

Cyclist-reported habits of helmet usage and differences in riding postures by using helmets

Jänsch, M., Otte, D.

¹ Accident Research Unit, Hannover Medical School

Abstract

Within the COST Action TU1101 the working group WG 1 is dealing with acceptance criteria and problems in helmet use while bicycling concerning conspicuity, thermal stress, ventilation deficits and other potential confounding.

To analyze the helmet usage practice of bicyclists in Europe a questionnaire was developed in the scope of working group 1 to collect relevant information by means of a field study. The questionnaire consists of some 66 questions covering the fields of personal data of the cyclist, riding and helmet usage habits, information concerning the helmet model and the sensation of the helmet, as well as information on previous bicycle accidents. A second complementary study is conducted to analyze if the use of a bicycle helmet influences the seating geometry and the posture of cyclists when riding a bicycle and if the helmet vertically limits the vision. For this purpose cyclists with and without helmets were photographed in real world situations and relevant geometrical values such as the decline of the torso, the head posture of the upper vertical vision limit due to the helmet were established from the photos.

The interim results of the field studies which were conducted in Germany by the Hannover Medical School are presented in this study. Some 227 questionnaires were filled out, of which 67 participants had used a helmet and 42 of the 227 participants have had a bicycle accident before. For the analysis of the riding position and posture of the cyclist over 40 pictures of riders with a helmet and over 240 pictures of riders without a helmet were measured concerning the seating geometry to describe the influence of using a bicycle helmet.

Some results in summary: From the riders interviewed with the questionnaire only 11% of the city bike riders and 12% of the mountain bike riders always used the helmet, while 38% of the racing bike riders and 88% of the e-bike-riders always used the helmet. The helmet use seems not to change the sensation of safety of cycling compared to the use of a car. The arguments for not wearing a helmet are mostly stated to be the short distance of a trip, high temperatures or carelessness and waste of time. The reasons for using a helmet are stated to be the feeling of safety and being used to using a helmet. Being a role model for others was also stated to be a reason for helmet use. Concerning the sensation of the helmet 9% of the riders reported problems with the field of vision when using a helmet, 57% saw the problem of sweating too much, and 10% reported headaches or other unpleasant symptoms like pressure on the forehead when using the helmet. The analysis of the seating posture from the pictures taken of cyclists revealed that older cyclists generally have a riding position where the handle bar is higher than the seat (0° to 10° incline from seat to handlebar), while younger riders had a higher variance (between -10° decline and 20° incline). Further, elderly riders and riders with helmets seem to have a more upright position of the upper body when cycling. The vertical vision limit due to the helmet is determined by the front rim of the helmet (mostly the sun shade). Typical values here range from 0° (horizontal line from the eye to the sun shade) to 75° upwards, in which elderly riders tend to have a slightly higher vertical vision limit possibly due to the helmet being worn more towards the face.

The European Project COST Action TU 1101 is an expert network focusing on improving bicycle traffic safety with a special focus on helmets [1]. As a partner of this project the Hannover Medical School (MHH) is participating in the two field studies conducted by the working group 1 of this project. One field study aims to collect information on the habits of helmet usage of cyclists by means of a questionnaire, while the other field study aims at identifying if the use of a bicycle helmet influences the seating geometry and the posture of cyclists when riding a bicycle and if the helmet vertically limits the vision towards important traffic details. As the field studies are ongoing in the different countries this study will present some interim results of data collected in Germany at the Hannover Medical School.

Questionnaire on helmet usage

For the COST Action TU1101 a field study was conducted using a questionnaire to investigate the helmet using habits of bicycle riders in different EU-countries.

The questionnaire was developed among the COST partners and resulted in a paper questionnaire including questions from the fields of personal data, helmet data, sensation of the helmet, helmet usage as well as information a possible former bicycle accident. Due to the fact that some questions of the questionnaire were relevant for different respondents and some were not relevant (e.g. Helmet comfort is not relevant for a bicyclist without a helmet), the data collection was conducted by an interview instead of asking the interviewee to fill out the questionnaire by himself.

A representative investigation of bicycle riders was not required, however the location and the time of interviewing riders was distributed to different locations and times. In Germany Interviews were conducted at colleges/universities which lead to a significant portion of younger bicyclists and interviews were also conducted at supermarket during normal work hours which lead to a higher portion of elderly bicyclists. As an alternative a survey was also conducted at a public event for bicycle riders which on one hand lead to a rather mixed portion of respondents concerning the age, however this time the helmet wearing rate seemed to be higher. In general the focus of the chosen interviewees was set to riders using a helmet to gain as much possible information on the helmet topics of the questionnaire. Thus this study is not suitable to evaluate helmet wearing rates.

Some 227 questionnaires were filled out, of which 67 participants had used a helmet and 42 of the 227 participants have had a bicycle accident before.

The interim analysis of the data collected by the questionnaires shows that slightly more men were interviewed than women (129 men; 98 women) and that on significant difference in helmet wearing shares between men and women is found in the group (29% of the women and 30% of the men wore a helmet).

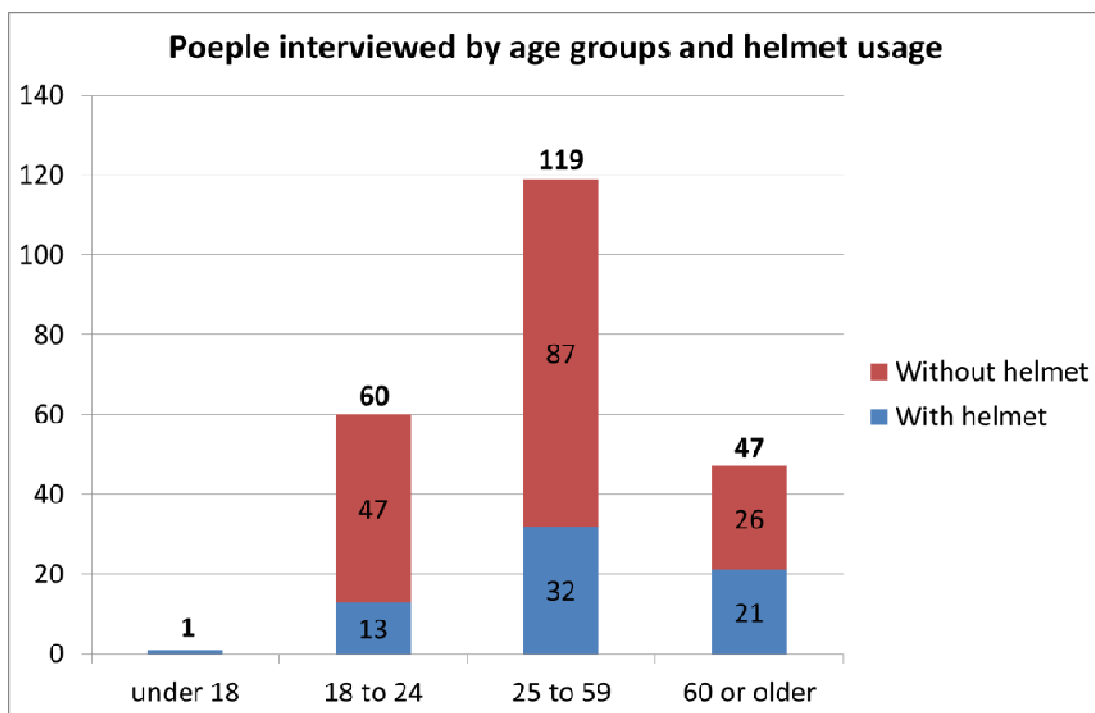


Figure 1: Distribution of age groups of people interviewed with the questionnaire.

