# A better understanding of single cycle accidents of elderly cyclists

S. de Hair*, C. Engbers**, R. Dubbeldam**, Th.Zeegers***, H. Liers****

*TNO, Steenovenweg1, 5708 HN Helmond, The Netherlands,
**Roessingh Research & Development, Roessinghsbleekweg 33, 7522 AH Enschede, The Netherlands
*** Fietsersbond, Postbus 2828, 3500 GV Utrecht, The Netherlands
**** VUFO, Semperstraße 2a, 01069 Dresden, Germany

**Abstract -** Cycling supports the independence and health of the aging population. However, elderly cyclists have an increased injury risk. The majority of injured cyclists is victim of a single-sided accident, an accident in which there is no other party involved [1]. The aim of the project 'Safe and Aware on the bicycle' is to develop guidelines for an advisory system that is useful in preventing single-sided accidents . This system is able to support the elderly cyclist; enabling the cyclist to timely adapt his cycling behaviour and improve cycling safety and comfort. For the development of such advisory system the causes of singles accidents and the wishes of the elderly cyclist must be known. First step to obtain this insight was an literature survey and an GIDAS research. Unfortunately accidentology research with GIDAS did not give the full understanding of the pre-crash situations and (especially the behaviour related) factors leading to the accident. The second step was consultation of elderly cyclist through a questionnaire (n=800), in-depth interviews (n=12) and focus group sessions (n=15). This offered complementary information and a much better understanding of the behavioural aspects. Results concern the behaviour in traffic and identify specific physical (i.e. problems looking backwards over the shoulder) and mental issues. Furthermore, the needs and wishes for support in specific cycling situations were identified.
In conclusion; The GIDAS results together with the information obtained contacting the elderly cyclists enabled setting up requirements for an advisory system, which is useful in preventing single-sided accidents

## INTRODUCTION

In the Netherlands, the number of fatal accidents in traffic has been showing a declining trend for years. However, the number of serious injuries has been increasing again since 2006. A large proportion of the number of people with serious injuries consists of cyclists. Approximately 80% of the seriously injured cyclists are victim of a single-sided accident, i.e. an accident in which no other party is involved [Weseman 2011].
Older people (65 years and older) are overrepresented in the group of seriously injured cyclists involved in single-sided accidents [Zeegers 2010]. On average the risk of older people to sustain an injury in a cycling accident is 3.2 times higher per cycling kilometre than for non-elderly [Zeegers 2010] and it is increasing with age. Within the group of older cyclists, people over 75 years are particularly vulnerable. The risk of hospitalization is more than 4 times as high for them [SWOV 2009]. Elderly cyclists tend to and need to adapt their behaviour according to their mental and physical abilities in order to avoid cycling accidents [Hagemeister 2011].
Beside the risk of cycling, cycling also offers positive aspects:
- It is good for the health
- It keeps people mobile and independent.

However, it is thought that cycling accidents may be further prevented and cycling comfort enhanced when more (specific) information about traffic conditions is known by the cyclist in advance. The general purpose of the project 'Safe and Aware on the Bicycle' therefore is to specify requirements (wishes, needs and expectations) in order to come up with recommendations for a feed-forward system that provides the elderly cyclist with information, which enhances safety and increased bicycle comfort. The proposed system might have the following functions;
- To inform in advance about a safe route for the elderly cyclists.
- To inform about dangerous conditions in advance and while cycling, e.g. the weather
- To warn about potential hazardous locations and/or situations while cycling
- To warn about potential dangerous behaviour while cycling.

## METHODS
To improve the general understanding of the accident mechanisms and causes, accident analysis studies have been performed and reported in literature. So far, most studies on bicycle accident analysis are based on police records [SWOV 2009]. These studies, however, are not representative for

the occurring number of accidents, nor for the number of cycling injuries: Bicycle accidents are highly under-reported by the police (current registration rate = 5 %). Hospital records might provide better insight in the number of accidents and injuries, but also hospitals do not register all accidents: Often treatment or hospitalization does not take place when minor accidents occur. Hence, the actual number of accidents is very likely to be higher compared to what is stated in police records and 'light' single-sided bicycle accidents resulting in minor injuries are underrepresented in official statistics [Zeegers 2010, SWOV 2009]. Many policymakers and regulators base their cycling policy and changes in cycling infrastructure on the official statistics. Therefore, causes of single-sided accidents with minor injuries, which do not end up in (hospital or police) statistics, are not recognized as problematic [Hagemeister 2011].

To obtain a better insight in single sided accidents of elderly cyclists (65+) the following information sources were used; Starting with a literature survey and a database research (using the database of the German In-Depth Accident Study GIDAS). The literature survey was used to get a good overview of the problems of single sided accidents, like critical situations, characteristics of elderly, risky behaviour and accident causation. GIDAS was used to give more in-depth knowledge on the accidents. On top of this desk study the elderly cyclists were consulted through a questionnaire (n=800), in-depth interviews (n=30) and focus group sessions (n=15). The questionnaire was used to obtain general information about the elderly cyclists, critical cycling situations and potential technological solutions and user needs and desires. The interview was used to complement the results gathered in the questionnaire and to obtain in-depth information about topics that were found significant in the questionnaires. The focus group sessions were used to obtain requirements for the specification of the advisory systems based on user needs.

