Danish Road Safety Council

Fact sheet

Bicycle helmets

September 2017

1. Summary

- The most recent meta-analysis on cyclists involved in a crash or a fall concludes that helmet use is associated with odds reduction for head injury of approximately 50 %. For serious head injuries, helmet use is approximately associated with odds reduction of 70 % (Olivier & Creighton, 2016).
- Previous meta-analyses also conclude that bicycle helmet use markedly reduces the risk of head injuries (Attewell et al., 2001:347; Thompson et al., 2000:7; Elvik, 2013:251).
- In Denmark, the proportion of head injuries among seriously injured cyclists is strikingly lower for cyclists who did wear a helmet at the time of the accident than for cyclists who did not wear a helmet at the time of the accident. 15% of the seriously injured cyclists using a helmet got a head injury, whereas 31% of the seriously injured cyclists not using a helmet got an injury to the head (Vejdirektoratet, 2017).
- There are three overall types of arguments against promoting bicycle helmets; that bicycle helmets do not have an effect, that bicycle helmets lead to a decline in the number of cyclists, and that the bicycle helmet is not the best way to increase cyclist safety (SWOV, 2012).
- The argument that the bicycle helmet does not have an effect is false. All meta-studies have concluded that helmets signficantly decrease the risk of injuries to the head.
- The second argument that bicycle helmets cause a decline in the number of cyclists is not true as a general statement. There is some evidence, though, that helmet legislation might lead to a decline in cyclists. In a recent survey in Denmark, 5 % stated that they would stop biking if a helmet law made it cumpolsury for all cyclists to wear a helmet, while 12 % stated that they would bike less (Epinion, 2016). On the other hand, the results of the survey also show that information and campaigns on bicycle helmets do not lead to a decline in the number of cyclists (ibid.). In light of this, campaigns and incentives rather than legislation seems to be the way forward in Denmark.
- The argument that bicycle helmet use is not the best way to increase cyclist safety misses the point. Infrastructure measures and campaigns towards drink driving, speed and distraction on the one hand and promoting bicycle helmets on the other hand are not mutually exclusive measures. Rather, we should encourage all effective measures at hand to improve cyclist safety.
- It is the opinion of the Danish Road Safety Council that especially among children and teenagers, it is crucial that it grows into a habit to wear bicycle helmets, and that parents insist on their children wearing a helmet. Furthermore, parents should act as role-models for their children.

2. Why the bicycle helmet is an essential part of traffic safety

Increased cycling contributes with solutions to important societal problems, but it is also associated with the emergence of new problems. On the one hand, there are large environmental and health benefits of increased cycling (Oja et al., 2011; de Hartog et al., 2010). On the other hand, increased cycling is a road safety issue. The risk of getting killed or being severely injured is higher for cyclists than for drivers and passengers in cars (Hansen & Jensen, 2012). In light of this, the Danish Road Safety Council has a positive attitude to cycling, but it is important that more is being done to increase the safety of cyclists.

Turning to statistics of road accidents, road safety in Denmark has in general undergone a positive development in the last decade with the numbers of deaths and injuries declining. When it comes to cyclists, however, we have not witnessed the same decline in fatalities as among drivers of motorized vehicles (Forsse et al, 2015). The same pattern can be found in other European countries (SWOV, 2013). A part of the explanation is that the security systems of cars (seat belts, airbags, ESC, autonomous emergency braking systems etc.) have been steadily improved and widespread (European Commission, 2015). On the other hand, one of the main 'security systems' available for cyclists, the bicycle helmet, is much less widespread (Olsson, 2017). Therefore, there is a large potential for increasing cyclist safety by raising the bicycle helmet wearing rate.

This fact sheet will first point to the scientific studies that have assessed the effect of bicycle helmets. Following that, new data on the helmet wearing rate and head injuries in Denmark is presened. Next, the arguments against helmets are assessed. Finally, the road ahead for bicycle helmets is put forward.

3. The beneficial effect of bicycle helmets – the scientific evidence

Over the years, a lot of scientific evidence on the positive effects of bicycle helmets has been produced. The scientific studies vary in their estimates of how much bicycle helmets reduce the risk of moderate and serious head injuries. However, all meta-analyses[1] conclude that bicycle helmets markedly reduce the risk of head injuries (Thompson et al., 1999; Attewell, 2001; Elvik, 2013; Olivier & Creighton, 2016). The table below illustrates the estimates of summary odds ratio reduction for injuries when wearing a helmet that meta-analyses have produced so far.

[1] Meta-analyses are studies that statistically summarize the results of previous studies meeting certain pre-defined criteria.

Table 3. Comparison of summary odds ratios (95% CI) from past systematic reviews and meta-analyses

Injury type	Thompson *et al.*[a]	Attewell *et al.*	Elvik[b]	Olivier & Creighton
Head	0.31 (0.26–0.37)	0.40 (0.29–0.55)	0.50 (0.39–0.65)	0.49 (0.42–0.57)
Serious head[c]	0.31 (0.23–0.42)	0.42 (0.26–0.67)	—	0.31 (0.25–0.37)
Face	0.64 (0.49–0.84)	0.53 (0.39–0.73)	0.79 (0.62–1.01)	0.67 (0.56–0.81)
Neck	—	1.36 (1.00–1.86)	1.28 (1.06–1.55)	0.96 (0.74–1.25)
Fatal[d]	—	0.27 (0.10–0.71)	—	0.35 (0.14–0.88)

