# Cycling habits and accident risk of older cyclists in Germany 

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#### Abstract

Cycling is a healthy activity for persons of all ages. But older cyclists have a high risk of having a severe or even fatal accident. A interview study was conducted in order to find out how age related problems affect cycling in older persons, how it influences their cycling behaviour, how they compensate for the problems. The relation of cycling habits to accidents of older cyclists was determined. We made a distinction between "safe" older cyclists who had had no accident after their $59^{\text {th }}$ birthday and others who had had at least one accident, including falls. The participants were cyclists between 60 and 90 years of age in Saxony, about one third each living in Dresden, in the rural area or in an area with a medium density. About half of them cycled daily or nearly daily, about one quarter 3-4 times per week and one quarter 1-2 times per week. The same proportion of safe cyclists was found in all age groups. Persons who cycled daily or nearly daily had a higher accident risk than persons who cycled less often. Distance cycled was not related to accident risk. Physical difficulties were not related to having had an accident with the exception of problems getting on or off the bike. Not compensating for sensory difficulties was related to having had an accident: Having a hearing aid and not using it when cycling and having visual problems and not restricting oneself mainly to familiar routes. The best predictor of having had an accident was red light running which shows that other factors than physical impairment play an important role in the accident risk of older cyclists.


Keywords: older cyclists, cycling habits, traffic safety, physical problems, violations.

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## 1 INTRODUCTION

Cycling is becoming more popular in Europe, and this trend will even increase with rising fuel prices. Cyclists are becoming older, just as the population as a whole. Cycling is an attractive mode of transport for all persons of all ages, for utility and for leisure purposes. Many cyclists do not consider cycling as an exercise in the sense of sports or as effort but as a means to get from one point to another but it nevertheless has positive effects on health just as exercising has [1, 2]. These positive effects of cycling have to be kept in mind when talking about the safety of cyclists of all ages. When persons switch from driving a car to cycling the largest positive effects are expected for persons of 65 years and older [3].
The negative side of cycling is that cyclists are the group of road users which had the smallest profit from the positive development in traffic safety in the last decades [4]. The subgroup of cyclists with the highest risk of a severe or fatal accident are older cyclists. In Germany, about every second cyclist who looses his or her life in an accident is 65 years and older [5]. Cyclists in general and older cyclists are not the main responsible road user in the reported accidents [6]. This means that cyclists should not be the only target group of measures to improve the safety of cyclists. Nevertheless, individual behaviour can help to avoid accidents - definitely single-vehicle accidents but partly also accidents with other road users. Age makes all kinds of road users physically more vulnerable [7] but persons in cars profit more from technical safety improvements in vehicles in the last decades. For this reason it is important to know how older cyclists are affected by the typical changes which accompany aging and how they compensate for their difficulties. Does this compensation improve their safety or does it even make them more prone to an accident?

## 2 METHODS

### 2.1 Participants

206 persons participated in the study, the vast majority of them lived in Saxony, few in rural areas in the southern part of Brandenburg. About one third each had finished school after 8 years, after 10 years, and held a general qualification for university entrance. The participants were divided into three age groups and into three groups of places of residence: Dresden (major town with about 500,000 inhabitants), rural areas and as the middle group outer conurbation area, small or medium city. If it was not clear to which group a location belonged it was defined on the availability of public transport - this was mainly necessary at the borders of cities. The participants were recruited via the press, via notices (at doctors, pharmacies, churches, ...) personal contacts and via other participants in a pyramid system. The latter methods was mainly necessary for participants of the oldest age group. The cyclists were offered $5 €$ for participating; about $20 \%$ waived the money.