## Methods literature review

The aim of this review was to obtain insight in risky situations and activities elderly cyclist face during their cycle trip. Further was investigated which accidents and accident types take place and what happens during the last few minutes before the accident takes place (actions and behaviour of the elderly cyclist). All with the scope to obtain data which is needed to specify a successful advisory system, in order to prevent single sided cyclist accidents. The focus is on accident causes related to behavioural aspects and habits and the bicycle itself, also attention is paid to infrastructural causes. This study focuses specifically on risky situations in order to come up with recommendation to overcome this kind of situations. Parameters taken into account are: age, cycle use, age, registration level, accident types, trip characteristics, risky situations.

## Methods accidentology research

In the literature review, often a reference to GIDAS is used. No specific query to single sided accidents is known. The GIDAS database has been used to obtain in-depth knowledge of single cycle accidents. The Netherlands does not have such an in-depth database. Therefore it was expected to be useful in addition to the Dutch national statistics: the police registration (BRON) and the hospital registrations (LIS). One has to take into account that German and Dutch circumstances can be different. The GIDAS database is mainly used for accidents with motorised vehicles, but offers also single sided cyclist accident cases. As a first step a statistical analysis to the in GIDAS registered single sided cyclist accidents with elderly (age 50+) was executed. As an indication; GIDAS consists of 5.590 injured cyclists after weighting with German national statistics. 31% of them are aged 50 or more. 17% of these accidents are single sided accidents. Parameters taken into account in the GIDAS analysis were: accident type, cyclist age, gender, location, injury type and level, time of day, weather and accident cause. As a second step the accident descriptions of the target group were obtained, in order to get a better understanding of the accident cause and circumstances of the pre-crash situation. In the GIDAS analysis all MAIS levels were taken into account.

## Methods questionnaire

The participants included men and women of 65 years and older who were still cycling. Most participants in this study were participants who signed up for the cycling school from the Dutch cyclist union. The participants received the questionnaire from the instructor that day or, if preferred, they received a link to the internet version of the questionnaire. Other respondents were recruited by the union for elderly (KBO): The paper questionnaire was attached in their monthly magazine. All of the respondents who filled in the paper version returned the questionnaire with the attached self-addressed envelope.

First some demographic aspects were asked, such as gender, age, province and living environment. Furthermore, the elderly cyclist was able to describe their experience regarding bicycle usage, physical and cognitive impairments, (adaptation of) cycling behaviour, critical cycling situations, technological experience and wishes with respect to technological support. The questions on technological experience were added to gain insight in the use of technological devices by this group of elderly cyclists.

## Methods interviews

At the end of the questionnaire, participants were asked if they were willing to participate in an interview. They could fill in their email address of telephone number if they were interested. All respondents were approached by telephone or email to make an appointment for the interview by telephone. An informed consent and an information letter were send to the participant by mail prior to the appointment. Themes in this interview were initially comparable to those in the questionnaire: demographics and bicycle details, frequency of cycling and most common destinations, physical and mental limitations, technology experience. Our first aim with the interviews was to check if similar answers were given compared to the questionnaires. In a second step, it was possible to ask more in-depth questions on specific items. Furthermore, the wishes and needs for support in specific cycling situations were identified. All interviews were audio-recorded and analysed afterwards by content analysis. Besides elderly cyclist also 'cycling school' teachers and bicycle traders were interviewed, in order to obtain an view of the elderly cyclists needs as objective as possible.

## Methods focus group session

Focus group sessions were organised in order to obtain information on technological details and specification of an advisory system. Participants are recruited via a local new paper and a local foundation. Intakes were done via telephone. The meetings took place at Roessingh Research & Development and lasted for 2,5 hour. Feedback is obtained on the following topics: kind of warning, location of warning, warning frequency and duration, extra desired functionality. Per topic people were asked to come up with their preferences. After 2 workgroup sessions it was observed that people find it difficult to imagine the advisory system and its parameters, resulting is less useful results. Therefore it was decided not to conduct more focus group sessions.

