turning left in countries where you drive on the right) is high in potential danger.

For pedestrians, subjective assessments of safety matched the objective situation with regard to safety in terms of crossing the roads (secured pedestrian crossing) under different conditions.

It was not possible in the investigation to analyze any data on the safety of paths or sidewalks used by both pedestrians and cyclists or on which cars park. These were perceived as being particularly unsafe.

Figure 15:
Accident type map (three-year map) and photograph showing a black spot including crossing-over accidents and a traffic situation rated by respondents as unsafe

3.3.2 Car drivers

Some situations subjectively assessed by car drivers as being unsafe are not clearly backed up by the objective findings from the nationwide accident statistics:

- In built-up areas, with regard to accidents involving personal injury (categories 1 to 3) there is no age-related increase in turning-off accidents (accident type 2) or turning-into/crossing accidents (accident type 3) caused primarily by older road users. With regard to accidents involving serious damage to property (accident category 4), however, the percentage of accidents of accident type 3 in built-up areas rises for the over-50s. On roads outside built-up areas, the percentage of accidents of type 3 rises with age in all accident categories, while the percentage of accidents of type 2 remains the same regardless of age.
- Turning left (and thus crossing oncoming traffic) without traffic lights is assessed by only 20% of respondents as unsafe. That means that the majority of car drivers are not aware of the actual danger of an accident when there are no dedicated traffic lights for drivers turning left.
- Overtaking another road user on a road outside a built-up area is perceived to be unsafe, although the percentage of accidents caused by senior citizens in longitudinal traffic on these roads falls as they get older, and the percentage of accidents caused by overtaking remains the same across all ages.

One possible explanation is that road traffic situations subjectively perceived to be unsafe (e. g. overtaking on roads outside built-up areas) are avoided wherever possible or handled by drivers in a way that counteracts the risk (e.g. increased attentiveness and reduction of speed for other driving maneuvers) [7].

The subjective assessments with regard to the causes of accidents match the objective findings well in every case. The findings are confirmed, above all with regard to complex traffic situations at intersections (right of way regulations, situations on joining or leaving freeways), by Wiebusch-Wothge [8].

4 Risk forecasts

Based on the results of the analysis, a cautious forecast was made of future road traffic safety trends for older road users up to 2020, 2030 and 2050. Taking into account the trend in mobility [9], the demographic trend [10], current road safety indices and assumptions about the future implementation of measures of relevance to road safety in the areas of infrastructure and automotive technology, scenarios were developed for mobility and measures implemented and then combined to form three overall scenarios that served as the basis for different versions of the risk forecasts [1]:

- The scenario for a smooth transition and promotion of motorized individualism is based, on the one hand, on increasing motorization and mobility (of older people as well) and, on the other, on traffic planning and technical automotive measures to increase road safety.
- The scenario for dynamic adaptation and promotion of safe local mobility reverses the current trend and assumes declining motorization and automotive mobility with the focus on measures to implement safe local mobility.
- The scenario illustrating the status quo and continuation of current practice is the reference case for the first two overall scenarios.

Up to the year 2030, there are no differences worth mentioning between these three overall scenarios because the more effective measures (Figure 16) take a long time to prepare and implement.

Not until the implementation of the measures progresses do clear differences between the scenarios develop by 2050. The scenario for the promotion of motorized individualism reveals the strongest effects. This is primarily attributable to the long-term effectiveness of measures outside built-up areas, although in built-up areas, as well, its effects exceed those of the scenario for the promotion of safe local mobility. Only in built-up areas does the latter have an impact beyond that of the continuation of current practice scenario.

As far as older road users are concerned, the differences are even more clearly in favor of the scenario for the promotion of motorized individualism. The main reason for this is that the measures in the field of driver assistance systems will be the most important factor in reducing the numbers of fatalities and injuries as a result of accidents - fatalities, in particular, but also serious injuries - by 2050.

Older road users account for a particularly high percentage of the people in these accident categories.

Even beyond 2030, the packages of measures underlying the two scenarios for the promotion of local mobility and the continuation of current practice will not achieve much more than compensate for the continued increase in accident costs resulting from accidents in which older people are killed or injured – an increase that can be expected up to 2050 as a result of demographic and mobility trends.