Table 1. Age and place of residence of participants.

|  | $60-69$ years | $70-79$ years | 80 years | Sum |
| :--- | :---: | :---: | :---: | :---: |
| Dresden | 26 | 27 | 19 | 72 |
| Outer conurbation area / small or medium city | 26 | 26 | 13 | 65 |
| Rural | 27 | 28 | 15 | 70 |
| Sum | 79 | 81 | 47 | 207 |
| Minimum age | 60 | 70 | 80 | 60 |
| Maximum age | 69 | 79 | 90 | 90 |
| Mean age | 65.09 | 73.44 | 82.60 | 72.33 |
| Standard deviation age | 2.60 | 2.86 | 2.80 | 7.22 |

### 2.2 Interview

In the first step, in-depth-interviews were conducted with 16 male and 14 female cyclists between 60 and 90 years of age (mean age 74.8 years). The interview guide for these interviews was developed based on the literature of behaviour and accident risks on older cyclists. The results of the interviews were transcribed and analysed.
The fully standardised interview for the main study was developed on the basis of the results of these in-depth-interviews. The topics of the final interview were mobility habits, behaviour in traffic (e.g. cycle on which parts of the road, feeling of safety, violations), health / physical difficulties and their compensation in the areas motility, cardiovascular system, neurological system, muscle strength, diabetes, vision, and hearing.
The cyclists were asked if they had had at least one accident - including falls - after their $59^{\text {th }}$ birthday. If yes, they were asked for details of the latest accident. We assumed that the latest accident had the best chance to be recalled. We did not assess the number of accidents because we expected the number to be less reliable than the fact that the person had had at least one accident, especially for persons who had had several accidents.
It took between 45 and 120 minutes to work on the final interview. The cyclists could choose if the interview took place at the university, at their home or by phone. All persons who were interviewed on the phone received the material by mail beforehand. They got all questions with answer options and a number of pictures with different traffic signs, sketches of cycling facilities and types of bike frames.
Part of the results of the standardised interview is presented here.

## 3 RESULTS

### 3.1 Bike use, type of accidents



Figure 1. Frequency of bike use and average distance cycled per week.

Figure 1 shows the frequency of bike use and the distance cycled. As many participants did not know the distance covered exactly we helped them estimate it in categories. About half of the participants cycled daily or nearly daily, about one quarter each 1 to 2 and 3 to 4 times per week, 3\% 1-2 times a week and no participant less. The distance cycled per week was up to 14 km for $17 \%, 14-35 \mathrm{~km}$ for $40 \%, 35-70 \mathrm{~km}$ for $28 \%$ and more for $15 \%$.

## Accidents

109 persons had had no accident after their $59^{\text {th }}$ birthday, 97 persons had had at least one accident. The information about the latest accident showed that among these 97 latest accidents there were 33 collisions: 15 with a car, 14 with a bike, 1 with a motor assisted bike with a combustion engine, 2 with a pedestrian, 1 with a dog. 64 accidents had occurred without another party.

### 3.1 Demographic characteristics and accidents

The correlations between demographic characteristics and the fact if the cyclist had had at least one accident after her or his $59^{\text {th }}$ birthday were calculated.

The correlation of age and the fact if the person had had at least one cycling accident after the $59^{\text {th }}$ birthday was $r=.06$ ( $N=206, p=.435$ ). This means that in all ages the same amount of cyclists without any accident - including falls - could be found. This number is NOT corrected for age. In spite of the fact that the older cyclists had had many more opportunities to have had an accident the proportion of cyclists who had no accident was unrelated to age.
The correlation of gender and having had an accident after the $59^{\text {th }}$ birthday was $r=-.09$ ( $N$ $=206, p=.205)$. This means that the same proportion of men and women had had no accident after their $59^{\text {th }}$ birthday.

### 3.2 Exposition and accidents

Cyclists living in differently dense areas were not equally likely to have had an accident $F(2,203)=5,942, p=.003, N=206$. The Scheffé test showed that the only significant difference was between major city and rural area: $p=.004$ : In the rural area more cyclists had had no accident after their $59^{\text {th }}$ birthday than in the major city. The persons in the city cycled more often than the other groups but this did not alone account for the effect. The correlation between density of place of residence and the accident after the $59^{\text {th }}$ birthday is $r=.23$ ( $N=206$, $p \leq .001$, one-tailed significance), the partial correlation after controlling for frequency of bike use is $r=.17$ ( $N=201, p=.006$, one-tailed significance).


Figure 2. Frequency of bike use and percentage of persons who had an accident after their $59^{\text {th }}$ birthday.