## RESULTS

## Literature review

The causes of single-sided bicycle accidents can be related to infrastructure, the role of the bicycle and behaviour of the cyclist as has been indicated in accident analysis studies based on police and hospital records. Concerning the role of the infrastructure [Schepers 2008] and [Ormel 2009] show for example that 20% of the single-sided accidents involve a collision with an object, such as a pole or a curb. Slippery road and bumps in the road are also frequently given as an accident reason. Furthermore several studies show that junctions are often experienced as problematic [SWOV 2012]. In general, intersections are experienced as complex situations, where attention simultaneously has to be given to various traffic situations. Especially turning left is experienced as a problem by elderly people. Regarding the role of the bicycle in single-sided accidents, little is known. Elderly often make use of a relatively common bicycle although there are many alternative bicycles available with a low entry and

mirrors, especially designed for seniors. However, elderly often choose not to use such adapted bicycles because of multiple reasons [Berveling 2012]. Older people feel uncomfortable about these bicycles. Purchasing such a bicycle confronts them with their disability and these bicycles are not yet well established in society. Besides that, their disability normally occurs very gradually and older people generally like to hold on to old habits and behaviours. Furthermore, bicycle related causes almost never occur independently. Usually the condition of the bicycle plays a role in combination with the behaviour of the cyclist [Reurings 2012]. Although the study of [Kruijer 2013] has illustrated that the use of electric bicycles does not lead to more accidents, [Fietsberaad 2012] suggests that the use of electric bicycles can lead to accidents when the engine (pedal support) starts too abrupt.

The behaviour of cyclists is reported to play an important role in single-sided cycling accidents studies from hospital and police records: For all age groups, about half of these accidents were related to cycling behaviour such as a clumsy steering or braking manoeuvre or getting hitched during getting on or off the bicycle [Ormel 2009, Kruijer 2013]. According to [Ormel 2009] one fourth of the cyclists aged 55 and older indicated getting on or off their bicycle as the cause of the accident. This is significantly more than in other age groups (8%). Because the above cycling behaviour studies are based on data from respondents who have been treated at an emergency room, little is known about the 'light' cycling accidents and their mechanisms and causes.

So far, only one study analysed the relationship between cycling abilities or behaviour and accident mechanisms of self-reported cycling accidents [Hagemeister 2011] show that the proportion of single-sided cycling accidents increases (65% vs. 55%) and are more frequently related to own cycling behaviour (60% vs. 50%) compared to cycling accidents in hospital records. As a comment, we note that the victim's own role is usually overrated in self-report studies and therefore external roles are usually underrated. The risk of sustaining a cycling accident could be related to physical impairments such as problems getting on or off the bicycle or not-compensating for sensory difficulties. Most cyclists indicated to adapt their cycling behaviour according to their physical and mental impairments, e.g. older cyclists often get off their bicycle or turn left indirectly (first cross one street and then cross the other). Sometimes elderly have trouble to look over their shoulder: They trust on their hearing or they indicate their upcoming change of direction well in advance without actually looking over their shoulder. Interestingly, the study of Hagemeister and Tegen-Klebingat shows that adults aged 60 years and older violate traffic rules. The researchers connect this behaviour to the search for subjective certainty. Additional subjective findings show that elderly cyclists are scared when they are passed by traffic with a high difference in speed. In particular, a shock reaction occurs when elderly do not hear the vehicles and therefore do not anticipate the overtaking manoeuvre.

## Accidentology research

The first step in the GIDAS analysis was a parameter analysis of all single sided cycle accidents. GIDAS consists of 22.347 reconstructed accidents. In 6.641 a cyclist is involved. 6.239 cyclists are injured. After weighting with German national statistics 5.590 injured cyclists remain. Of these cyclists 31% are aged 50 years or more. There is a higher proportion of female (54%) than male (46%) in this category. About 12% of the cyclist accidents are single cyclist accidents. A comparison between the target group (50+) and the reference group (age 15-49) showed that the target group has a higher share of single accidents (17% compared to 12%), a higher share of driving accidents (loss of control) and a lower percentage of turning off the road. Further is remarkable the high percentage of accidents with animals and physical disability of cyclist of the elderly cyclists. With increasing age the likelihood on a severe injury (high MAIS value) increases (figure 1) as well as the risk of a fatal accident.

Focussing on the single cyclist accident only the following can be concluded. The major proportion of the accidents take place in urban area, and on a straight road. Most accidents take place during day, with increasing age the share increases. As expected, hardly any accidents occur during rain or snowfall. The road conditions show an equal share of the age categories. About 80% take place on dry roads. Of course, these numbers cannot be used to draw conclusions on the risk levels involved.

Figure 2 shows the top 10 of the most common accident types of single cycle accidents in GIDAS. Besides the accident types, the accident causes were studied. With respect to accident causation the

following can be concluded. The analysis is based on the official German list of accident causes. The list of available accident causes is not very detailed and not always appropriate for the accidents studied (single sided cyclists accidents). The accident causation study shows a high proportion (50%) of 'other mistake of driver' (including 'inattention', 'distraction', 'missing controllability'). Alcohol as accident causation factors decreases with age. In general 20% were intoxicated. In comparison to the reference group the share of bad road condition as contributing factor increases with age. Inappropriate speed is not only a problem for younger cyclists. Often this parameter is mentioned in combination with special road conditions. The share of physical disabilities increases significantly with elderly cyclists. Obstacles on the road (including animals) is a problem, especially for age group 75+. Technical deficiencies (including bad lighting, brakes, tyres) are not essential. Transport of baggage as contributing factor is low (5%) although the share increases with cyclist age. The behaviour of the driver and road user are not coded as initiated factor, but often as contributing factor. 75% of the injured cyclists are male. However, there is an increasing share of women aged 75+ (probably due to their higher life expectancy). The share of recreational trips is large. The number of shop visit increases with age. The share of travel to work (above age of 65) is as expected not present anymore. The share of cardiovascular diseases increases. Probably the real values are higher, as people forget to report it. A strong correlation between medication and illness can be seen.

