



1. Summary

- The most recent meta-analysis concludes for cyclists involved in a crash or a fall, helmet use is associated with reducing the risk of injury to the head with approximately 50 %. For serious head injuries, helmet use is associated with a 70 % reduction of risk, approximately (Olivier & Creighton, 2016).
- Previous meta-analyses also concludes that the bicycle helmet markedly reduces the risk of head injuries (Attewell et al., 2001:347; Thompson et al., 2000:7; Elvik, 2013:251).
- In Denmark, helmet use has increased since 2004 (Olsson, 2017). At the same time, the proportion of head injuries among injured cyclist has decreased (Vejdirektoratet, 2016)
- There are three overall types of arguments against the promotion of bicycle helmets; that bicycle helmets do not have an effect, that bicycle helmets lead to a decline in cyclists and that bicycle helmets are 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 so far have concluded that helmets significantly decrease the risk of injuries to the head.
- The second argument that bicycle helmets lead to a decline in 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 compulsory for all cyclists to wear a helmet, while 12 % stated that they would bike less (Epinion, 2016). On the other hand, the survey also shows that information and campaigns promoting bicycle helmets do not lead to a decline in cyclists (ibid.). In light of this, campaigns and incentives rather than legislation is the way forward in Denmark.
- The argument that bicycle helmets are not the best way to increase cyclist safety misses the point. Infrastructure measures and campaigns towards drink driving, speed, distraction etc and promoting bicycle helmets are not mutually exclusive measures. Rather, we should encourage all effective measures that we have at hand to improve cyclist safety.
- It is the opinion of the Danish Road Safety Council that especially when it comes to children and teenagers, it is crucial that it becomes a habit for them 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 is associated with solutions to important societal problems, as well as 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 represents 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 the 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 system' of bicyclists, the bicycle helmet, is much less widespread (Olsson, 2017). Therefore, there is a large potential for increasing the safety of cyclist by making the bicycle helmet wearing rate higher.

This fact sheet will first point to the scientific studies that have assessed the effect of the bicycle helmet. Following that, new evidence on the helmet wearing rate and injuries to the head in Denmark is presented. Next, the arguments against helmets are assessed. Finally, the road ahead for the bicycle helmet 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 the bicycle helmet reduces the risk of moderate and serious injuries to the head. However, all meta-analyses¹ concludes 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 the meta-analyses have produced so far.

¹ Meta-analyses are studies that combine the results from previous studies.


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

Injury type	Thompson <i>et al.</i> ^a	Attewell <i>et al.</i>	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)

^aAdjusted summary odds ratios for head and serious head, crude odds ratio for any facial injury.

^bRandom effects meta-analysis adjusting for publication bias except for neck injury.

^cBrain injury in Thompson *et al.*¹⁷ and Attewell *et al.*¹¹

^dFatal injury of any type for Attewell *et al.*¹¹

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

The table illustrates that the risk of head injuries are reduced by approximately 50 %, while the risk of serious head injuries are reduced by almost 70 % according to the most recent meta-analysis (Olivier & Creighton, 2016:10). Apart from that, the studies of Attewek et al. (2001) and Elvik (2013) concludes that a bicycle helmet slightly increases 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 the evidence clearly points to that helmets reduces the risk of these injuries.

4. Danish evidence – cyclist casualties

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 casualty 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. First, “non-head injury” denote injuries on arms, legs or the body. Second, “injuries to several parts of the body” denote injuries to injuries on more than one part of the body. For example, a cyclist with a head injury and a arm injury or a cyclist with an arm injury and a leg injury will be categorized in this way. Third, “injuries only to the head” 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 2011-2015 544 serious head injuries were reported. In these five years, 54 fatal head injuries among cyclists were also reported to the police (Vejdirektoratet, 2016).