The distribution of the age of the interviewed people on different groups (Figure 1) shows that the majority of riders can be found in the age group between 25 and 59 years of age, while older riders 60 years or older more frequently had worn a helmet in 21 of 47 cases (45%).

In 151 cases the type of bicycle used by the rider was known of which the majority had used a “city-bike”, with 68% (102 cases). Only about 17% of the interviewed riders had used a mountain bike and 9% had used a racing bike. A total of 8 riders using E-bikes were interviewed which accounts for a share of about 5%.

In the scope of the questions concerning the personal data and helmet usage habits the riders were asked how often they usually wear a bicycle helmet. Some differences were found in the answers here depending on the type of bicycle used, see Figure 2. While the riders of city bikes and of mountain bikes in the great majority of cases answered that they rarely or never use a helmet (75% of city bikes; 81% of mountain bikes), the riders of racing bikes seem to be have a higher desire for safety: “Only” 54% answered that they rarely or never use a helmet while some 38% stated that they always use a helmet. Of the 8 riders of pedelecs/E-bikes seven stated that they always use a helmet and only one rider claimed never to use a helmet. It will be interesting to see if this high helmet wearing rate was only coincidence because a closed group of 7 elderly riders was interviewed or if this result is reproduced in the data collected in future and by other counties.

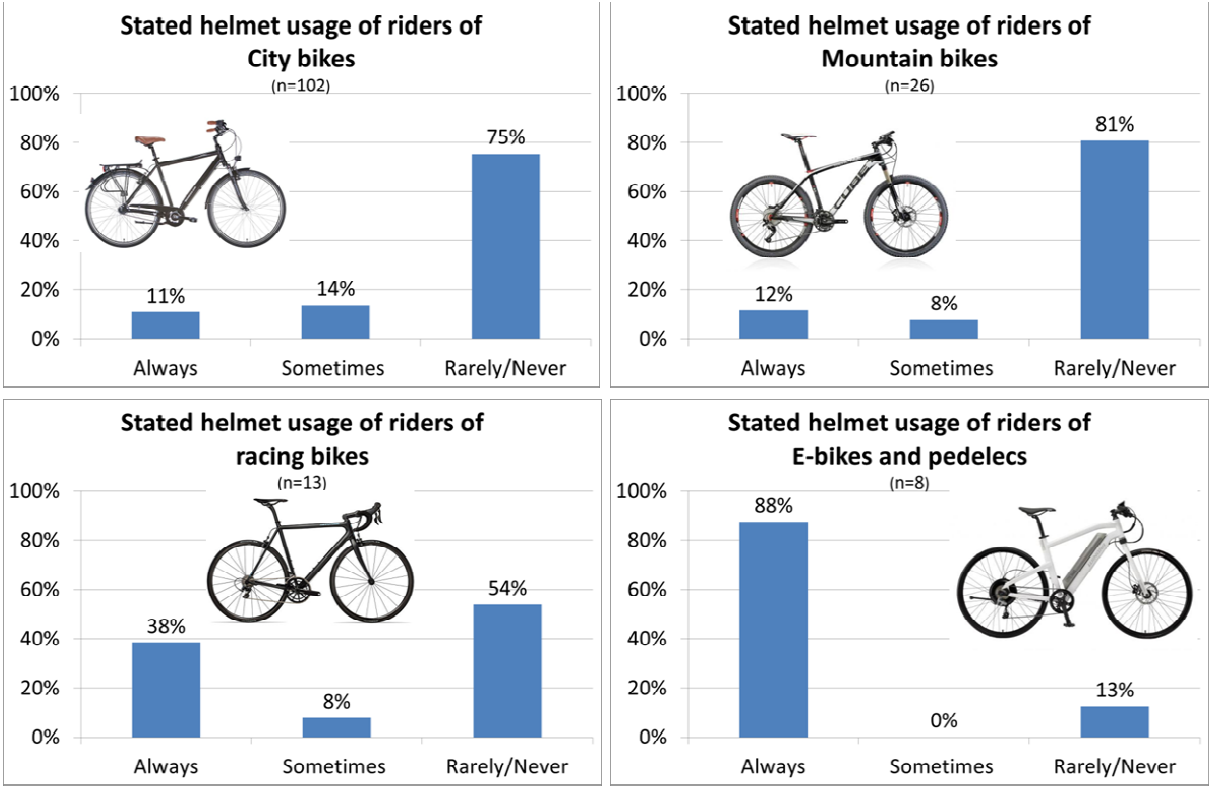


Figure 2: Stated helmets usage rates of riders of different types of bicycles.

Further the safety sensation when riding bicycle was asked: The riders were asked if they felt that cycling was much safer, a little safer, about the same, a little more dangerous or much more dangerous compared to driving a car and compared to walking. Here in general most riders think that cycling is more dangerous than walking or driving a car (Figure 3). When looking at the differences between the group of riders that had used a helmet and the group that had not used a helmet, there seems to be a

slight tendency towards a the feeling that riding a bicycle is more dangerous among those that had used a helmet: 74% of the helmet users thought that cycling is more dangerous than driving a car, compared to only 67% of the riders without a helmet and 88% of the helmet users thought that cycling is more dangerous than walking, compared to only 78% of the riders without a helmet.