5 Favourable measures for older road users

The results of the study give clear indications about where action is needed in the future. Solutions must be found, in particular, for the following problem areas:

- simplification of the infrastructural layout of the road system to subdivide the actions involved in driving to a sequence of steps wherever possible;
- slowing of the traffic flow to compensate for delays in perception and slow reactions and allow errors to be negated (implementation of a "forgiving road system");
- improvements to the design and operation of intersections to achieve better recognizability, orientation, clarity, adequate clearance times and in some cases the breaking up of complex intersections into a network of junctions or roundabouts;
- advanced warnings with digestible amounts of information and a lower overall density of information;
- improvements to the noticeability and legibility of traffic signs, markings, control systems and traffic systems.

Core aspects concern the slowing, simplification and improved "legibility" of traffic situations. These aspects remain valid regardless of the type of road use of older people and are also relevant for users of public transport systems.

The results of the risk forecasts show the effectiveness of the following measures, in particular:

- the introduction and consistent expansion of the use of driver assistance systems that help to compensate for slower, inadequate or false perceptions and reactions and can assist with certain aspects of driving;
- the improvement of the safety of turning off a road, turning into a road and other activities at intersections for drivers and cyclists (both in built-up areas and outside them);
- a speed limit on main roads in built-up areas, above all to improve the safety of pedestrians and cyclists;

- safety measures for pedestrian crossings (also by clearing fields of vision and keeping them free);
- the construction or marking of cycle paths or lanes (in built-up areas, above all, also in order to separate cyclists from pedestrians to improve pedestrians' subjective perceptions of their safety);
- measures designed to enforce the speed limit and implement a "self-explanatory" road design/layout on roads outside built-up areas.

Comparing older people's avoidable accident costs saved by the individual measures (assuming their full implementation) results in the ranking of the three most effective measures shown in Figure 16. It is based on an effectiveness factor calculated in relation to the location-dependent least effective measure (effectiveness factor = 1) on the basis of the avoidable accident costs – and thus permits weighting of the individual measures in relation to each other.

Regardless of location, an automatic emergency braking system is the most effective means of improving the safety of older road users.