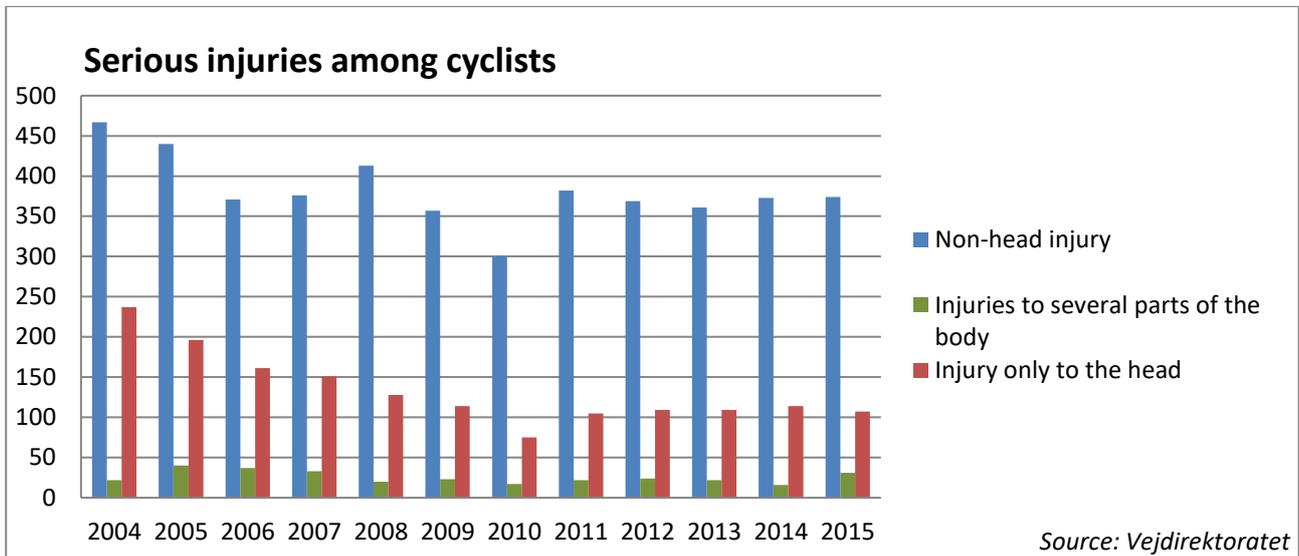


Figure 1: n=6496)

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 gone up, 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.

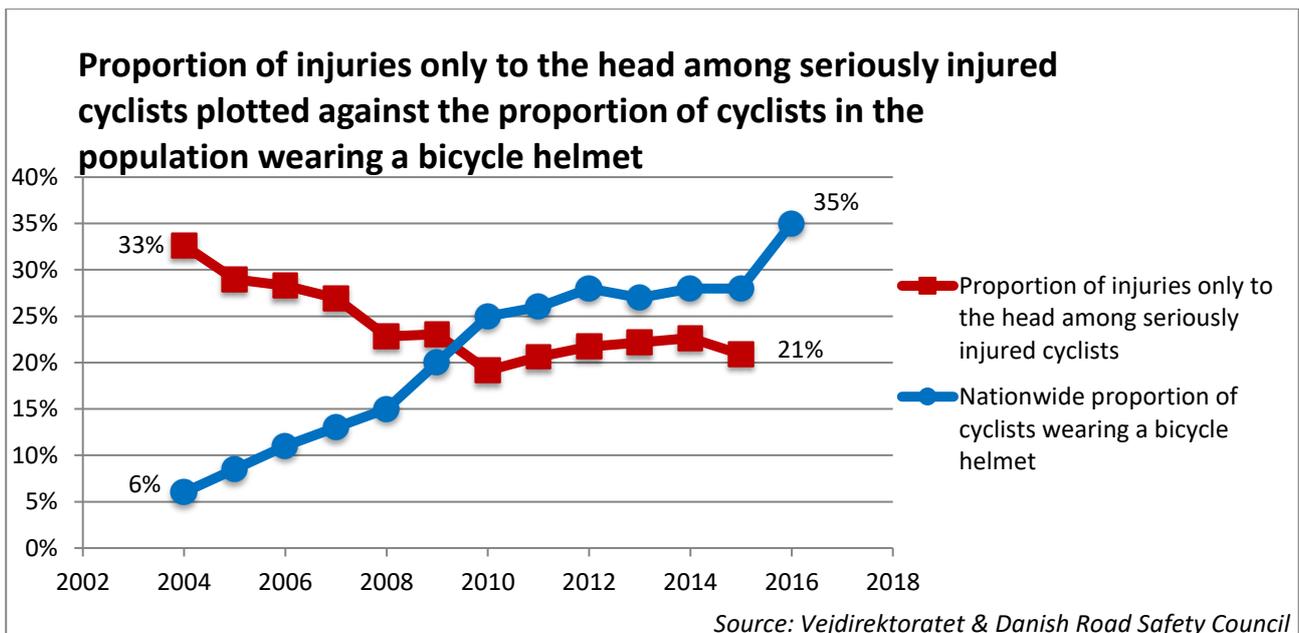


Figure 2: n(Vejdirektoratet) = 6496; n(Danish Road Safety Council) > 7100 in each of the following years: 2004, 2006, 2008, 2010, 2011, 2012, 2013, 2014, 2015, 2016. Note: Proportion of injuries only to the head is calculated as the number of: $\frac{\text{"Injury only to the head"}}{\text{"Injuries to several parts of the body"} + \text{"non-head injury"}}$