As alternative approach to the top 10 accident causation overview, the accident descriptions of all single cyclist accidents of elderly cyclists were investigated. Based on this a new classification was made, that fits better to single cycle accidents. The results are shown in figure 3. This offered insight in the scenarios, but unfortunately the focus was more on the crash part of the accident than the pre-crash part. For the advisory system specification the pre-crash part is most relevant.
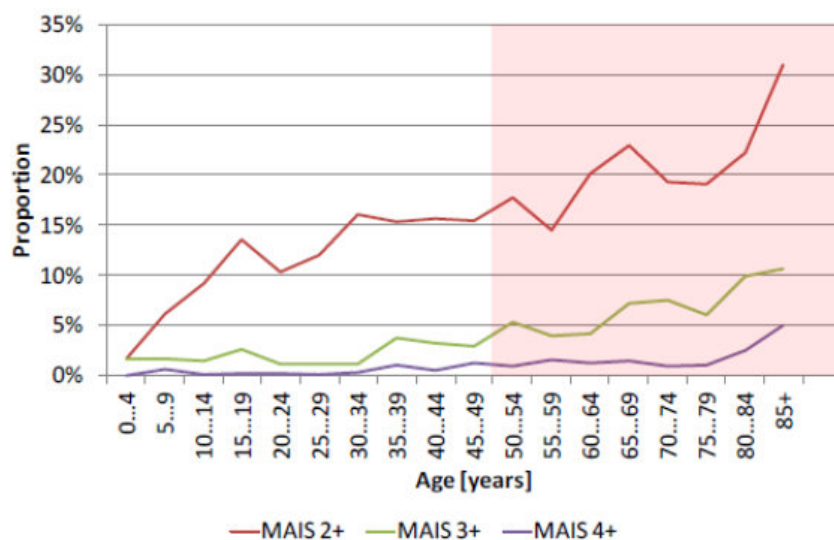


**Figure 1: Injury Severity level (MAIS) of injured cyclist as a function of age [registered in GIDAS weighted with national statistics (n=5590)]**
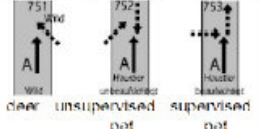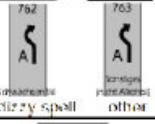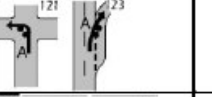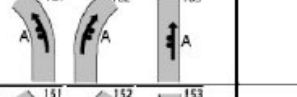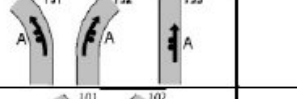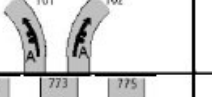
| Loss of control accident on straight roads |  | 25,0% |
|---|---|---|
| Other accidents |  | 17,3% |
| Animals on the road |  | 9,5% |
| Sudden physical disability |  | 7,9% |
| Other loss of control accidents |  | 5,1% |
| Loss of control accident while turning off |  | 4,7% |
| Loss of control accident due to road condition |  | 4,6% |
| Loss of control accident on a steep hill up/downwards |  | 4,4% |
| Loss of control accident in a bend |  | 4,3% |
| Sudden vehicle damage |  | 2,7% |

**Figure 2: Top 10 single accident types of age group 50+ [registered in GIDAS weighted with national statistics (n=5590)]**
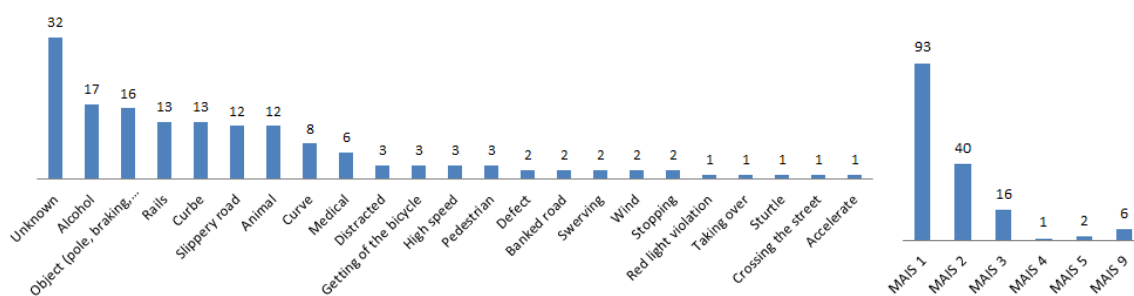


**Figure 3: Classification of single sided cyclist accidents in GIDAS based on accident description [single case analysis]**

## Questionnaire

In total 1400 questionnaires were spread. In total 879 questionnaires were completed.
The mean age of the participants was 72,4 years (SD = 5.7 ; range = 65 - 104) with an even distribution between men and women (men: 45,9%; women, 53,9% men). Most respondents lived in a

village of rural environment (75%) compared to a city (25%) and were the provinces from Gelderland, Overijssel and Noord-Brabant.