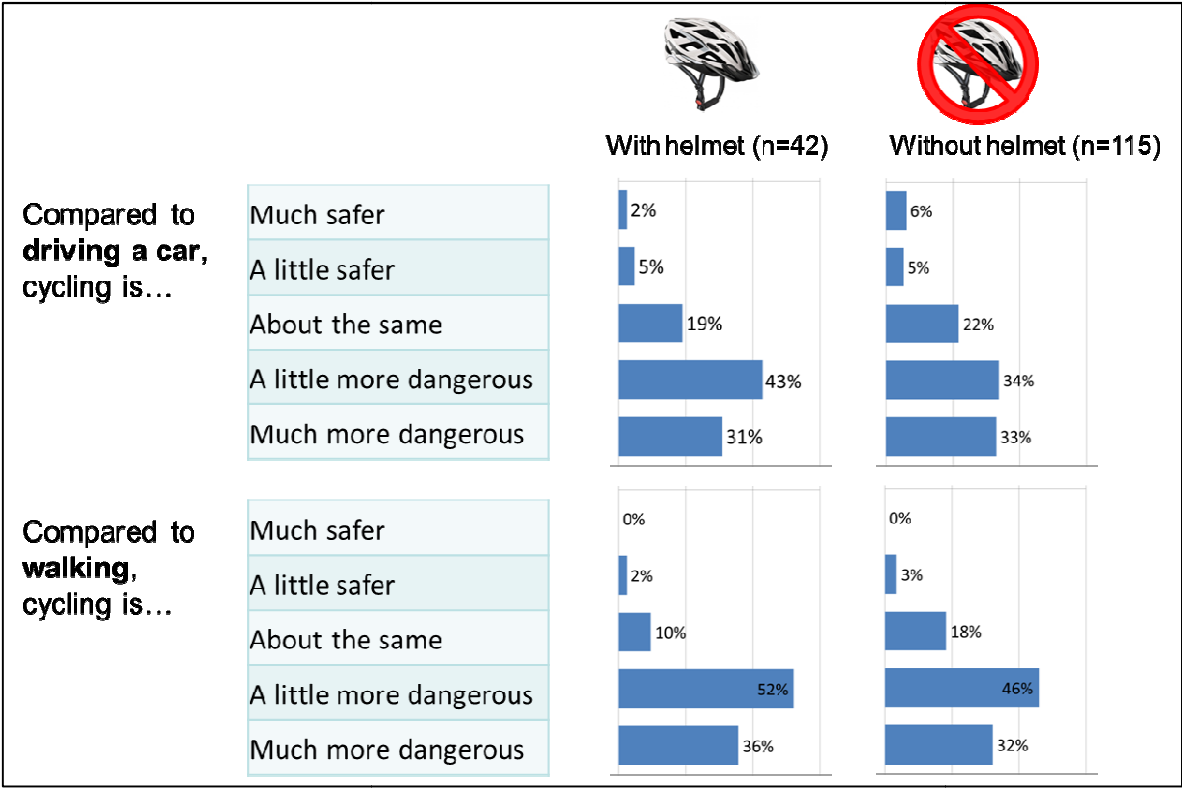


Figure 3: Safety sensation of riding a bicycle compared to driving a car or walking.

To identify the reasons of riders for using a helmet or respectively for not using a helmet, a list of possible reasons was given and the interviewed people were asked to rate the relevance of each of these reasons with: 0 - never a reason; 1 – rarely a reason; 2 – often a reason; 3 – mostly a reason; 4 – always a reason. Figure 4 shows the mean values of the ratings of these reasons for using a helmet and for not using a helmet.

If you do / don't wear a helmet, please rate the following reasons
 (0 - never a reason; 1 – rarely a reason; 2 – often a reason; 3 – mostly a reason; 4 – always a reason)

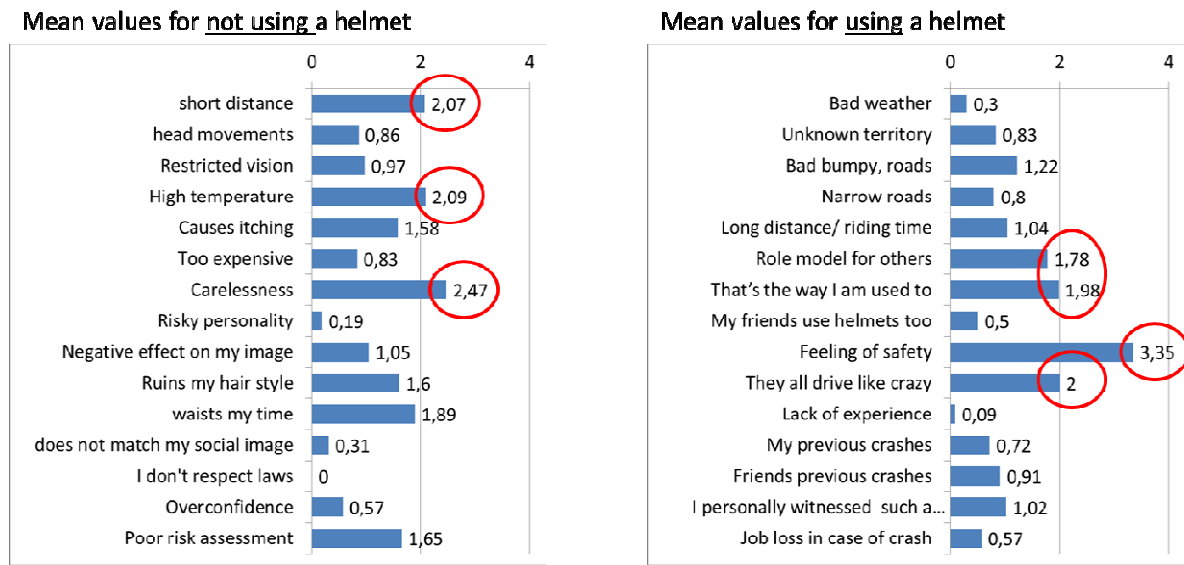


Figure 4: Reasons for using a helmet and respectively for not using a helmet

Among the most common reasons for not wearing a helmet were reasons like “I will only go a short distance”, “it’s too warm (high temperature)” and mostly carelessness with a mean value of 2.47. Riders that at least sometimes used a helmet answered that the reason for using the helmet was mostly the feeling of safety (mean value of 3.35). Other reasons with high scores for using a helmet are that the other traffic participants are felt to represent a danger - “they all drive like crazy” (mean value of 2), being used to wearing a helmet as a reason for wearing a helmet with 1.98 and being a role model for others e.g. children (mean value 1.78).

One reason for not wearing a helmet which was often mentioned but which was not anticipated and thus was not found on the list of reasons was: “when I reach my destination I have to carry around my helmet”.

The information on the sensation of using a bicycle helmet and whether there are any constraints when using the helmet was also collected with the questionnaire. Here none of the 67 interviewed riders with a helmet stated that they had hearing problems when using a helmet. However 6 riders (9%) stated that they feel that the helmet does narrow their field of vision. From the 63 riders that responded to the question if using the helmet makes them sweat more, 34 (57%) half responded with yes. Asked about headaches or other unpleasant symptoms after using a bicycle helmet 6 riders (10%) said that they do sometimes feel unpleasant symptoms: 4 stated that they sometimes have a headache, one rider felt a pressure on the forehead and one lady responded that she gets a dry and itchy skin on the head from using a helmet.

The interviewed riders were ultimately asked about previous bicycle accidents. From the 42 riders that had a bicycle-accident before some 34 indicated the type of accident they had had (Figure 5). With 70% the majority of riders stated that they had a single-vehicle accident (e.g. a fall due to a driving error). A collision with a car had been the case in 21% of the accidents while collisions with other types of road users or with fixed objects had rarely occurred (only 3% each).