The correlation between frequency of cycling and the variable accident after $59^{\text {th }}$ birthday was $r=.27$ ( $N=204, p \leq .001$, 1-tailed significance), the correlation between distance cycled per week and accident after $59^{\text {th }}$ birthday was $r=.092$ ( $N=204, p=.093$, 1-tailed significance). The

Scheffé test shows that more accidents were reported by persons who cycle daily or nearly risk than by persons who cycle 3-4 times $(p=.005)$ per week or 1-2 times per week ( $p=.008$ ). There is no difference in accident proportion between persons who cycle daily or nearly daily and persons who cycle 1-2 times per month $(p=.346)$, probably due to the small group of participants who cycle so seldom. This means that persons who cycle daily or nearly daily reported more accidents than persons cycling less often. This result is also presented in Figure 2.

### 3.3 Physical problems, their consequences and compensation



Figure 2. Physical / health problems in seven areas and their effect on cycling.

The cyclists were asked if they had problems in seven areas which might affect them when cycling. Figure 2 shows the results. Those persons who stated that they had problems which affected them when cycling were asked for the consequences and potential ways to compensate for the problem.
Diabetes and problems with the nervous system and were reported very rarely, by 2 and 4\% of the cyclists.

86 persons reported problems with motility which affected them when cycling. $48 \%$ of them reported problems turning their head when turning to a side with the bike. $26 \%$ had difficulties getting on or off the bike, and 20\% felt unsafe in traffic because of these problems.
47 persons had problems with the cardiovascular system which affected them when cycling. $81 \%$ of them said that ascending slopes were harder to get up than in the past, $55 \%$ said that they were less fit than in the past, and $17 \%$ felt unsafe in traffic because of these problems. Typical mechanisms of compensations were a gear shift on the bike, cycling more slowly, taking more breaks, cycling shorter distances than in the past and avoiding ascending slopes. 54 persons reported that their muscle strength had decreased and that it affected them when cycling. The inquired consequences were only affirmed by less than $10 \%$ of them. The mechanisms of compensation were the same as for cardiovascular problems and parking the bike on even ground.
72 Persons reported problems with their vision (without glasses). $31 \%$ of them said that they had poorer eyesight in the dark, and $11 \%$ felt less safe in traffic because of their problems with vision. Typical mechanisms of ways to compensate for problems with vision were to wear glasses and to have checked the visual acuity regularly. Only 197 participants were outside
their homes in the dark. 64\% of them reported that they were sensitive to glare in the dark, $40 \%$ of this subgroup said that they tried not to cycle in the dark.
35 persons reported difficulties with hearing (without hearing aid) which affected them when cycling, $31 \%$ of these persons said that they felt less safe in traffic because of their hearing problems, $25 \%$ said that they were startled often because they had not heard other road users approaching. 20 of the persons whose hearing affected them when cycling had a hearing aid, $70 \%$ had it on when cycling, $30 \%$ had it off.
For the seven fields of physical problems, correlations between the extent of the problem and the effect on cycling and the fact if the cyclist had had at least one accident after her or his $59^{\text {th }}$ birthday were calculated. Table 2 shows the results. The correlation of $r=.14$ between the reported effect of visual problems and the accident variable was significant, all others were not significant.

Table 2. Correlations ( $r$ ) between physical / health problems and accident after $59^{\text {th }}$ birthday, $N=204-206$.

| Physical problem | Extent of problem | Effect on cycling |
| :--- | :---: | :---: |
| Motility | .07 | .07 |
| Cardiovascular system | .10 | .05 |
| Nervous system | .05 | .00 |
| Diabetes | .07 | .01 |
| Muscle strength | -.02 | .03 |
| Vision (without glasses) | .05 | $.14^{*}$ |
| Hearing (without hearing aid) | .02 | .00 |

Note. Extent of problem and effect on cycling were coded as $1=$ none, $2=$ small, $3=$ medium, 4 = fair, $5=$ much. Accident after $59^{\text {th }}$ birthday was coded as $0=$ no accident, $1=$ at least one accident.

* This correlation reached significance with $\mathrm{p}=.022$ (one-tailed), $\mathrm{N}=205$.