Most participants used a ladies bicycle (70,8%) instead of a men's bicycle (28,5%). 41.1% used a normal bicycle, 29,9% used an electric bicycle and a normal bicycle and 29.1% used an electric bicycle only. The participants who had an electric and a normal bicycle mostly used the electric bicycle (62,4%). The electric motor was most commonly located in the front wheel (52.3%), in comparison with 30,1% in the rear wheel and 10,2% in the crankshaft. 21.4% had an adjustment to the bicycle, of which 5,1% used a mirror. 69,6% of the elderly participants stated not to have any adjustment. Most participants cycle more in summer than in the winter. In summer, more than 60% of the participants cycled every day in comparison to less than 40% in winter.

Most common cycling destinations were shopping, visiting friends and recreational tours. Of the participants, 64.8% replied not to consider the time of the day when cycling and 19.7% did not consider the weather condition when cycling. Participants that did consider the weather, mostly considered snow, slippery conditions and rain. In bad weather conditions the participants reported to adapt their behaviour: more concentrated (37,5%), more cautious braking (31.4%), slower cycling (25,1%). 88% stated that he or she is in good health and is moderately active on a regular basis (figure 4). The majority (85%) of the participants felt confident on their bicycle.
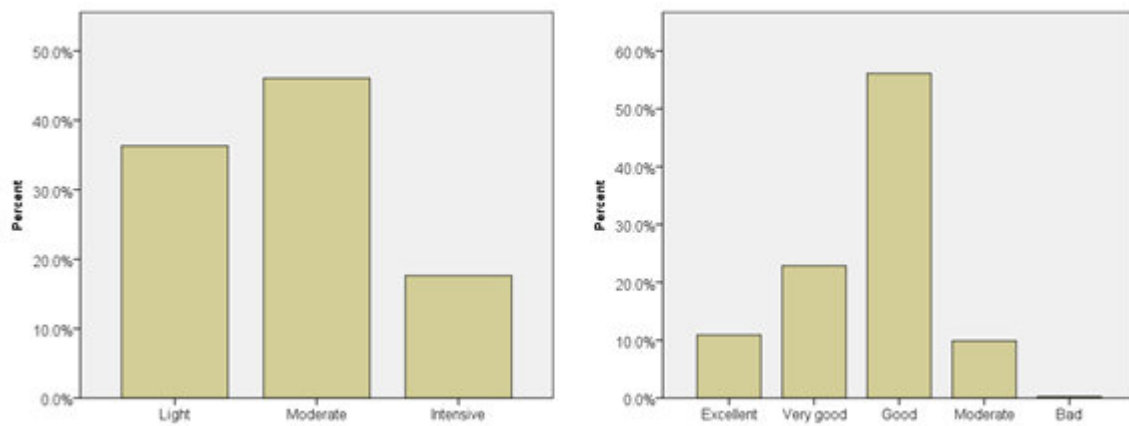


**Figure 4: (left) activity level of participants (right) health level of the participants [based on questionnaire feedback]**
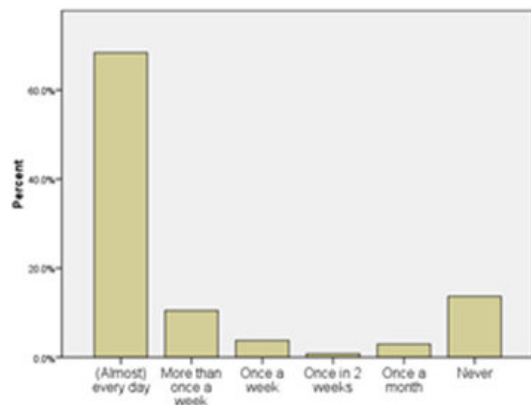


**Figure 6.** Use of computer/laptop

**Figure 5: use of computer/laptop of the participants [based on questionnaire]**

About 50% of the participants stated to have physical problems, such as; Sore knees (13,7%), limited endurance (12.4%), stiff and/or sore neck (11,1%), reduced hearing ability (11.1%). 35,9% of the participants mentioned to have mental problems i.e., reduced reaction time (12,4%), fear to fall off their bicycle (12,2%), feeling uncomfortable in messy, chaotic or unclear traffic situations (16.7%). More than 80% adjusted their cycling behaviour since they became 50 years old; they became more

patience in traffic and paid special attention to reducing speed on time. Almost half of the participants (42,9%) admitted to violate traffic rules, for example; 32% cycled on the wrong side of the road and 22% cycled on a pedestrian area.