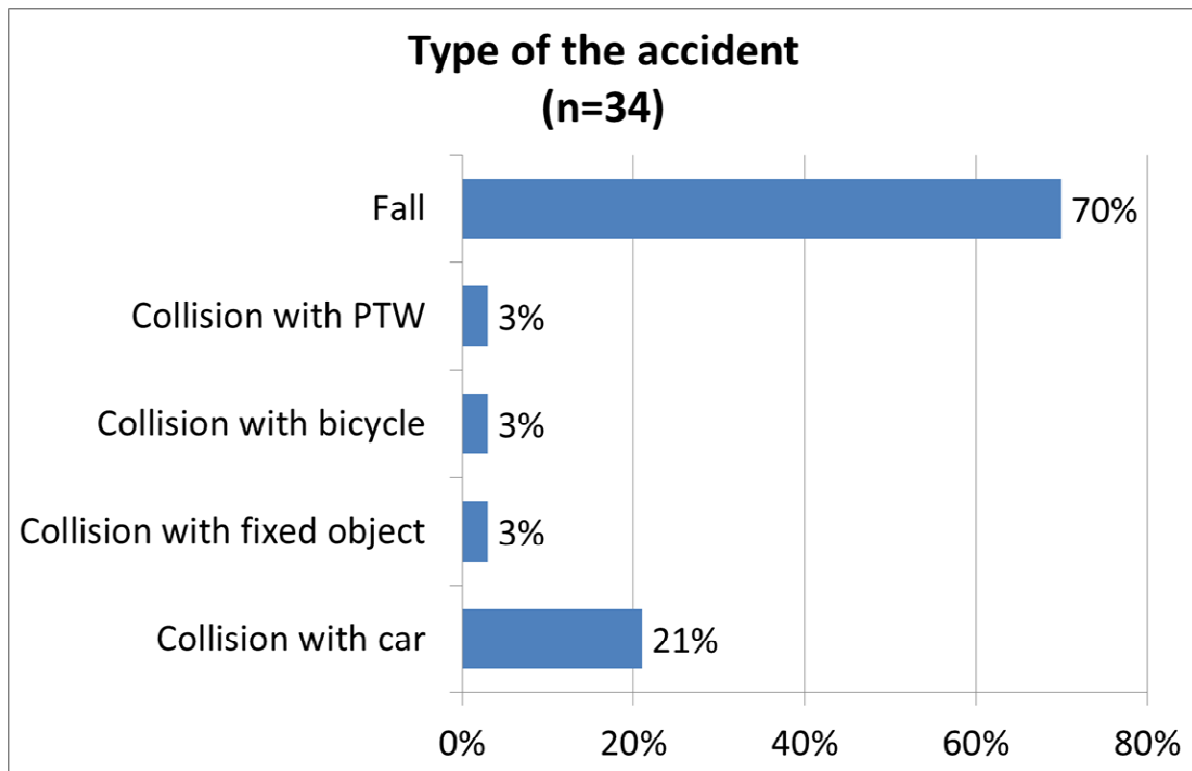


Figure 5: Type of bicycle accident of 34 interviewed riders that had had a bicycle accident before.

If the respondents had been wearing a helmet at the time of the accident and if the helmet had an impact during the accident, they were additionally asked where the main impact zone on the helmet was.

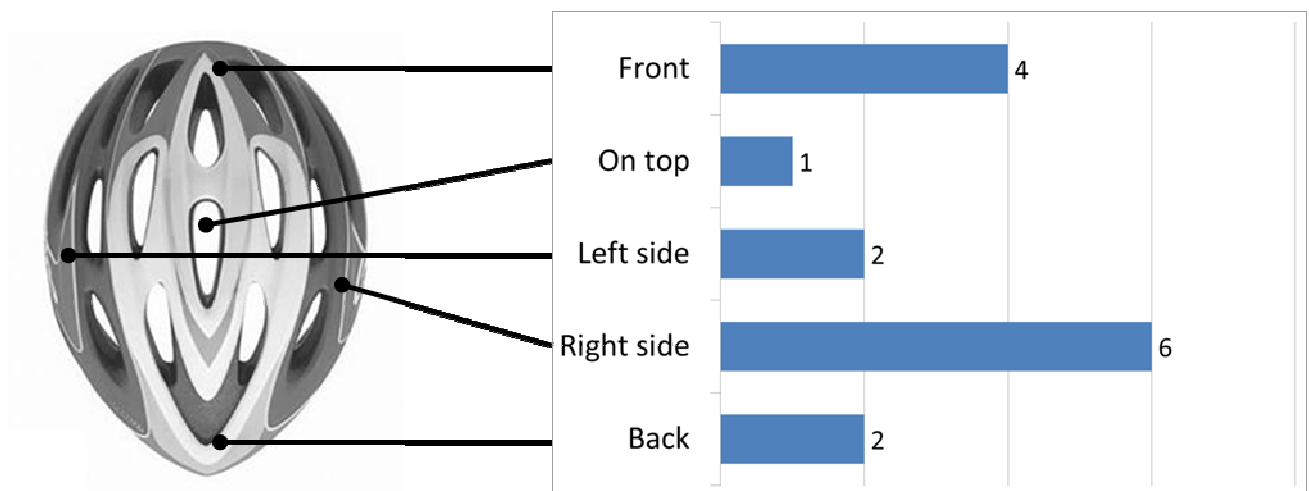


Figure 6: Main impact zones on the helmet during a bicycle accident from 15 respondents.

As displayed in Figure 6, 4 of the 15 riders stated that their helmet had an impact at the front while only twice an impact at the back of the helmet and only once an impact at the top of the helmet were reported. Mostly however the impact had occurred at the sides of the helmet: 8 riders stated that the impact was either on the left side (2 riders) or on the right side (6 riders).

Influence of the bicycle helmet usage on the posture of cyclists

Next to the above mentioned study via questionnaire the COST Action TU1101 also conducts a study to identify if the usage of a helmet has an influence on the seating posture of a cyclist such as a more upright seating position or head posture. This is done in different EU-countries by taking pictures of cyclist and comparing the seating geometry of riders with a helmet and riders without a helmet.

Bicycle riders which did and did not use a cycle helmet were photographed while riding the bicycle in a real world (non fictional) situation. The picture was taken anonymously from a large distance using a telephoto lens without the perception of the bicyclist. To be able to measure the seating posture correctly it is necessary to take pictures of cyclists riding rectangular to the photo axis (taking a picture exactly from the side of the cyclist).

To define the seating geometry the sitting decline SD (angle of the cyclist's torso) and the angle between the handlebar and the seat HS were established for both riders with and without helmets (see Figure 7). Subsequently the inclination of the line of the visual limit VL was investigated from pictures of riders using a helmet and the head posture HP was measured by the inclination of the line from the ear to the eye (see Figure 8).



Figure 7: Establishment of angles relevant for seating geometry and vision limits



Figure 8: Establishment of the head posture angle by measuring the inclination of the line from the ear to the eye.

As the pictures taken could be askew a horizontal reference line was established in a first step which was used as a base line to measure the angles (see red line in Figure 7). A possible reference for this purpose is the line between the two axles of the bicycle, but could also be a horizontal line of building if e.g. the axles of the bicycle wheels are not visible on the photo.

In Germany the pictures were mostly taken during normal working hours at a “bicycle highway” which represents a major bicycle path separated from other traffic and which connects an urban district with the city centre. From the 290 pictures which were taken of cyclists some 42 riders had been wearing a helmet. Again this share of helmet wearers cannot be called representative because the focus of this study was set to collecting as many cyclists with a helmet as possible.

The interim analysis of the cycle geometry shows that slightly more pictures of male riders with a helmet were taken than of female riders with a helmet (23 men; 19 women) and that in the group of riders without a helmet the amount of male riders (157) was also higher than the amount of female riders (91). It has to be noted that the gender and the age group of the rider was estimated from the pictures.