Analyzing the police data also shows that the proportion of head injuries among seriously injured cyclists is strikingly lower for seriously injured cyclists who wore a helmet than for seriously injured cyclists who did not wear a helmet. 16% of the seriously injured cyclists using a helmet got an injury only to the head, whereas 31% of the seriously injured cyclists not using a helmet got a injury only to the head (see figure 3)².

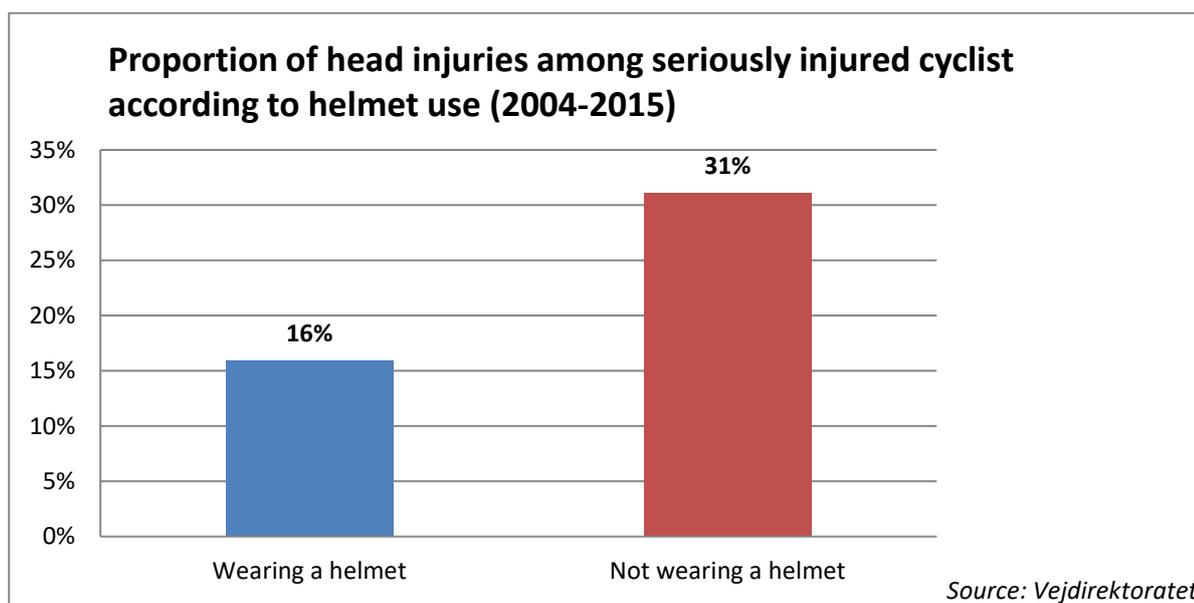


Figure 3: $n(\text{injured cyclists with a helmet}) = 1428$, $n(\text{injured cyclists not wearing a helmet}) = 2788$.

4.2 Causalty ward data

The police data, on which the above is built upon, does not cover all the injuries following road accidents. Especially lesser injuries are probably underreported (Statistics Denmark, 2014:6). Data from the causalty wards captures a part of this underreporting problem, as there are reported a much larger number of injuries among cyclists to the causalty wards than to the police. Yearly, more than 3000 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 declining proportions of head injuries from the police data should also be present in the data from the causalty wards. Figure 4 illustrates that it is the case. The proportion of skull fractures,

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 17%, while 33% of cyclists not wearing a helmet got a head injury. If we on the other hand assume that the category "injuries to several parts of the body" always include head injuries and let the category count as head injuries, the proportion of head injuries among cyclists wearing a helmet is 20%, while the proportion of head injuries among cyclists not wearing a helmet is 36%.



whip lashes and/or concussions has been declining since 2004, just as it was the case in the police data.