47,3% of the participants had fallen of their bicycle since they became 50 years old at least once. Many causes were mentioned, but most common causes were slippery roads, fall while getting on of or off their bicycle or a collision with the curb. Poles and other obstacles are frequently mentioned to be badly or not visible.

The use of electronic devices such as computers and laptops was quite high within our group of elderly cyclists (figure 5). Only 17% stated never to use a computer or laptop and internet (figure 5). The use of smartphones and tablets was less frequently reported; 23% uses a tablet and 17% a smartphone. Navigation systems are not frequently used by the participants in this study, 76.2% does not use a navigation system.

The needs and wishes for support in specific cycling situations were identified (figure 6). This table shows the importance of several functions for a feed-forward system. Of our elderly cyclists, 81.5% would like to be informed about dangerous locations; 82.1% would like to be warned about a slippery road, 76% would like to be informed when there is traffic behind them and 71.4% would like to be informed about an upcoming traffic situation.
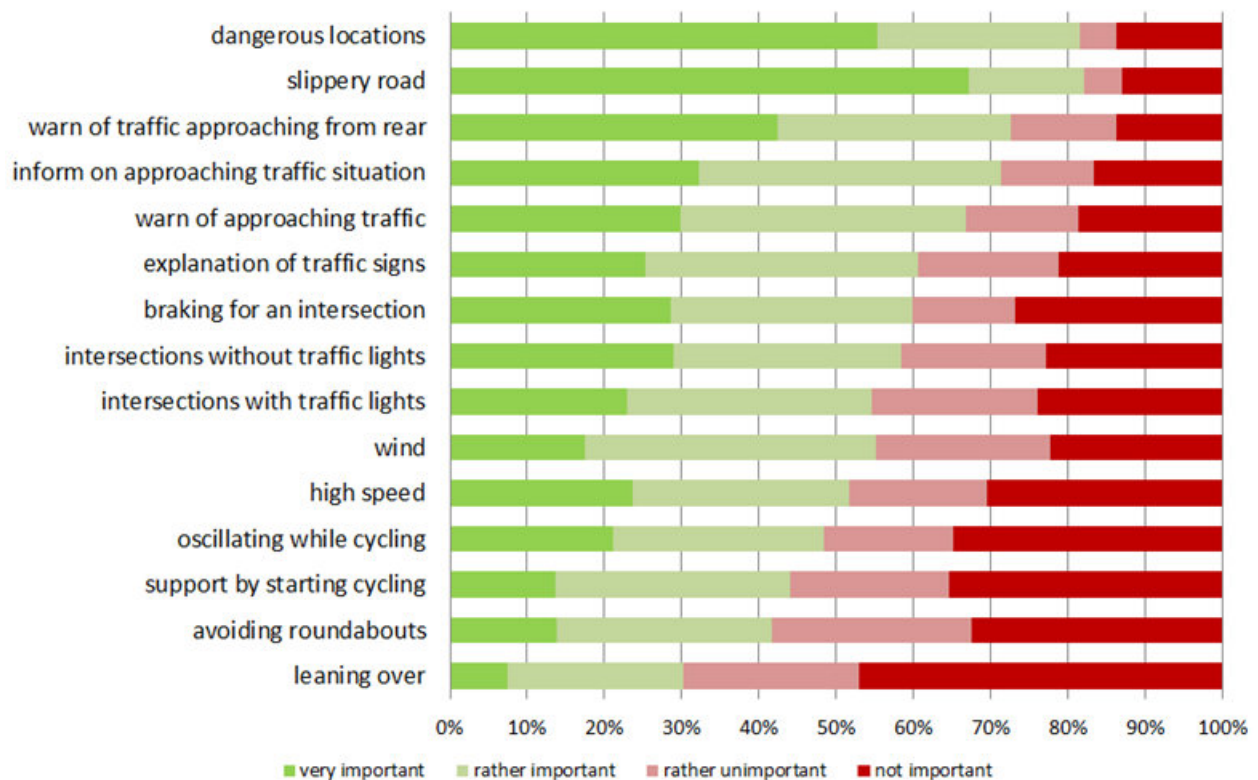


**Figure 6: Overview of needs and wishes for support in specific conditions; importance of feed-forward functions [based on questionnaire]**

## Interviews

Results from the personal interviews complemented the above knowledge and provided more in-depth information.

Twelve interviews were conducted. The mean age of the participants was 81,7 years and consisted of 15 men and 13 women. Eight were living in a rural environment and four were living in a city. Five were cycling on a normal bicycle, three on an electric bicycle and 4 used an electric bicycle as well as

a normal bicycle. All respondents cycled in summer, two of them did not cycle in winter months and six cycled less. Only three also use their bicycle when there is snow or the road is slippery.
In general, the respondents with an electric bicycle were satisfied with their bicycle. However, some participants mentioned to have some trouble with the weight of their bicycle and the transition between a normal bicycle and an electric one. Some respondents complained about the advice they received from the bicycle dealer.