The distribution of the riders with and without a helmet on the different age groups is shown in Figure 9. The riders that had been wearing a helmet were clearly younger than the riders that had not been wearing a helmet: About 69% of the riders with helmet were from the age group of 19-40 years, while only about 43% of the riders without a helmet were of this age. Accordingly there were less riders with helmet found in the age groups of 41-65 years (21%) and 66 years or older (10%) than riders without a helmet (groups of 41-65 years: 40% and 66 years or older: 16%).

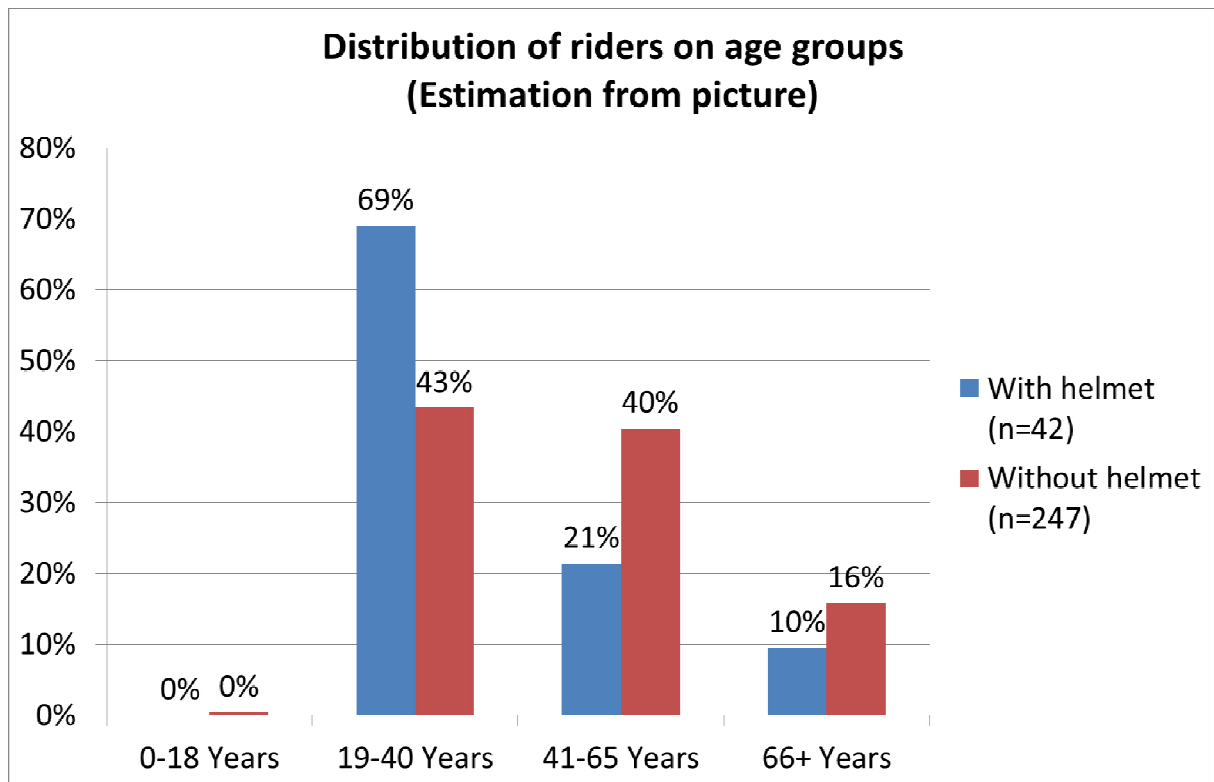


Figure 9: Distribution of photographed riders on age groups

The analysis of the inclination between handle bar and seat was done by calculating the cumulative frequency of the riders with a helmet and comparing that to those not wearing a helmet for different age groups, see Figure 10 and Figure 11. Over 10% of the riders (independent of the helmet usage) had a negative inclination which correlates with a seat position being higher than the handle bar. For riders where the seat is below the handle bar ($>0^\circ$) there seems to be a slight bias towards higher handle bars and lower seats in the group of riders not wearing a helmet (red line in Figure 10). When comparing the two age groups “40 years or younger” and “41 years or older” there seems to be a slight tendency towards higher inclination angles with the older riders (Figure 11, red line) which means that they tend to sit more upright. It has to be stated however, that due to relatively low case numbers up to now no significant differences can be identified. It can be expected that the final analysis or the full study with cases from other countries will provide more significant results.

A similar slight influence of the helmet usage and the riders age can also be found on the sitting decline (which describes the inclination of the riders back; Figure 12, Figure 13). This correlation was expected as the sitting decline is dependent of the height of the handle bar relative to the riders seat. The red line in Figure 12 displays the cumulative frequency of the sitting decline of riders without a helmet. Here about half of the riders without a helmet have a decline of the back of just under 70° while that of the riders with a helmet is a few degrees lower. The influence of the age, Figure 13, on the sitting decline seems to be less pronounced than the influence of the helmet usage but is still visible.

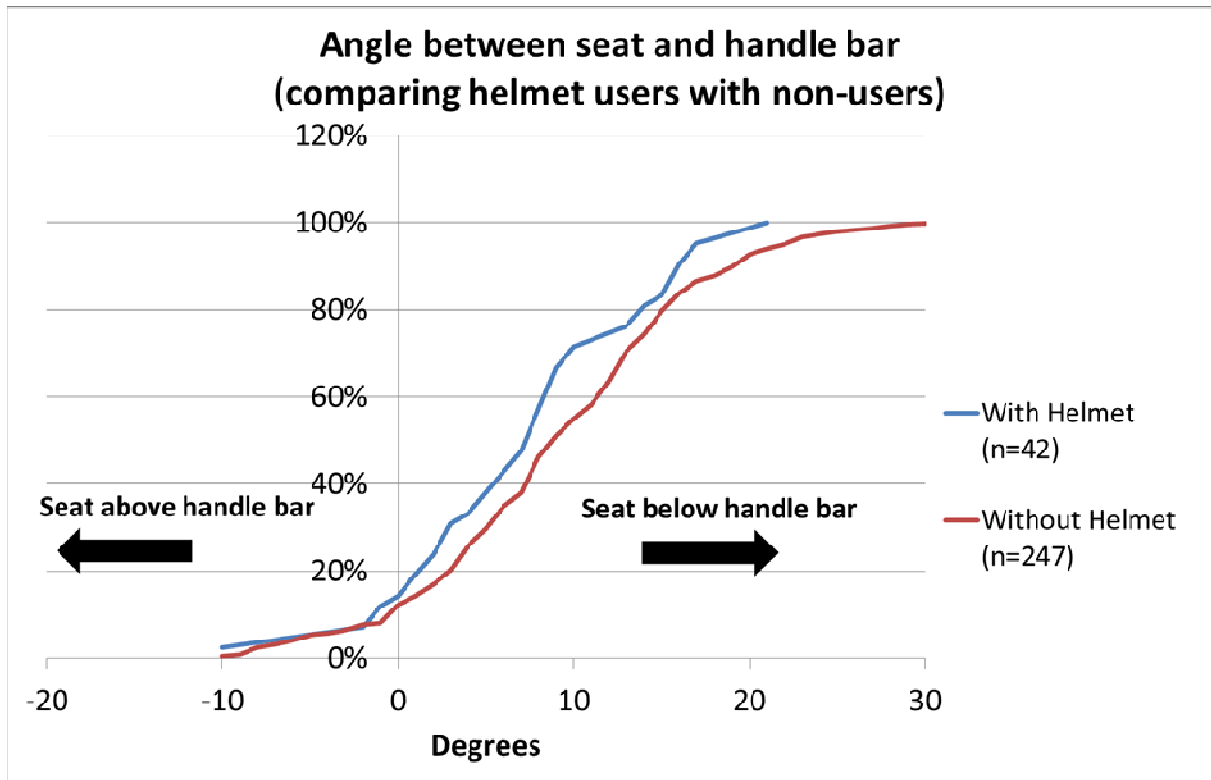


Figure 10: Angle between handle bar and seat (cumulative frequency), comparing riders with and without a helmet.