[a]Adjusted summary odds ratios for head and serious head, crude odds ratio for any facial injury.
[b]Random effects meta-analysis adjusting for publication bias except for neck injury.
[c]Brain injury in Thompson *et al.*[17] and Attewell *et al.*[11]
[d]Fatal injury of any type for Attewell *et al.*[11]

(Source: Screenshot from Olivier & Creighton, 2016:10)

The table illustrates that in the most recent meta-analysis, the risk of head injuries is reduced by approximately 50 %, while the risk of serious head injuries is reduced by almost 70 % (Olivier & Creighton, 2016:10). Apart from that, the studies of Attewell et al. (2001) and Elvik (2013) conclude that bicycle helmets slightly increase the risk of neck injuries. However, the most recent meta-analysis does not find any correlation between helmet use and neck injuries (Olivier, 2016:10). Even if it really is the case that bicycle helmets slightly increase the risk of neck injuries, it is important to stress that injuries to the head in general are the most fatal of injuries, and that evidence clearly points to helmets reducing the risk of these injuries.

4. Danish evidence – cyclist causalties

In the statistics on injured cyclists and the helmet wearing rate in Denmark, there are several empirical patterns that also serve as solid indications of the effect of bicycle helmets. There are two different types of statistics on road accidents in Denmark; those registered by the police and those registered by the causalty wards. In the next section, data from these sources are analysed.

4.1 Politice data

For the purpose of this fact sheet, there are three types of injuries in the data from the police. First, "non-head injury" denotes injuries on arms, legs or the body. Second, "injuries to several parts of the body" denotes injuries to more than one part of the body. For example, a cyclist with a head injury and an arm injury or a cyclist with an arm injury and a leg injury will be categorized in this way. Third, "head injury" means that only the head was injured in the accident.

Figure 1 shows that the number of serious injuries among cyclists declined from 2004 to 2010, after which the number has increased. In 2012-2016, 547 serious head injuries were reported. In these five years, 50 fatal head injuries among cyclists were also reported by the police (Vejdirektoratet, 2017).

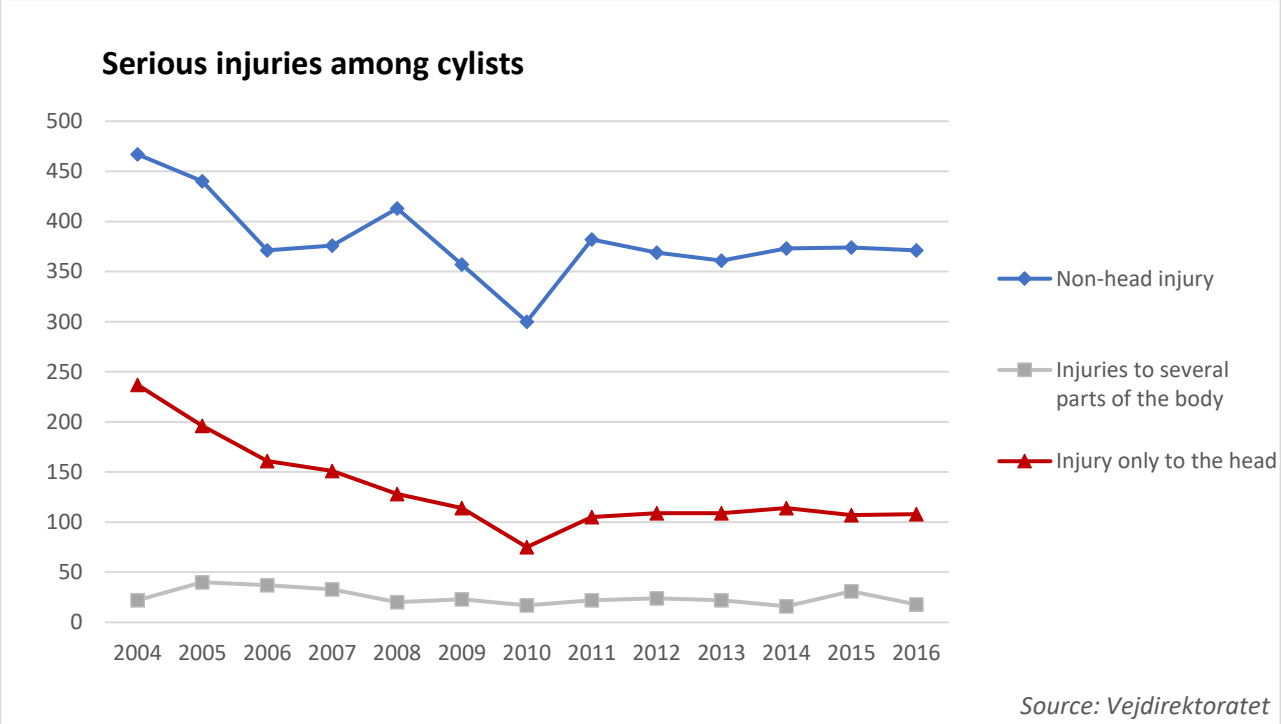

Figure 1: *n=6.993*

From 2004 onwards, the Danish Road Safety Council has systematically observed the proportion of cyclists in Denmark wearing bicycle helmets (Olsson, 2017). While this rate has been rising, the proportion of seriously injured cyclists, who only got a head injury, has been declining (see figure 2). This indicates that the rising helmet wearing rate in Denmark has reduced the number of serious head injuries.