If a person said that she or he had a certain problem further questions were asked for more special kinds of this problem. The majority of these problems were unrelated to the fact if the person had had an accident after the $59^{\text {th }}$ birthday. The only significant correlation found was between "Because of my motility problems I have problems to get on and/or off my bike" (no/yes) and the accident. This correlation was $r=.28$ ( $p=.011, N=85$ with motility problems). These difficulties were only related to falls and not to collisions. Table 3 summarizes the crosstabs of predictors of accidents.
Some incidents of not compensating for physical problems were related to accidents: "In order to deal with these [i.e. vision] problems I take mainly familiar routes": $r=-.24$ ( $p=.041, N=74$ with problems with vision which affected them when cycling): Persons who did not take mainly familiar routes were more likely to have had an accident. Insignificant correlations were found when collisions and falls were analysed separately.
Persons who had a hearing aid and did not switch it on when cycling were more likely to have had an accident.,"I have my hearing aid switched on when cycling": $r=-.47$ ( $p=.031, N=21$ persons with hearing aid). When accidents were split up, a significant correlation was only found with collisions and not with falls.
Not cycling shorter distances on days when one feels less fit was related to having had an accident: $r=-.20(p=.037, N=110$ persons who experience differences when cycling between days when they feel more or less fit). The same tendency was found for not cycling shorter distances in order to compensate for problems with the muscoskeletal system: $r=-.29$ ( $p=.033, N=55$ persons who have problems with the muscoskeletal system which affect them when cycling). Not cycling shorter distances for both reasons only predicted falls and not collisions.

Table 3. Crosstabs of predictors of at least an accident after $59^{\text {th }}$ birthday, a collision or a fall, correlations and chi ${ }^{2}$ values

|  |  | Accident after 59th birthday | Collision after 59th birthday | Fall after 59th birthday |
| :---: | :---: | :---: | :---: | :---: |
|  |  | No Yes Sum | No accident at all <br> Collision <br> Sum | ```No accident at all \\ Fall \\ Sum``` |
| Because of my motility problems I have problems getting on and/or off my bike. | No | 37 26 63 | 37 14 51 | 37 12 49 |
|  | Yes | 616 | 6 3 3 | 61319 |
|  | Sum | 434285 | 431760 | 432568 |
|  |  | $R=.28,(p=.011) ; c h i^{2}=6.455,(p=.014)$ | $r=.05(p=.724) ; c h i^{2}=0.130,(p=.704)$ | $r=.41(p=.001) ; h^{2}=11,366,(p=.002)$ |
| Because of my motility problems I use a rear mirror | No | 43 37 80 | 43 15 58 | 43 22 65 |
|  | Yes | $1 \begin{array}{lll}1 & 6\end{array}$ | 12 | 1 4 5 |
|  | Sum | 44 43 87 | 441761 | 442670 |
|  |  | $R=.22,(p=.046) ; c h i^{2}=4.010,(p=.058)$ | $r=.20(p=.128) ; c h i^{2}=2.363,(p=.185)$ | $r=.25(p=.040)>; c h i^{2}=4.236,(p=.060)$ |
| In order to deal with my vision problems I take mainly familiar routes | No | 27 38 65 | 27 12 39 | 27 26 53 |
|  | Yes | 7 2 9 | 7 1 8 | 7 1 7 |
|  | Sum | 34 40 74 | 34 13 47 | $\begin{array}{lll} \hline 34 & 27 & 61 \end{array}$ |
|  |  | $R=-.24(p=.041) ; c h i^{2}=4.180,(p=.071)$ | $r=-.15(p=.303) ; c h i^{2}=1.107,(p=.413)$ | $r=-.25(p=.054) ; c h i^{2}=3.765,(p=.066)$ |
| When I feel unwell I cycle shorter distances | No | 14 26 40 | 14 7 21 | 14 19 33 |
|  | Yes | 3931 | 391251 | 391958 |
|  | Sum | 53 57 110 | 53 19 72 | 53 38 91 |
|  |  | $R=-.20,(p=.037) ; c h i^{2}=4,375,(p=.048)$ | $r=-.10(p=.398) ; c h{ }^{2}=.736,(p=.395)$ | $r=-.24(p=.021) ; \operatorname{chi}^{2}=5.326,(p=.028)$ |