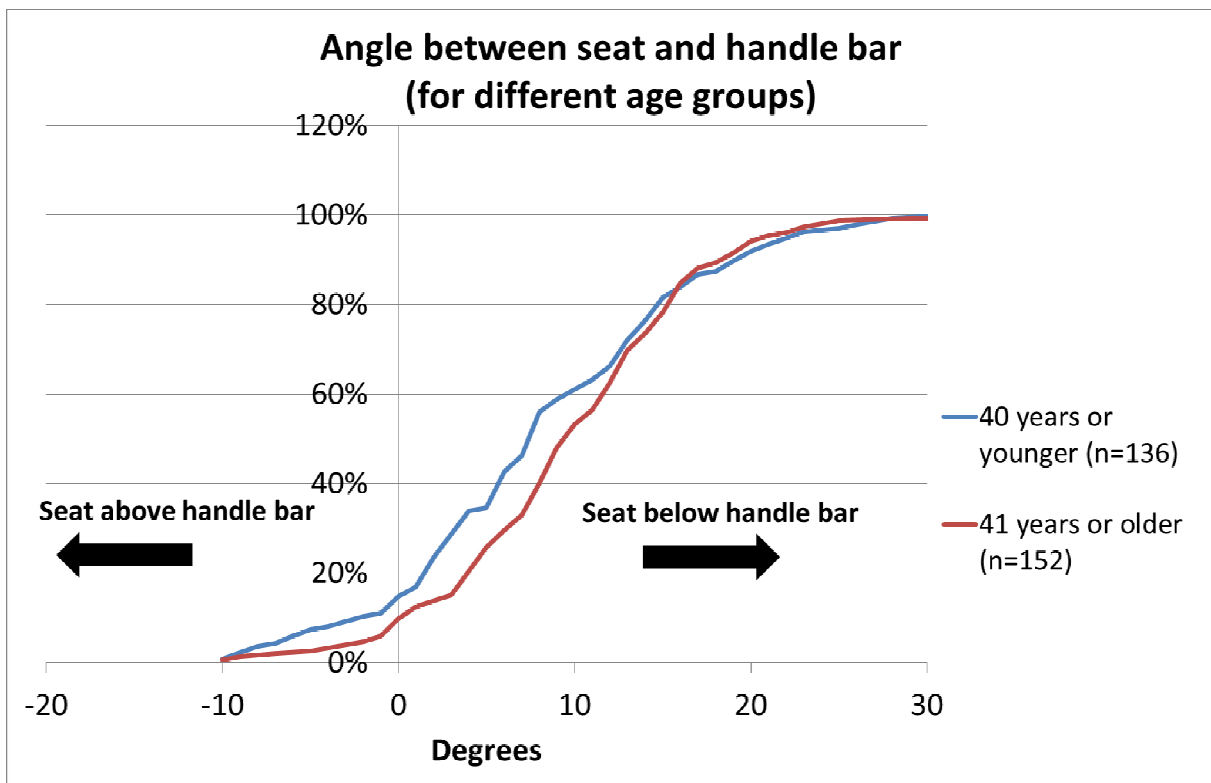


Figure 11: Angle between handle bar and seat (cumulative frequency), comparing younger riders with older riders.