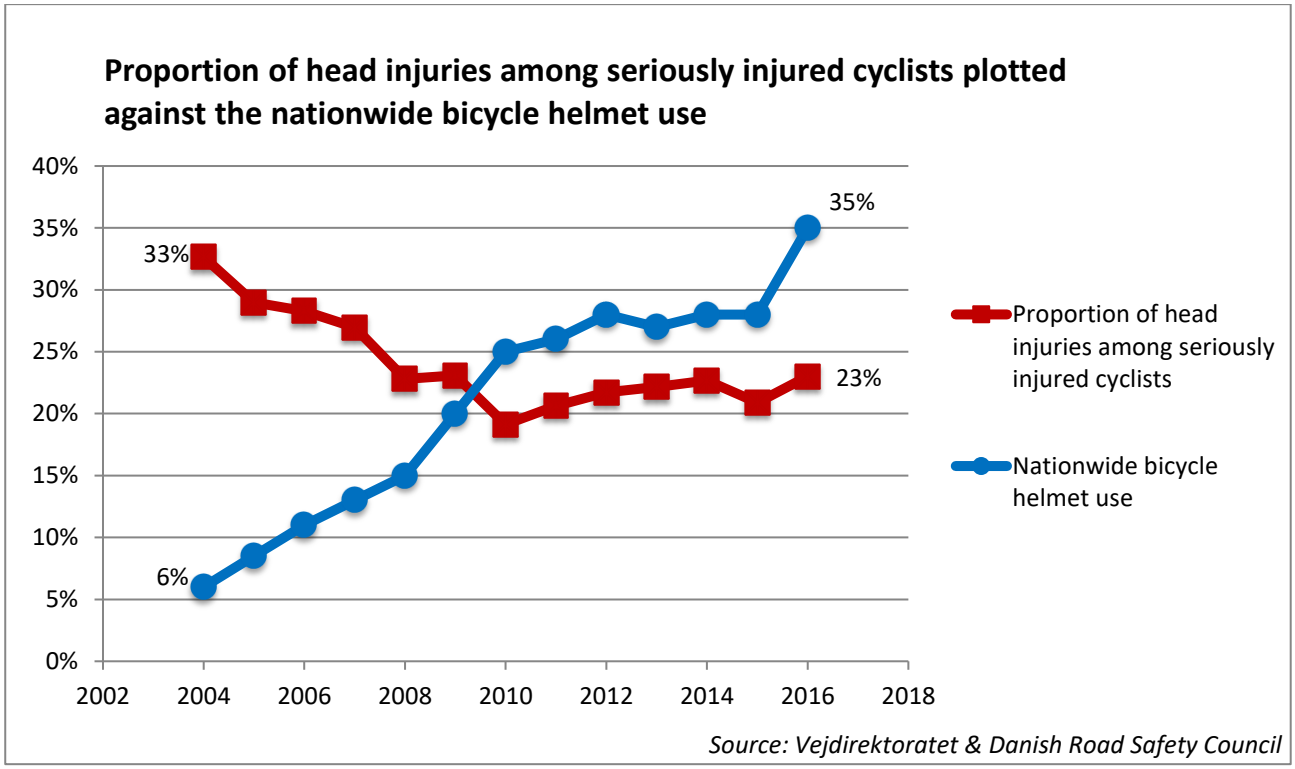

Figure 2: *n(Vejdirektoratet) = 6993; n(Danish Road Safety Council) > 7100 in each of the following years: 2004, 2006, 2008, 2010, 2011, 2012, 2013, 2014, 2015, 2016. Note: Proportion of injuries to the head is calculated as the number of:* $\frac{\text{"Head injuries"}}{\text{"Injuries to several parts of the body"+"non-head injuries"+"head injuries"}}$

However, the declining proportion of head injuries cannot solely be due to the rising helmet wearing rate. The proportion of head injuries have been declining for both the group of seriously injuried cyclists wearing a helmet as well as for the group of seriously injuried cyclists not wearing a helmet at the time of the accident (Vejdirektoratet, 2017). This indicates that there are other possible explanations for the decline.

It is still quite evident, though, that the bicycle helmet has a beneficial effect in a Danish context. The proportion of head injuries among seriously injured cyclists is strikingly lower for cyclists who wore a helmet at the time of the accident than for cyclists who did not wear a helmet at the time of the accident. 15% of the seriously injured cyclists using a helmet got an injury to the head, whereas 31% of the seriously injured cyclists not using a helmet got a head injury (see figure 3)[2].

[2] The difference in the percentages is robust to other ways of calculating the proportion of head injuries. If we do not include the category, ”injuries to several parts of the body” in the calculations, the proportion of head injuries among cyclists wearing a helmet is 16%, while 33% of cyclists not wearing a helmet got a head injury. On the other hand, if we assume that the category “injuries to several parts of the body” always includes a head injury and make the category count as “head injuries”, the proportion of head injuries among cyclists wearing a helmet is 19%, while the proportion of head injuries among cyclists not wearing a helmet is 36%.