|  |  | Accident after 59th birthday |  |  | Collision after 59th birthday |  |  | Fall after 59th birthday |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | No | Yes | Sum | No accident at all | Collision | Sum | No accident at all | Fall | Sum |
| Because of my muscoskeletal problems I cycle shorter distances | No | 14 | 21 | 35 | 14 | 3 | 17 | 14 | 18 | 32 |
|  | Yes | 14 | 6 | 20 | 14 | 2 | 16 | 14 | 4 | 18 |
|  | Sum | 28 | 27 | 55 | 28 | 5 | 33 | 28 | 22 | 50 |
|  |  | $R=-.29,(p=.033) ; c h i^{2}=4,583,(p=.050)$ |  |  | $r=-.07(p=.692) ; c h i^{2}=.170,(p=1.00)$ |  |  | $r=-.33$ (p=.020); chi ${ }^{2}=5.414,(p=.036)$ |  |  |
| I have a hearing aid and it is switched on when I am cycling. | No | 1 | 6 | 7 | 1 | 2 | 3 | 1 | 4 | 5 |
|  | Yes | 9 | 5 | 14 | 9 | 0 | 9 | 9 | 5 | 14 |
|  | Sum | 10 | 11 | 21 | 10 | 2 | 12 | 10 | 9 | 19 |
|  |  | $R=-.47$ ( $p=.031$ ); chi ${ }^{2}=4.677,(p=.063)$ |  |  | $r=-.78(p=.003) ; c h i^{2}=7.200,(p=.045)$ |  |  | $r=-.39(p=.098) ; \mathrm{chi}^{2}=2.898,(p=.141)$ |  |  |
| I own a bike helmet | No | 68 | 46 | 114 | 68 | 14 | 82 | 68 | 32 | 100 |
|  | Yes | 41 | 51 | 92 | 41 | 19 | 60 | 41 | 32 | 73 |
|  | Sum | 109 | 97 | 206 | 109 | 33 | 142 | 109 | 64 | 173 |
|  |  | $R=.15(p=.031) ; c h i^{2}=4.649,(p=.036)$ |  |  | $r=.17(p=.042) ; c h i^{2}=4.136,(p=.047)$ |  |  | $r=.12(p=.113) ; c h i^{2}=2.536,(p=.151)$ |  |  |
| I run red lights | No | 102 | 68 | 170 | 102 | 19 | 121 | 102 | 49 | 151 |
|  | Yes | 7 | 29 | 36 | 7 | 14 | 21 | 7 | 15 | 22 |
|  | Sum | 109 | 97 | 206 | 109 | 33 | 142 | 109 | 64 | 173 |
|  |  | $R=.31,(p \leq .001)$ | $i^{2}=19.61$ | ( 5 .001) | $r=.43(p \leq .0$ | chi ${ }^{2}=26.05$ | ( 5 .001) | $r=.25(p=.001$ | $i^{2}=10.5$ | = .002) |

Notes. All $c h i^{2}$ values have $\mathrm{df}^{=}$1. $p^{\overline{=}}$ Significance, 2-tailed. For the $c h i^{2}$ tests exact significances (Fisher) are reported.

Two instances of technical compensation were related to having had an accident: Persons who used a rear mirror were more likely to have had an accident: $r=-.22$ ( $p=.046, N=87$ persons who had problems with their motility which affected them when cycling). Using a rear mirror was only correlated with falls and not with collisions.

Persons who owned a helmet were more likely to have had an accident: $r=.15$ ( $p=.031$, $N=206)$. When the accidents were split up only the correlation with collisions was significant. The correlation between the frequency of wearing a helmet and having had an accident was not significant: $r=.00$ ( $N=92$ persons who owned helmet).

### 3.3 Violations and accidents

In the whole sample, the accident variable had the highest correlation with the statement " $\mid$ run red lights" (no/yes): $r=.31$ ( $p \leq .001, N=206$ ). When the accidents are split up into collisions and falls both correlations are significant: $r=.43$ ( $p \leq .001, N=142$ ) for collisions and $r=.25$ ( $p \leq .001, N=173$ ) for falls. The correlations with all other violations for which we asked were as well positive.