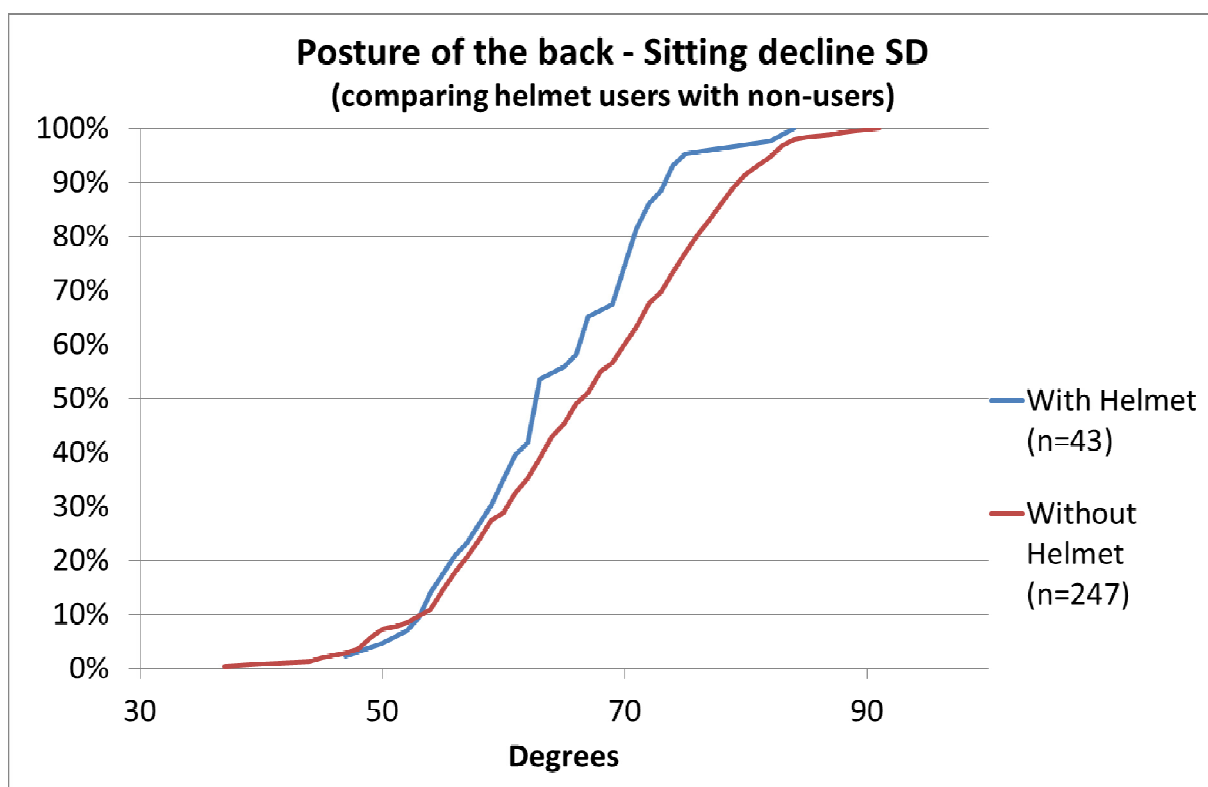


Figure 12: Posture of the back, comparing riders with and without a helmet

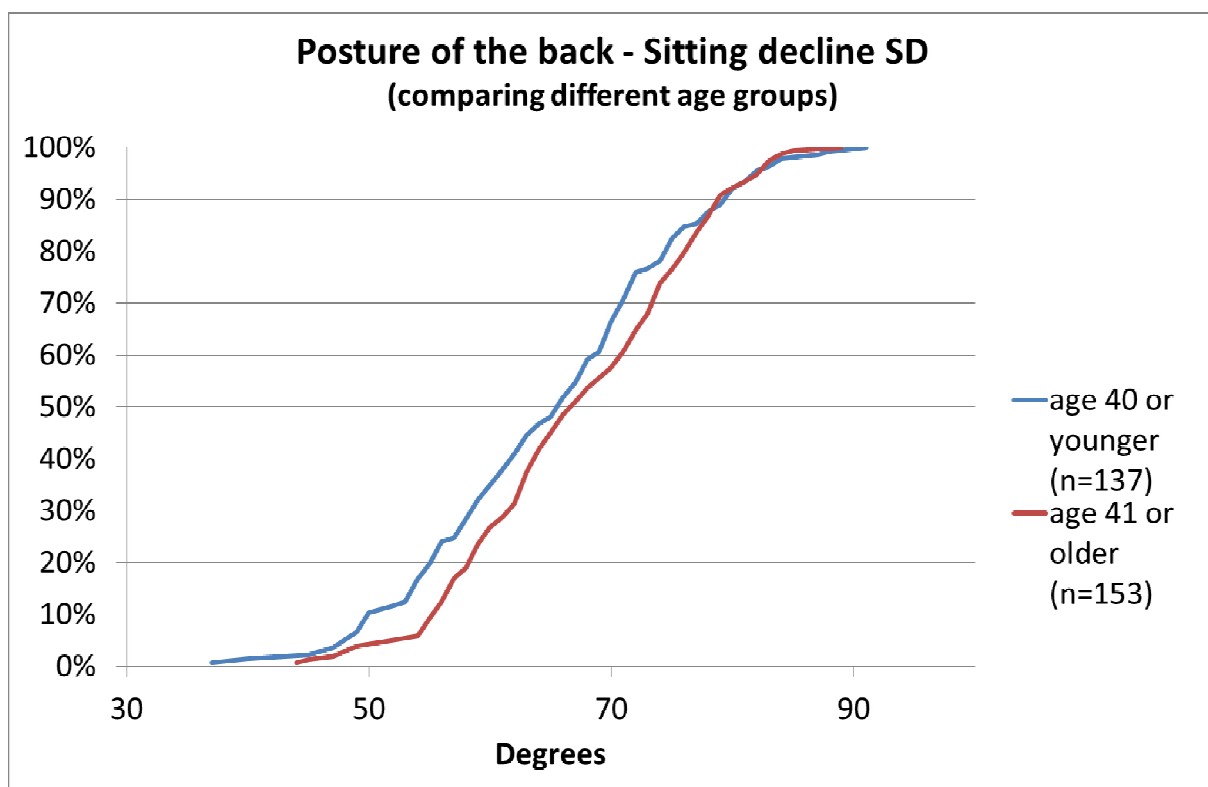


Figure 13: Posture of the back, comparing younger riders with older riders

The vertical vision limit VL due to the helmet was established by constructing a line from the eye to the front rim of the helmet (usually the sun shade) at the moment when the picture was taken. It is presumed that the influences from the momentary head movements are compensated by the high number of evaluated photos. The cumulative frequency of this angle for riders with a helmet of different age groups is displayed in Figure 14. Interestingly younger riders (40 years or younger) have found to have a higher vision angle upwards than older riders: While half of the younger riders have a vision limit upwards of just under 40 degrees, half of the older riders are just over 25 degrees and thus are at the limit of the upwards field of vision for cyclists with bicycle helmets when looking straight forward, as described in EN 1078 [2].

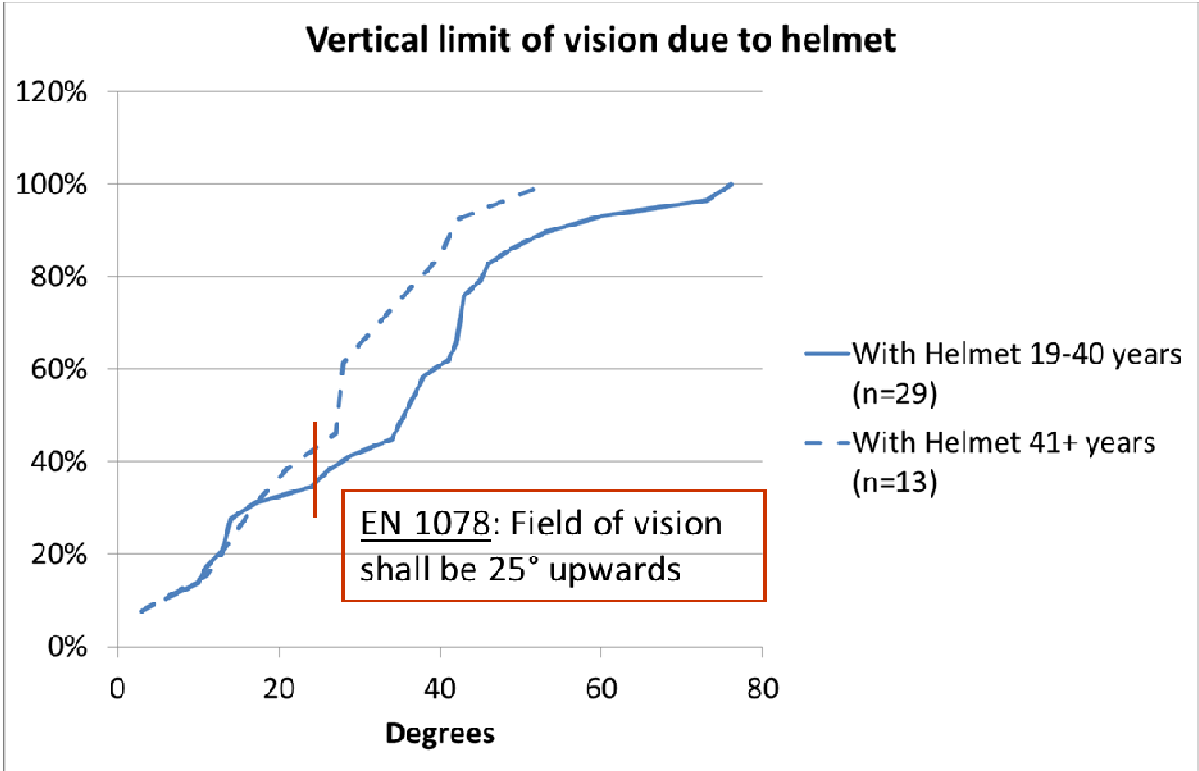


Figure 14: Vertical limit of vision due to helmet.