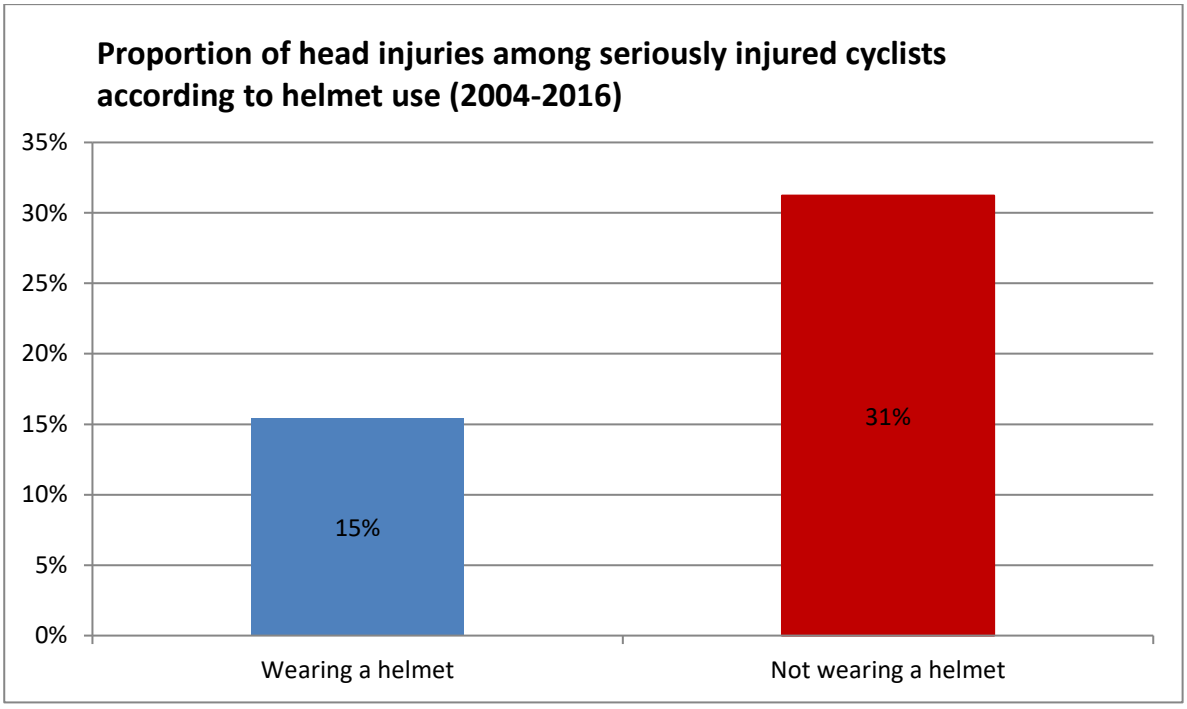

Figure 3: *n(injured cyclists with a helmet) = 1.642, n(injured cyclists not wearing a helmet) = 2.959).*

4.2 Causalty ward data

Police data, on which the above is based upon, does not cover all the injuries following road accidents. Especially less serious injuries are probably underreported (Statistics Denmark, 2014:6). Data from the causalty wards captures a part of this underreporting issue, as there are reported a much larger number of injuries among cyclists to the causalty wards than to the police. Yearly, more than 3.000 cyclists are in contact with the causalty wards due to skull fracture, whip lash and/or concussion (Statistics Denmark, 2016). However, data from the causalty wards is not as detailed as data from the police. Thus, there is no information regarding important parameters such as helmet usage and the severity of the injury. Nevertheless, we should expect that the trend of decling proportions of head injuries should also be present in the data from the causalty wards.

Figure 4 illustrates that it is the case. The proportion of skull fractures, whip lashes and/or concussions has been decling since 2004.

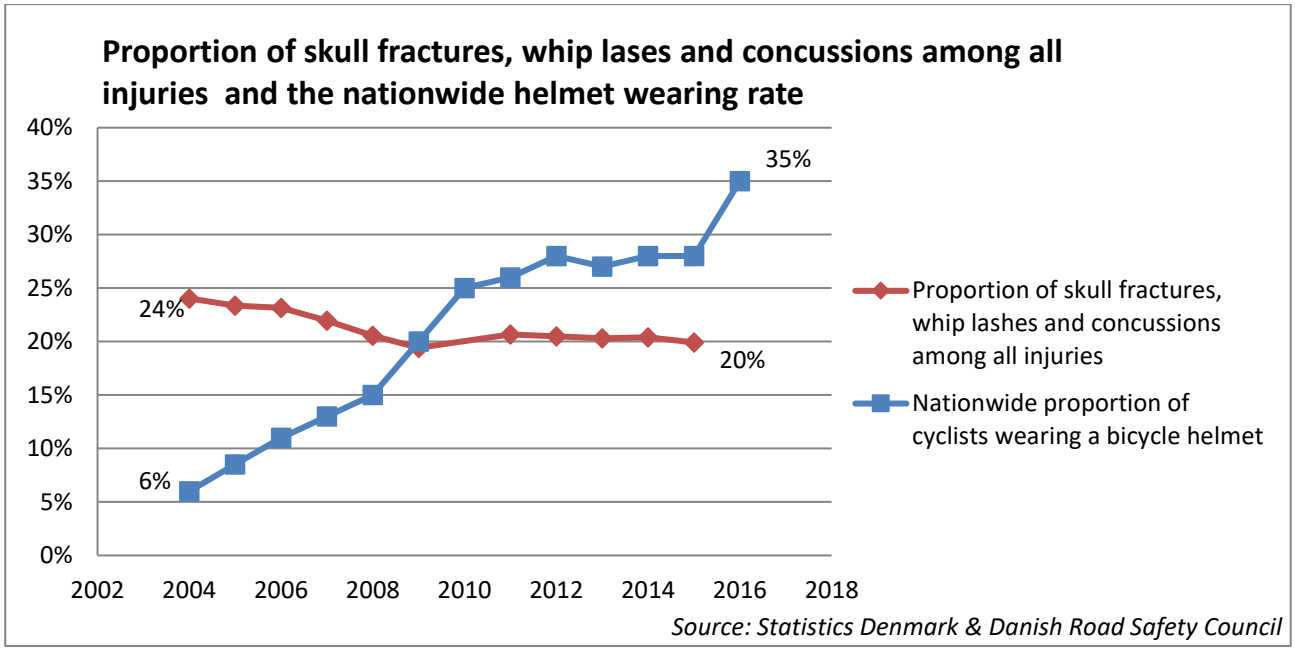

Figure 4: *n(Statistics Denmark) = 171.635. n(Danish Road Safety Council) = see figure 2*