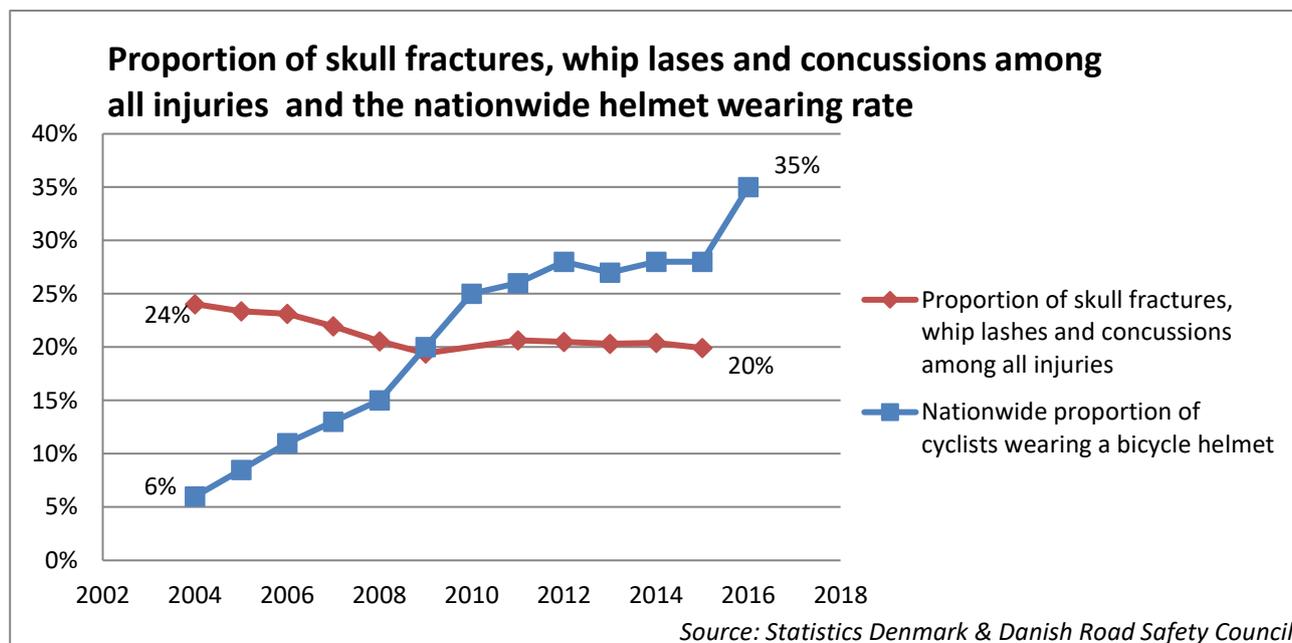


Figure 4: $n(\text{Statistics Denmark}) = 171.635$. $n(\text{Danish Road Safety Council}) = \text{see figure 2}$

If we look at different age groups with regard to helmet wearing rate (figure 5) vis a vis the proportion of skull fractures, whip lashes and/or concussions among all injuries (figure 6), the pattern becomes even more obvious. Figure 5 shows that the helmet wearing rate has soared since 2004, especially in the age groups “under 11 years old” and “11-15 years old”. Therefore, we should expect that the proportion of skull fractures, whip lashes and/or concussions among these age groups has decreased more for these age groups than for the rest of the population. The expectation is confirmed in the results depicted in figure 6: the proportion of skull fractures, whip lashes and/or concussions among 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 casualty wards.