To investigate if the difference of the vertical limit of vision is related to the head posture (do older riders possibly lower their head more than younger riders?) the cumulative frequency of the inclination of the line between the ear and the eye are displayed in Figure 15. There seems to be no influence of the age on the head posture: for both age groups about 20% of the riders had an inclination of the ear-eye-line of 0 degrees or less (thus were looking more downwards) while nearly about 20% of the riders had an inclination of the ear-eye-line of 15 degrees or more (were looking more upwards). So if the younger riders have a higher vision angle upwards than the older riders and at the same time the head posture (looking upwards or downwards) is approximately the same for both age groups it can be assumed that older riders wear their helmets more turned forward into the face.

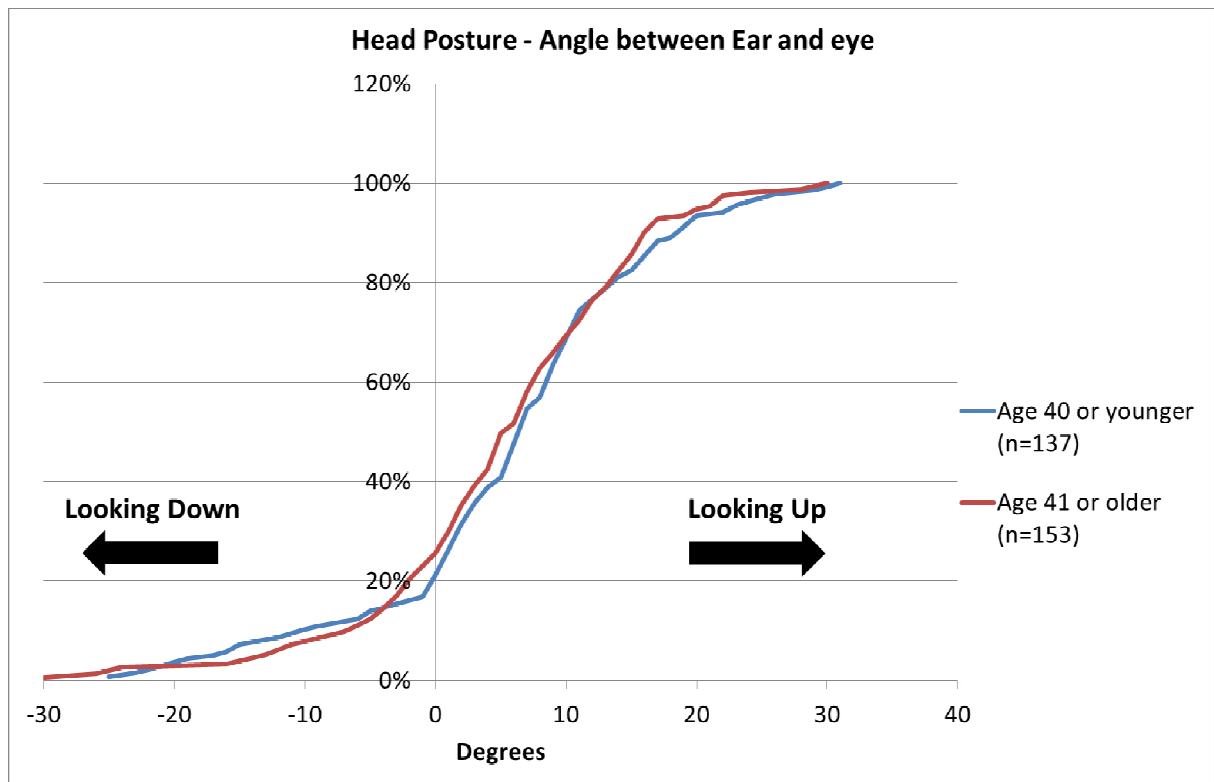


Figure 15: Head posture of riders with a helmet for different age groups.

Conclusion

The interim analysis of the two field studies (Questionnaire on helmet usage and riding posture from photos of cyclists) which were conducted by the Hannover Medical School (MHH) in the scope of COST Action TU 1101 already displayed some significant results even though only one partner and only a subsample of the target case number was available at the time of this study.

The 227 answered questionnaires which were available for the analysis are not representative for the cycling situation in the region of Hanover because the interviewed riders could not be randomly picked at random places during random times. However the study revealed that the helmet wearing rates seem to depend on the type of bicycle used. As such riders of racing bikes seem to use helmets more often than riders of other types of bicycles. It will be interesting to see if this relatively high wearing rate will be visible after the full scale study in other participating countries as well.

In general bicycle riders with or without a helmet thought that riding a bicycle is more dangerous than driving a car or walking. The reason for not wearing a helmet was mostly just carelessness or the need to carry around a helmet at the destination, while the most common reason for wearing a helmet was the feeling of safety with a helmet. So the riders are aware of the risk of riding a bicycle and believe that the helmet does have a potential for protection but carelessness and a missing solution where to leave the helmet at the destination often leads to not wearing a helmet.

Furthermore the questionnaire revealed that the helmet usage rarely leads to hearing problems of problems concerning the vision such as a narrowed field of vision. However some riders complained about unpleasant symptoms after using the helmet such as headaches. The fact that using the helmet makes you sweat more was also stated often as an unpleasant symptom.

Asked about previous bicycle accidents, those riders that had been in an accident before reported that it had mostly been a single vehicle accident where they fell off the bicycle for different reasons. Collisions with other traffic participants or with objects were rarely reported. Here the main impact zones of the helmet were stated to be the sides of the helmet and the front. Hence according to this analysis the main function of protection of the helmet should be to protect against injuries at the side of the head or at the face when hitting the ground.

For the second field study the methodology of taking pictures from bicycle riders to evaluate the seating posture has proven to be a viable technique to identify general angles describing the seating positions, even though it is not possible to identify the exact angles in every case. Together with the estimation of the age group to which the rider belongs it was possible to analyse the seating position depending on the helmet usage and the different age groups.

The incline of the line between the handle bar and the seat describes if and how much the handle bar is above the seat. Here older riders in general seem to have adjusted the handle bar higher above the seat than younger riders while at the same time there seems to be a slight bias towards higher handle bars in the group of riders not wearing a helmet – which correlates with the fact that there was a higher share of younger riders in the group of riders wearing a helmet. The posture of the upper body (sitting decline) was more upright for riders older than 40 years than for younger riders, which is certainly influenced by the higher handle bars in this group. At the same time the posture of the upper body also seems to be slightly more upright for riders not wearing a helmet (which have a greater share of older riders). The vertical vision limit due to the helmet is determined by the front rim of the helmet (mostly the sun shade). Typical values here range from just above 0° (horizontal line from the eye to the sun shade) to 75° upwards, in which elderly riders tend to have a slightly enhanced limit upwards meaning lower vision angle. However at the same time the analysis of the head posture revealed that there is no significant difference of the posture of the head (looking upwards or downwards) between the two age groups. Hence the enhanced vertical vision limit of older riders could be explained by those riders wearing the helmet more downwards towards the face.

In general the analyses of both field studies are producing interesting results. The case numbers at the point of this interim report are still quite small, especially taking into account that only one country of the participating countries was analyzed. The full scale study will have higher case numbers with which it will be possible to verify the results found in this analysis and which will allow identifying possible differences among different countries when it comes to habits of wearing cycle helmets or influences of the helmet on the seating posture.

Literature

[1] Internetpage <http://www.bicycle-helmets.eu>

[2] European Standard EN 1078