Seven respondents stated that they adjusted their cycling behaviour since they became 50 years. The most frequently mentioned adjustments were cycling with more patience, stopping more frequently and avoiding busy situations or times. Almost all (n=10) of the participants stated that their health is (very) good, meanwhile they all experience physical complaints e.g. suffer from a stiff and/or painful neck, less endurance or loss of strength. Many of the respondents mentioned that they have some difficulties with chaotic, busy and unclear traffic situations. Others also have trouble with a busy intersection. Actions that were named as more difficult are getting on and of their bicycle, looking backwards over their shoulder and taking a curve with high speed. Most of the respondents had troubles with racing cyclists and youth passing by at higher speeds. They do not hear the people who use a road bicycle and are frightened by them.
Most people had some trouble imaging a feed-forward system, but when given some examples they became enthusiastic. Nevertheless, some had some doubt about the technical possibilities and suggested the system should not be too complicated. Eight participants responded positive on using a feed-forward system, three had trouble imaging feed-forward system and one was negative. Regarding the mode of providing a warning or information, only one participant was positive about the signal being given by a display, the others preferred visual, audial or vibration signals.

## DISCUSSION AND FUTURE WORK

This study aimed at obtaining wishes and needs of elderly cyclist regarding a feed-forward system. The results of the interview and GIDAS analysis gave a good starting point for the exploration of the problem of single cyclist accidents. Overall the GIDAS results are in line with other sources. Based on the accident descriptions obtained, GIDAS shows a large share of cases in which alcohol, and objects (poles, rails, curbs and pets) play an important role. In contradiction to the Dutch statistics GIDAS shows less cases in which stepping on/off the bicycle, slippery road, cyclist being startled, curve and road bank side play a prominent role in accident causation. The injury level and injured body regions are well described and are complementary to the Dutch statistics. The risks based on GIDAS analysis are mainly related to infrastructure, in line with the police registration. The GIDAS database is designed for investigating every type of traffic accidents. The most users use the database for analyses related to motorized vehicles. The database is hardly used for the investigation of single sided cyclist accidents, which makes some parameters used to characterize a cyclist accident less suitable. A good example of a less suitable parameter for cyclist accidents is the coding of the accident causation and cyclist's mistakes. The accident causation for single sided cyclist accidents is often unknown or "other mistake". In the accident description the pre-crash information is missing in most of the cases. Unfortunately this made the applicability for the definition of an advisory system less useful as expected before. Nevertheless GIDAS is complementary to the Dutch statistics with respect to injury description. For specific use cases this GIDAS knowledge can be used. The GIDAS research offered the following insights:
- Accident classification based on manoeuvres does not offer a good insight in risk factors, in contradiction to what it normally does offer for cars.
- For single sided cyclist accidents the combination of factors leading to the accident is more significant to discriminate what happened rather than the manoeuvre. This requires another type of accident classification for cyclist accidents than used for motorcycle accidents.

The results of the questionnaires and the interviews provided detailed information about elderly cycling behaviour in traffic and their wishes for support. Mental and physical problems and their effect on cycling behaviour were identified. Most common bicycle destinations in this study were shopping or leisure tours, which are, according to [Ormel 2009], the types of rides during which most single-

sided accidents happen. This indicates that the most common cycling destinations are also the most risky ones. Most common problems mentioned by the participants in this study corresponded to literature, such as intersections [SWOV 2012] and turning left [Hagemeister 2011]. Remarkable is that the elderly in this study admitted to frequently violate traffic rules, this has been shown previously by [Hagemeister 2011]. According to Hagemeister, violating traffic rules is a strategy to enlarge their subjective safety, especially in complex situations. Alternatively, one could speculate that the smaller tendency of elderly to be sensitive to social control, could provide an explanation as well.

The respondents in this study used a computer, laptop and tablet intensively, which might indicate that they are getting used to modern technology.

So far, the results indicated that the elderly population is a risk group for falling off or with a bicycle: 50% of the participants reported a fall with their bicycle, which is in line with the findings from the self-reported bicycle accident study by [Hagemeister 2011]. Regarding impairments, especially, the inability to look over the shoulder and impaired hearing can be dangerous with the increasing use of quiet motorized transport (electric cars and motorcycles). Using a feed-forward system may provide support in such situations, e.g. by warning for traffic coming from behind. The interviews confirmed most findings of the questionnaire and proved to be a valuable addition to the questionnaire. Besides the interviews with seniors, several cycling instructors and bicycle sellers were interviewed. Their opinions and views were very valuable and important and complemented the results. Additional analyses are planned. Some relations need to be explored, for example; the relationship between violating the rules and fall history, the relationship between technology experience and feed-forward wishes or the relationship between physical and mental limitations and feed-forward wishes. In addition, differences between men and women and differences between the group who completed the questionnaire on paper and the group who completed the questionnaire online needs to be explored. Additional information about the feed-forward system needs to be further explored.