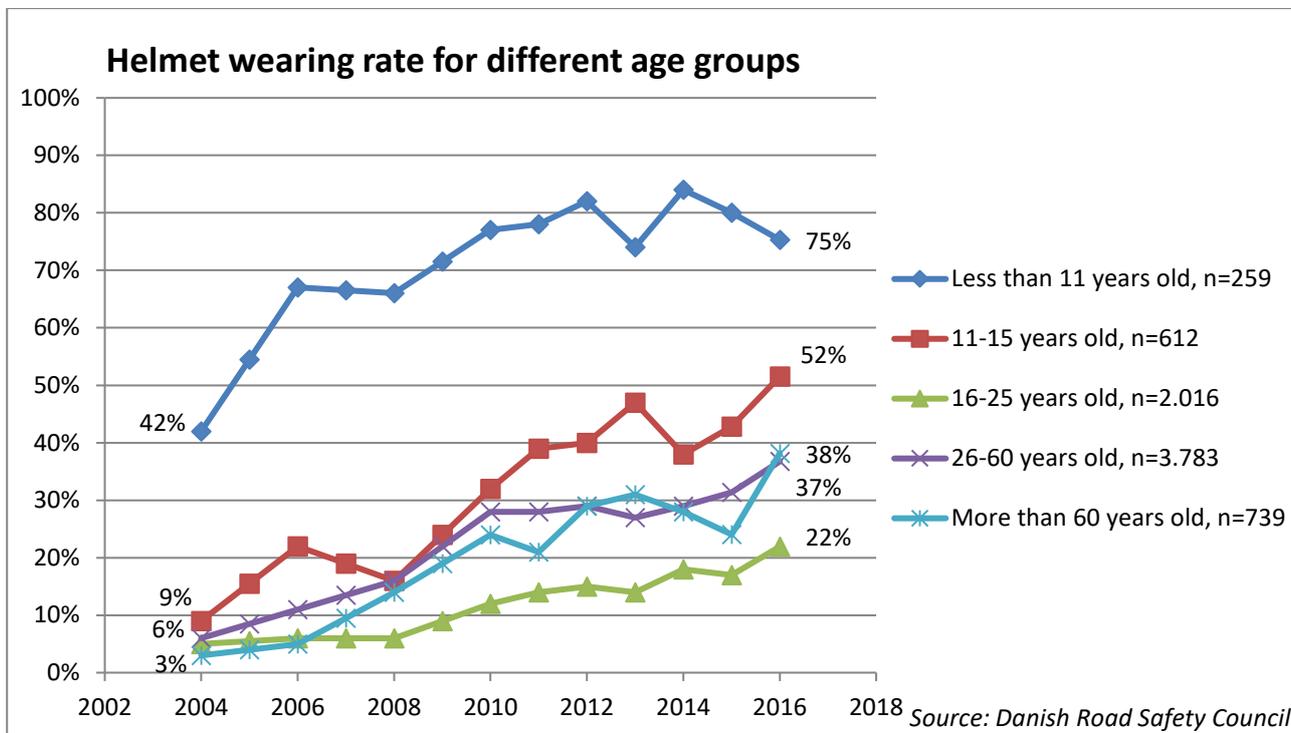


Figure 5: n is the number of observations in 2016.