As the n in the causalty ward data is much larger than in the police data, it is possible to disaggregate the trend of the proportion of skull fractures, whip lashes and concussions according to different age groups. This allows some interesting comparisons vis a vis bicycle helmet use among different age categories in the population of cyclists.

Figure 5 illustrates that the helmet wearing rate has soared since 2004, especially among children "under 11 years old" and "11-15 years old". Therefore, we should expect that the proportion of skull fractures, whip lashes and/or concussions has decreased more for these age groups than for the rest of the population. The expectation is confirmed in the results depctied in figure 6: the proportion of skull fractures, whip lashes and/or concussions has especially decreased among those aged 0-14.[3]

[3] The age categories of the helmet wearing rate and the proportion of skull fractures, whip lashes and/or concussions are not 100 % identical due to limited access to the data from the causalty wards. The sample size for seriously injured cyclists in the police data is too small to conduct an analysis of the trend by age categories.

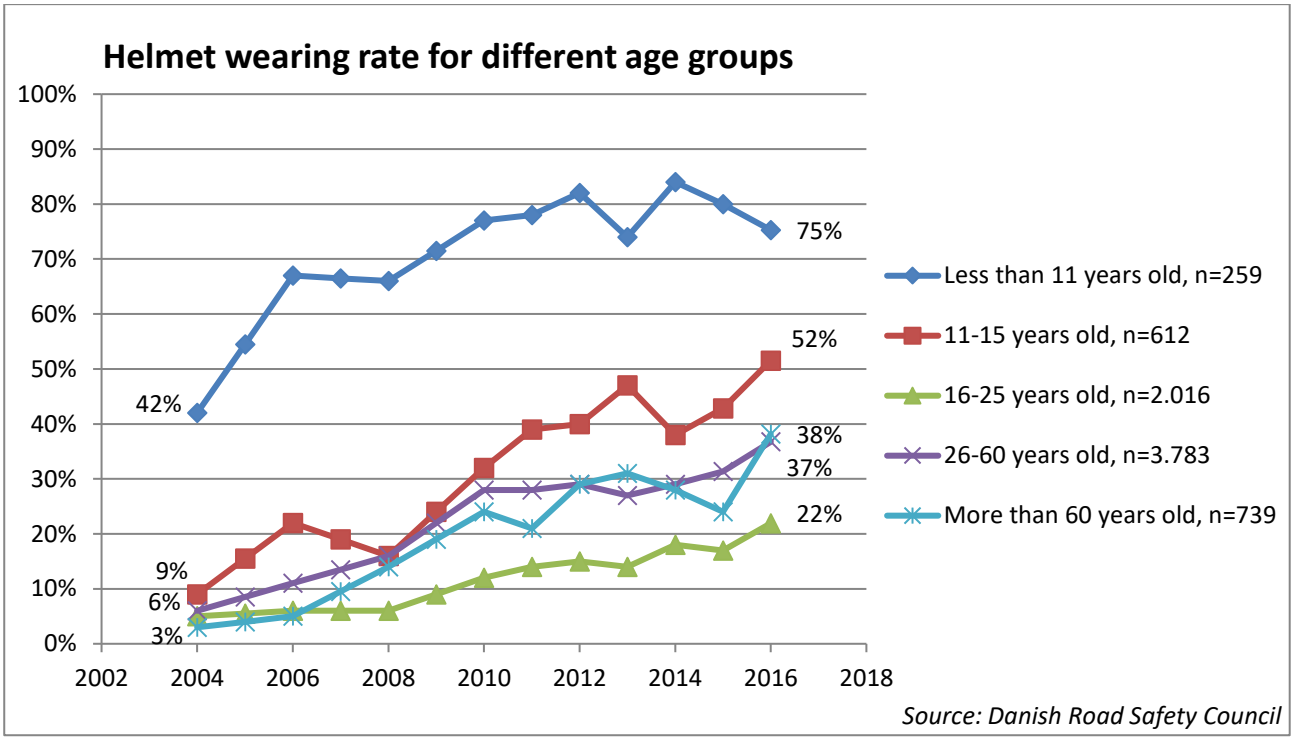

Figure 5:. *n is the number of observations in 2016.*

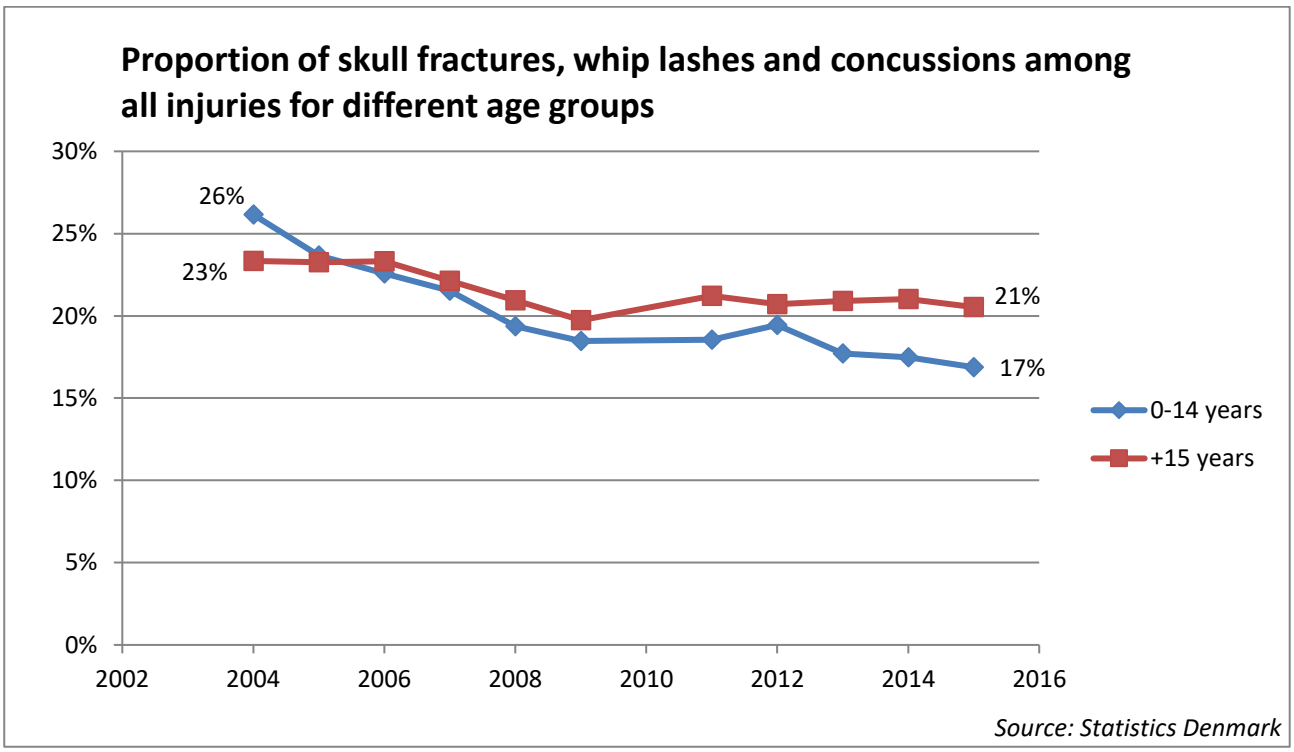

Figure 6: *n=171.635. (n>2.500 for injured 0-14 years in each year)*

5. Arguments against bicycle helmets

In spite of the quite massive evidence showing that bicycle helmets reduce the risk of head injuries, there are still actors that are against the use of helmets. The arguments can be grouped according to three headlines: a) that the bicycle helmet does not have an effect, b) that bicycle helmets lead to fewer cyclists, and c) that the promotion of bicycle hemets is not the best way to improve the safety of cyclists (SWOV, 2012). In the following, these arguments are critically assessed.

5.1 'It does not have an effect'

These arguments often claim that wearing a bicycle helmet leads to risk compensation, so that the cyclists and other road users take more risks when the cyclists use a helmet. The scientific evidence, however, is inconclusive (Elvik, 2013:252; Olivier & Walker, 2013; Walker, 2007). According to a Danish survey among cyclists, people do not think that wearing a bicycle helmet make them take more risks (Epinion, 2016; see figure 7).