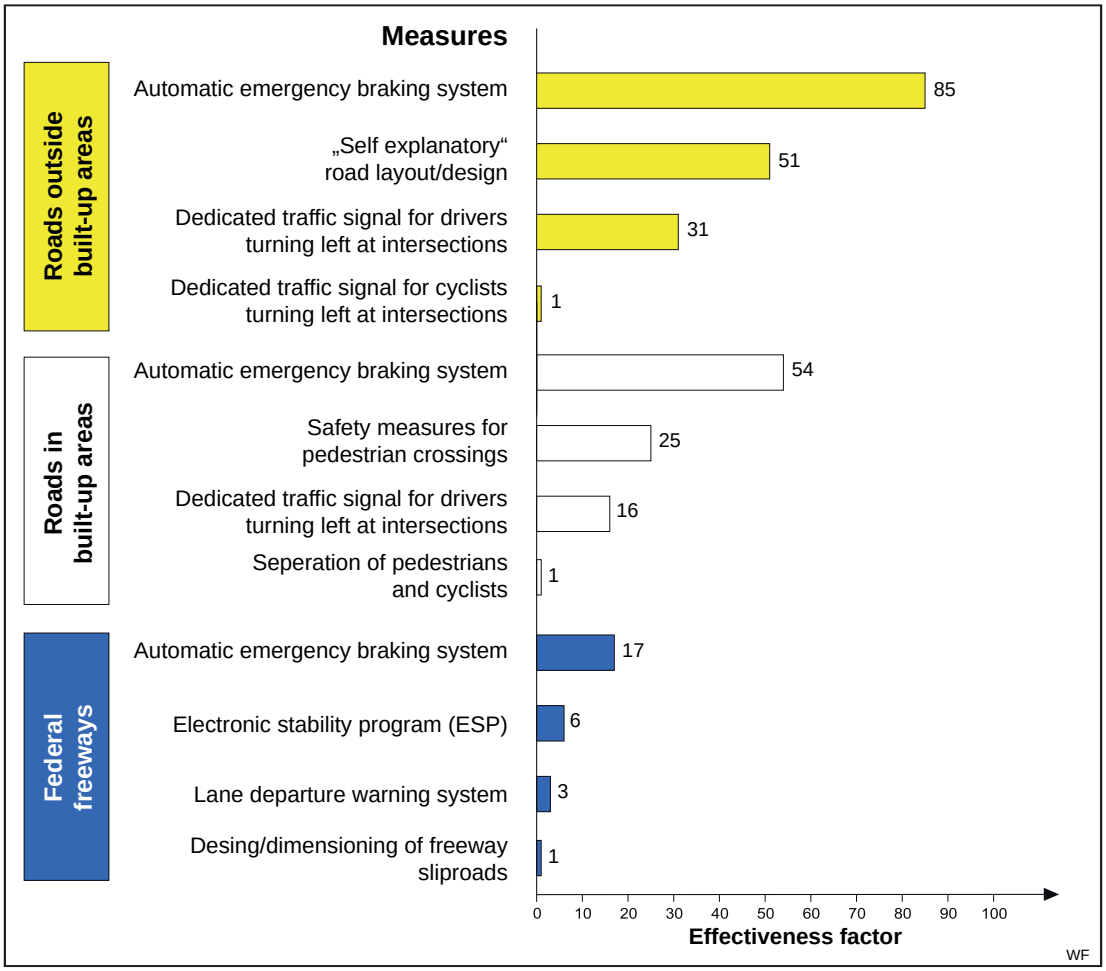

Figure 16:
Effectiveness factors of the measures by location
(Source: own calculations)

In built-up areas, the infrastructure-related measures of making pedestrian crossings safer and introducing dedicated traffic lights for drivers turning left at intersections are the second and third most effective measures. On roads outside built-up areas, the second and third places are also occupied by infrastructure-related measures: "self-explanatory" road design/layout and dedicated traffic lights for drivers turning left at intersections. On freeways, on the other hand, in addition to an automatic emergency braking system, two further technical automotive measures are most effective.

The various measures are of comparable importance when applied universally to road traffic safety (i.e. across all age groups). It is thus evident that the most effective measures also benefit all other age groups to approximately the same extent.

Regardless of the means of transport used, older people are not as agile as younger people and their reactions are slower. The following fundamental requirements in terms of how traffic is controlled and the road environment is designed and laid out are therefore increasingly important:

- accessibility;
- public safety (not just road safety);
- user friendliness of private vehicles and public transport systems;
- consideration of low walking and driving speed, limited agility and longer reaction times in traffic control;
- favourable mobility deals specifically for senior citizens using the public transport systems and further offers for individualized mobility services, particularly when it comes to care services and collection and delivery services.

6 Summary and the need for research

Complex situations, above all, are assessed by older road users themselves as being a problem. This study showed that objective research findings and the subjective assessments of the age group are largely in agreement.

However, the increase in the number of accidents involving older people, which has been evident for some time, must be subjected to a more differentiated evaluation – not just against the background of the demographic trend. The analyses of the accident statistics have made it clear, for example, that older road users who are primarily responsible for causing traffic accidents are themselves the main victims in terms of serious injuries and fatalities.

Problems associated with an age-related decline in capabilities in traffic necessitate compensatory measures whose effectiveness was quantified in risk forecasts for three time horizons – 2020, 2030 and 2050 – on the basis of combined scenarios, taking into account demographic trends, mobility and measures to be implemented. It was revealed that an improvement of the road safety of older people is essential if we want to at least compensate for – if not further reduce – the increasing economic damage that will otherwise be incurred. On the other hand, the calculations for the scenarios show that the avoidable costs offer considerable potential for investments to be made in the transport system to improve road safety.

Measures to introduce driver assistance systems (inparticular partly automated driving), infrastructural measures to improve

the safety of turning off a road, turning into a road and other maneuvers at intersections, increasingly "self-explanatory" road design/ layout on roads outside built-up areas and measures to enforce speed limits and adapt speeds to suit the requirements of cyclists and pedestrians in built-up areas all make a contribution toward improving the road safety of older road users. These measures also benefit all road users.

The study revealed that further research is required into the following aspects:

- the road safety and behaviour of older pedestrians when crossing the road in different conditions in terms of traffic and infrastructure (for example, the existence, type and design/size of secured pedestrian crossings, the vehicle speeds, the design of the road cross-section or the type of urban utilization);
- the road safety and behaviour of older cyclists in different conditions in terms of traffic and infrastructure (for example, the existence, type and location of cycle paths or lines in the road cross-section, the options for cyclists turning left and thus across oncoming traffic and the vehicle speeds);
- the road safety and behaviour of older drivers at intersections depending on infrastructure standards and other factors;
- the effects of age-related declines in capabilities and illnesses on the road safety of older road users;
- the basic requirements and methods for successfully tackling the issue of road safety with older people living independently in private households.

Some of these aspects are covered by existing official regulations governing road traffic. Results from the investigations could thus be used to adapt these to suit the specific requirements of older road users.

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