## 4 DISCUSSION

We found that age and "safe" cycling - having had no accident after the $59^{\text {th }}$ birthday - are unrelated. This means that age as such makes accidents not more likely. This is remarkable because the older cyclists had had many more opportunities to have had an accident after their $59^{\text {th }}$ birthday than the younger cyclists. This shows that adequate behaviour which takes into account the typical problems of aging persons is important for traffic safety. Another contributing factor might be that some cyclists who feel at high risk or feel physically severely impaired might give up cycling as a former study had shown [8]. Balance problems are one of these factors which might lead to giving up cycling - instead of changing to a tricycle which most older cyclists do not see as a mobility option.
In our sample gender and having had at least one accident after the $59^{\text {th }}$ birthday are unrelated. In statistics, men have more cycling accidents than women [6]. This does not contradict our results because we did not assess the number of accidents. The underlying idea was that we did not expect to get a correct number for the falls in many years.
Cycling in the city is more dangerous than in rural areas. The reason might be the denser traffic which leads to more encounters. Some violations (cycling on the footpath, using the bike path in the wrong direction and running red lights) were also more often reported in the city than in the other regions [ 9 ]. This might also contribute to the higher accident risk.
Exposition measured as the number of kilometres a person cycles is not related to accident risk. On the other hand persons who cycle daily or nearly daily have a higher risk than persons who cycle less often - and below this threshold there is not more relation between cycling more or less often. This might point to the fact that some persons cycle "always", "everywhere" and "under all conditions". This might expose them to a higher risk than cycling a longer distance per se.

Most physical problems are unrelated to accidents. This points at the fact that compensation is at least partly possible. One exception are problems getting on and off the bike which are related to having had an accident after the $59^{\text {th }}$ birthday and to falls. The only compensation for having difficulties getting on or off the bike which is prominent among older road users are "ladies'" bikes for men or bikes with an extra deep step-through. (None of the female participants had a "mens'" bike for daily use.) Tricycles are no option for the vast majority and still need much more attention in the public and much more acceptance in society. As uneven surfaces affect tricyclists more than bicyclists these bikes need a better infrastructure. In combination with electric support they might be a very attractive means of transport for older cyclists who feel not ashamed when they are looked and stared at and commented on.

The relation between compensation and accident risk is not unequivocal. There are instances that insufficient compensation or no compensation at all might put older cyclists at risk: not cycling shorter distances when feeling less fit or having muscoskeletal problems. This points to the fact that some self-restriction might be adequate. Perhaps the same attitude of cycling "always", "everywhere" and "under all conditions" which might underlie the higher risk of persons cycling daily or nearly daily can be found here. It is not clear what the cause of such an "extreme" affinity to cycling is: attitude, habit (maybe lifelong), instrumental reasons (cycling is the cheapest, the fastest, the most convenient or even the only available means of transport), enjoyment some physical effort or a mixture of all of these. As cycling is a very easy way to get the necessary physical exercise to remain healthy one must be careful when advising older cyclists to restrain themselves. Too much self-restriction might cause more harm than the accident risk is worth, at least when cycling is not replaced by other physical activities. If a person is impaired in her or his mobility without a bike such physical activities might be limited to activities in the house which do not have the benefits of social contacts just as cycling has.
A novel result is found in the relation of having a hearing aid but not using it when cycling and the risk of having an accident or a collision. This result is insofar plausible as cyclists - different from car drivers - and similar to pedestrians can and do use auditory information in traffic. Observations show that cyclists do not always orient themselves to the back before changing lane or turning. Students and older cyclists were the groups which were most likely not to orient themselves to the back before changing lane or turning [12]. Turning unexpectedly to the left without orienting is risky for cyclists [13]. In a study $85 \%$ of the older cyclists said that they were well able to hear if a car was approaching from the back [14]. This means that the majority of cyclists do not have the impression that they might have difficulties when relying on their hearing. This is a very dangerous attitude. Our qualitative interviews showed that some persons with a hearing aid are annoyed by the wind noise and for this reason switch it off. It is not clear which role cycling plays when a person buys a hearing aid - Do hearing aid acousticians ask older persons if they cycle? It is not clear when the cyclist discovers that he or she has a problem with wind noise - How long are hearing aids not used at all? It is not clear which role the cost of a better hearing aid which is able to turn down the wind noise by electronics plays. We did not assess the temporal relation between getting the hearing aid and the reported accident but intend to do this in another study.