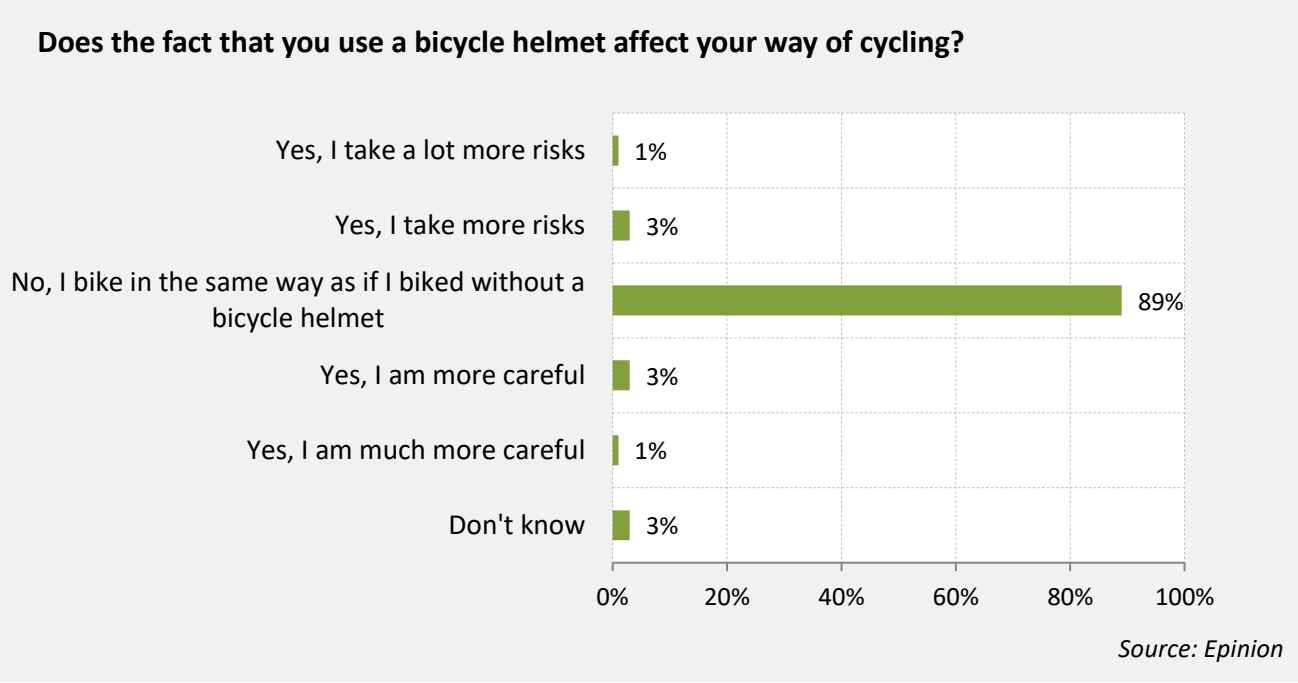

Figure 7: *n=604*

On top of that, all meta-analyses conclude that wearing a bicycle helmet leads to lower risks of head injuries, as previously stated. It is therefore beyond doubt that wearing a bicycle helmet reduces the risk of head and brain injuries. Additionally, the type of injuries that the helmet protects against can have serious consequences. Brain injuries have temporary and in the worst cases permanent consequences for the functioning of the brain, something which adversely affects the injured as well

as the families of the injured (Kammersgaard, 2015:1415; Nielsen, 2017). An increase in the use of helmets would be highly socioeconomic beneficial.

5.2 'Bicycle helmets lead to a decline in the number of cyclists'

Opponents of bicycle helmets often claim that bicycle helmets cause a decline in the number of cyclists. It is not strictly true. There are some studies, though, which have demonstrated that obligatory helmet wearing legislations could have caused a decline in cyclists and worse public health and inefficiency (Robinson, 2006; De Jong, 2012). On the other hand, there are also studies showing that helmet wearing legislations do not cause a decline in cyclists (Dennis et al., 2010).

In a Danish context, a helmet legislation could lead to a decline in the number of cyclists. In a survey conducted on behalf of the Danish Road Safety Council, respondents were asked whether a compulsory helmet law would affect their biking habits. 5 % of the respondents stated that they would stop biking if a helmet law made it cumpolsury for all cyclists to wear a helmet, while 12 % stated that they would bike less (Epinion, 2016; see figure 8). This pattern was consistent across different frequencies of biking among the respondents.