The main problems as identified in the questionnaires and interviews were confirmed, as well as the potential solutions. Further was identified that a relation exists between the main problems people experience and the solutions they are looking for. This indicates people would like to be supported for their main problem. In the focus group session only one type of advisory system was selected for further specification, namely the rear ward looking assistant. Other assisting system were not taken into account. People indicated they prefer to use a rear ward assistant rather than a rear view mirror. People are prepared to pay for a solution, but they found it hard to quantify the exact amount of money they like to pay for it. The following additional information is obtained from the focus group session: people like to be warned more often and early preferably displayed on their steering wheel. No common view on the type of warning was retrieved. It seemed to be rather difficult to imagine how a type of warning would feel like and what would be most preferable. In simple experiments (done within the project but not further described in this paper) it was found that people need to experience a warning in order to be able to judge their preference. Therefore it was decided not to proceed with the focus group sessions (in which people could not experience the warnings). The focus group sessions did offer insight in people's preferences with respect to system configuration settings; like for example they like to be able to switch of the device (when cycling in a group) or they only want to obtain a warning when they are really being taken over.

## CONCLUSION

The GIDAS results together with the information obtained contacting the elderly cyclists enabled setting up requirements for an advisory system which will help to reduce the number of killed and severely injured elderly in single cyclist accidents. The information retrieval methods used in this study each have their own advantage. They are complementary and offer together a good insight in the problems of single sided accidents.

- The literature study and accident analysis study are good measures to start the exploration of the problem of single cyclist accidents. They give an objective view on the accident problems. However under-registration and the lack of detailed of pre-crash information require the need for more information. The in 2013 finished in-depth study of the SWOV offers complementary information.

- Questionnaires, interviews and focus group session are a subjective, but useful complementary method to gain insight in the pre-crash phase as well as the user needs and desires. The results are in line with the literature review and the accidentology analysis, but offered the potential to gain more in-depth information. This is essential to come to the design for the specification of an advisory system.

So far, we concluded that the older people in this study were in good health and cycle frequently. Although they stated they were in good health, they do have physical and mental problems. Half of all respondents fell of their bicycle since their fifties, which confirms that this age group is a risk group when it comes to falling off or with a bicycle. The subjects stated that they feel confident and secure on a bicycle, but when situations become complex or chaotic, they lose control. The respondents mentioned several situations in which they would like to be informed or warned by a feed-forward system. This might indicate that there is a need for such a system. The results of this study will be used within the project 'safe and aware on the bicycle' for recommendations and specifications for various applications to be used in a feed-forward system.

## ACKNOWLEDGEMENTS

## REFERENCES

- Weseman, P. & Weijermars, W.A.M., Verkeersveiligheidsverkenning 2020. Leidschendam: Stichting Wetenschappelijk Onderzoek Verkeersveiligheid, 2011
- Zeegers, Th. Ongevallen met oudere fietsers. Utrecht: Fietsersbond, 2010
- SWOV, Factsheet Fietsers, Leidschendam: Stichting Wetenschappelijk Onderzoek Verkeersveiligheid, 2009
- Hagemeister, C. & A. Tegen-Klebingat, Fahrgewohnheiten älterer Radfahrerinnen und Radfaherer. Köln: TÜV Media GmbH, 2011
- Schepers, P., De rol van infrastructuur bij enkelvoudige fietsongevallen. Rijkswaterstaat Dienst Verkeer en scheepvaart, 2008
- Ormel, W., K. Klein Wolt & P. den Hertog, Enkelvoudige fietsongevallen. Een LIS-vervolgstudie. Rijkswaterstaat Dienst Verkeer en Scheepvaart, 2009
- SWOV, Factsheet. Ouderen in het verkeer. Leidschendam: Stichting Wetenschappelijk Onderzoek Verkeersveiligheid, 2012
- Berveling, J. & H. Derriks, Opstappen als het kan, afstappen als het moet. Een sociaal-psychologische blik op de verkeersveiligheid van fietsende senioren. Den Haag: Kennisinstituut voor Mobiliteitsbeleid, 2012
- Reurings, M. C. B., W. P. Vlakveld, D. A. M. Twisk, A. Dijkstra & W. Wijnen, Van fietsongeval naar maatregelen: kennis en hiaten. Leidschendam: Stichting Wetenschappelijk Onderzoek Verkeersveiligheid, 2012
- Kruijer, H., Hertog, P. den, Klein Wolt, K., Panneman, M., et al., Fietsongevallen in Nederland; een LIS, vervolgonderzoek naar ongevallen met gewone en elektrische fietsen. Amsterdam ,VeiligheidNL, , 2013
- Fietsberaad Gat in de markt voor veilige producten fietsende senioren. Beschikbaar op: http://fietsberaad.org//index.cfm?lang=nl&repository=Gat+in+de+markt+voor+veilige+producten+fietsende+senioren#Comments., 2012