Adequate compensation for sensory impairment is necessary for older cyclists. Risks when cycling also arise from having a hearing aid and not using it when cycling or having visual problems and not cycling mainly on familiar routes. More research is needed in order to find out how persons with visual or auditory impairment can adequately compensate for their problems. This research is not necessarily limited to older persons but should include all age groups. Good infrastructure which is kept up well might help persons with visual problems: Curbs which are easy to see, no posts on cycle paths, clear markings [more examples can be found in 10] A questionnaire study with patients suffering from macular or tapetoretinal degradation between 14 and 60 years shows that compensating for visual problems when cycling is possible up to a certain extent. The accident risk when cycling increases when the visual acuity is less than 0.2 or the visual field diameter is less than $60^{\circ}$ [11].

Two instances of technical compensation were related to accidents. Owning a helmet, but not the frequency of wearing it, was related to accidents and collisions. As risk compensation cannot account for the negative effect of owning a helmet other explanations come to mind. We did not ask the cyclists how and on which occasion they got the helmet. If they had bought or got it after the accident this would explain the correlation. They might also have bought the helmet because they felt unsafe in traffic or after a near accident or they might have got it from a well-meaning relative or friend who thought that they were no longer safe in traffic. This will be asked in our next study.
Rear mirrors which are mounted on the bike are not very comfortable to use: They do not remain well adjusted, they provide no information when one is cycling on cobblestones. Besides, they have to be used continuously just as rear mirrors in a car. If they are used for one look before a lane change the danger might be in the dead angle, or estimating a vehicles velocity might be difficult. The correlation of using a rear mirror with falls but not with accidents leads
to the conclusion that persons who feel unsafe buy a rear mirror. This question will also be addressed in our next study.

## Beyond age

The best predictor of accidents of older cyclists was running red lights. This is no prominent cause of cycle accidents in Germany. The main risky behaviours are cycling on the footpath and using bike paths in the wrong direction, in short: cycling where other road users - mainly car drivers - do not expect cyclists. But running red lights might be the most prominent violation. Each time it needs a decision. One might assume that running red lights is only a predictor of collisions but this is not the case. Though the correlation with collisions is higher than the one with falls the latter correlation is also significant. For this reason running read lights might indicate very different potential predictors of accidents like attitude towards risks, overconfidence in ones competence to deal with traffic, or even disregard for social behaviour in traffic. These risk factors are not limited to older cyclists.
It is also remarkable that in this case the relative timing of the accident and red light running is clear: The statement "I run red lights" was made after the accident. Obviously accidents of older cyclists do not change their behaviour towards more rule obedience, at least not to a level that they accept red lights as much as safe cyclists do. A study on bus drivers also showed that they did not learn from accidents [15]: Accidents did not lead to changes in the measured acceleration.

## Limits of the study

In this study, interview data were used. For the assessment of physical and health problems this meant that we did not ask for a medical diagnosis (though it might have been given, which was likely the case for Diabetes) but the subjective problems of the cyclists. We intended to assess problems which the cyclists experience.
It can be questioned if a person who is more than 80 years old is able to reliably recall an accident after the $59^{\text {th }}$ birthday which then is more than 20 years ago. As the cyclists themselves are the most reliable source one can find we have to rely on their data.

In our cross-sectional study only correlations were determined. They do not allow a causal interpretation. Some causal relations can nevertheless be excluded. It can be derived that having had an accident after the $59^{\text {th }}$ birthday does not change the behaviour of cyclists in the direction of more rule-obedience - at least not to an extent that cyclists who had an accident became afterwards more obedient than those cyclists who had never had an accident.

All predictors explain only a small part of the variance found in accidents. Many questions remain open, and many more predictors -also from different sources of information - should be used to explain more. More knowledge is necessary to know why, how far and under which condition self-restriction might help the cyclist to remain safe and to profit from the benefits of cycling.

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