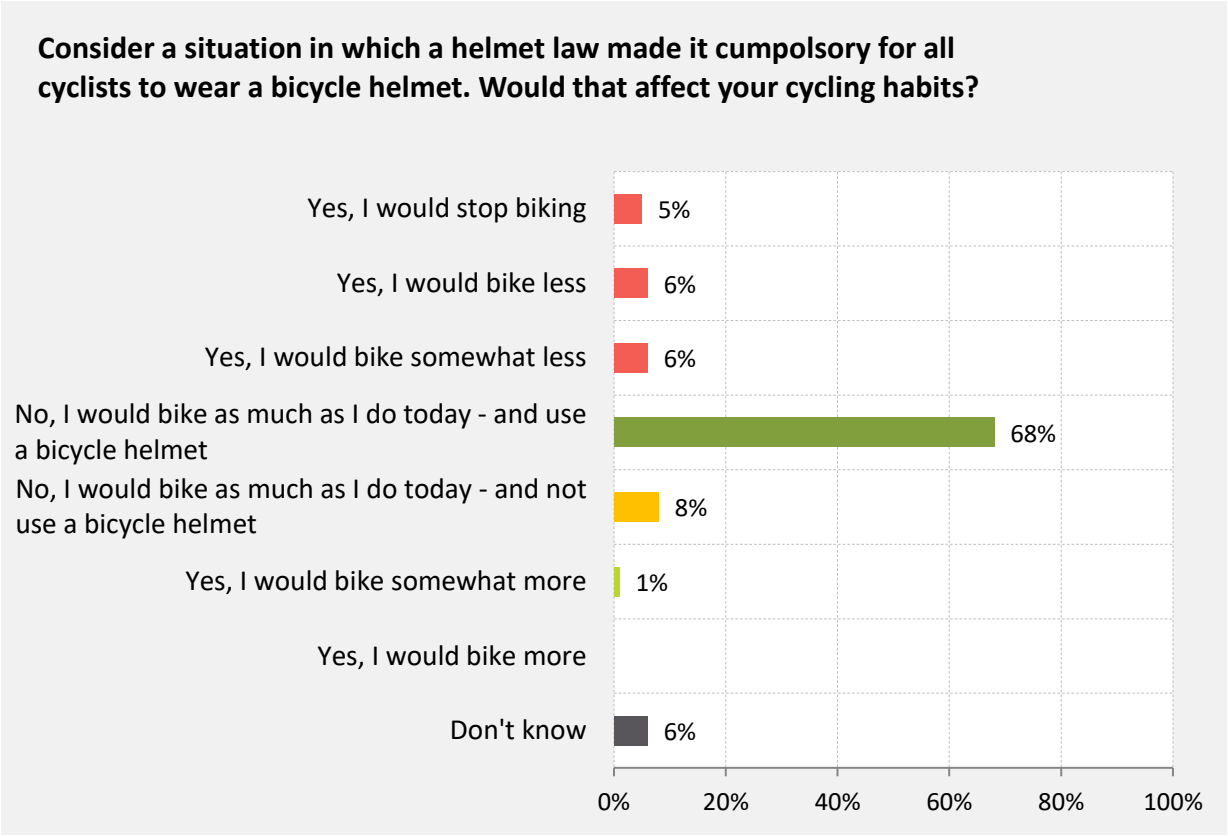

Figure 8: *n = 1506. Source: Epinion (2016).*

In light of this, it is the opinion of the Danish Road Safety Council that campaigns, information and incentives rather than legislation is the way forward in Denmark. Some have argued that campaigns on bicycle helmet use also lead to a decline in the number of cyclists. In the survey mentioned aboive, however, cyclists responded that the campaigns of the Danish Road Safety Council did not make them feel more unsafe and that they do not bike less because of information and campaigns from the Council (Epinion, 2016). Thus, nothing points to a negative effect of bicycle helmet campaigns and information on the amount of cycling.

Finally, one could discuss whether Denmark should make the wearing of bicycle helmets compulsory for children below the age 15. In fact, 84% of the Danish cyclists think this is a good idea (Epinion, 2016). However, bicycle helmet counts from Denmark and Sweden show that the increase in the helmet wearing rate for Danish and Swedish school children has been almost identical since 2004, even though a legislation in Sweden in 2005 made it compulsory for children below the age of 15 to use a bicycle helmet (Larsson, 2016; Olsson, 2017).

5.3 'Bicycle helmets are not the best means to improve cyclist safety'

This argument is especially widespread in regions where cyclists are few in numbers and the infrastructure not geared towards the safety of cyclists.

It is true that many cities and regions should make greater efforts in creating safer infrastructure for cyclists. It is also the case that campaigns towards drink driving, speed offenders and distraction should continue, and that ways of increasing the visibility of cyclists must be considered (Lahrmann et al., 2014). These measures clearly improve cyclist safety. But so does the wearing of bicycle helmets. It is thus not a question of mutually exclusive measures. Rather, we should encourage all effective measures that we have at hand for improving cyclist safety. And since the bicycle helmet is a quite inexpensive way of increasing cyclist safety, it is probably a very cost-effective measure to promote helmet use through campaigns, interventions and information.

6. The road ahead

In light of the comprehensive evidence, the Danish Road Safety Council urges all actors on the bicycle and traffic safety arena to keep stressing the beneficial effects of bicycle helmets. Despite the large number of actors promoting cyclist culture, it is worrying that only a few organisations, such as the Danish Cyclist's Federation and TrygFonden, cover the safety aspect of cycling.

In terms of target groups of campaigns and interventions, there are some groups that are particularly important. First, it is crucial that it becomes a habbit for children and teenagers to wear a bicycle helmet and that parents insist on their children wearing a helmet. This focus is due to several factors. a) Road accidents are always tragic, but especially so, when they involve children and young people. b) The risk of being severely injured or killed is high for people aged 16-19 years in comparison with other age groups (Hansen & Jensen, 2012). c) The systematic helmet counts by the Danish Road Safety Council show that helmet use start decreasing when children reach the age of 10-12

years old (Olsson, 2017). d) It seems plausible that a habit of using a bicycle helmet that is established as a child or teenager, will be more persistent throughout adulthood. All these factors motivate the Danish Road Safety Council's and TrygFonden's campaign, "Nederen Forældre" (see https://www.sikkertrafik.dk/kampagner/nederen-foraeldre)

Second, young students are an important target group. Young people aged 16-25 have a significantly lower helmet wearing rate than other age groups (Olsson, 2017). A lot of young students do think it is reasonable to wear a bicycle helmet, but there are some obstacles to using a helmet. These obstacles are mainly about the price of helmets, postponement of buying a helmet, and friends who do not use a bicycle hemet (Danish Road Safety Council, 2015). At the same time, more than a third of the Danes who never wear a bicycle helmet want to use a helmet; they just need to buy one first (Capacent Epinion, 2008; Epinion, 2013).That is the motivation for the Danish Road Safety Council's and TrygFonden's events, "Hjælp en Hjelmløs[4]". The events consist of five-day interventions at campuses in which employees from the Danish Road Safety Council sell helmets for 50-100 DKR (approximately 6,5-13,5 EUR) and guide on the fit of the helmets. The evaluation of the intervention in 2015 finds that 75% of those who did not have a helmet previously and who bought a helmet, use the helmet 7 months after the event (Nielsen, 2016). The interventions are thus an effective way to "nudge" helmet use (Thaler & Sunstein, 2008).

Third, it is important to increase the helmet wearing rate among the elderly, as the risk of serious and fatal injuries per kilometer of bicycle transport are higher for those aged 75-84 than among the those aged 20-74 (Hansen & Jensen, 2012:31).

On a final note, the increase in the number of electric bicyclists, makes bicycle helmet promotion of even greater importance (DTU, 2014). Evidence indicates that electric bicyclists are more prone to traffic accidents. The higher speed of electric bicycles increases the risk of accidents as well as the severity of accidents (Helbo & Jensen, 2015:17). There are also other factors that possibly explain why electric bicyclists are involved in more severe accidents than non-electric bicyclists. Other road users are not used to the high acceleration and high speed of electric-bicyclists. This is especially so for elderly bicyclists - who in Denmark are also using electric bicycles more often than young people (Helbo & Jensen, 2015:8). Furthermore, a study from Australia shows that the electric bicycle in itself was a factor in one out of four accidents (Helbo & Jensen, 2015:17).

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