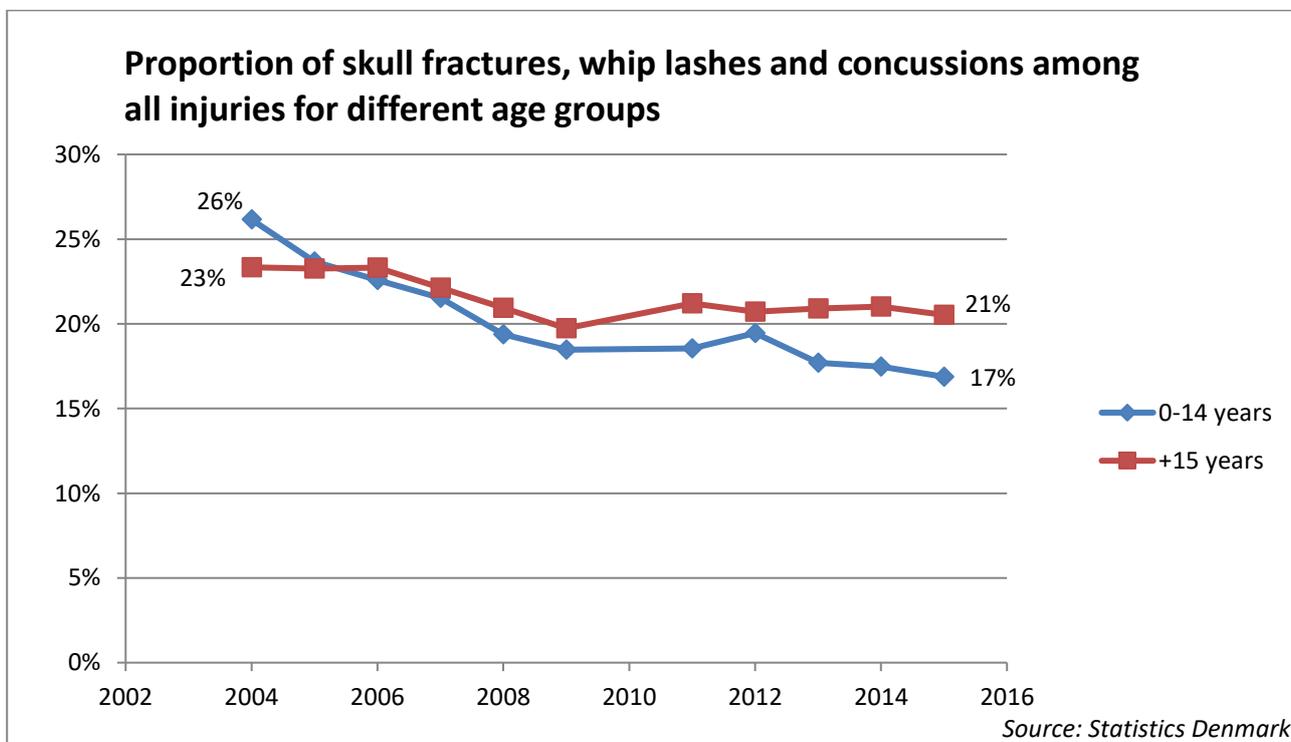


Figure 6: n=171.635.



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 helmets is not the best way to improve the safety of cyclists (SWOV, 2012).

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. However, the scientific evidence is inconclusive (Elvik, 2013:252; Olivier & Walker, 2013; Walker, 2007). According to a Danish survey, people do not think that wearing bicycle helmets make them take more risks (Epinion, 2016; see figure 7).

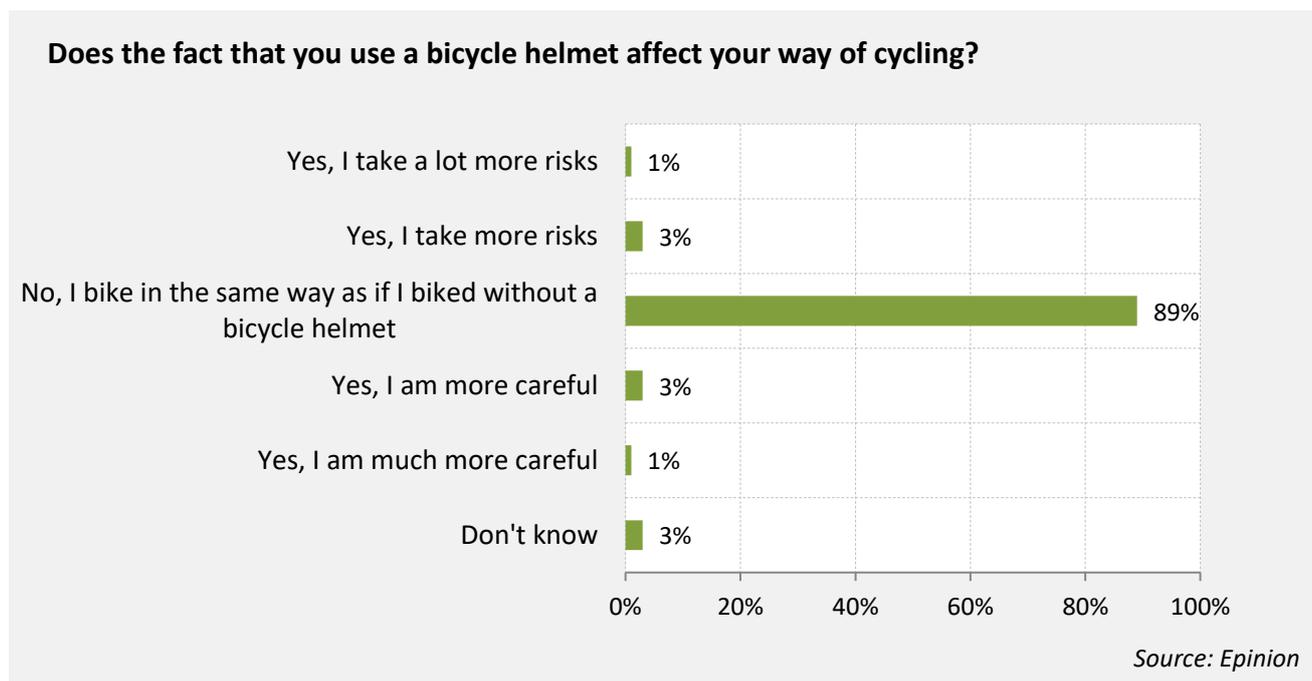


Figure 7: n=604

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 injuries to the head and brain injuries. Additionally, the types 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). 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 point to the fact that bicycle helmets lead to a decline in the number of people who use the bicycle for transportation. 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 does not cause a decline in cyclists (Dennis et al., 2010).

In a Danish context, a helmet legislation in Denmark 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 patterns. 5 % of the respondents stated that they would stop biking if a 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.

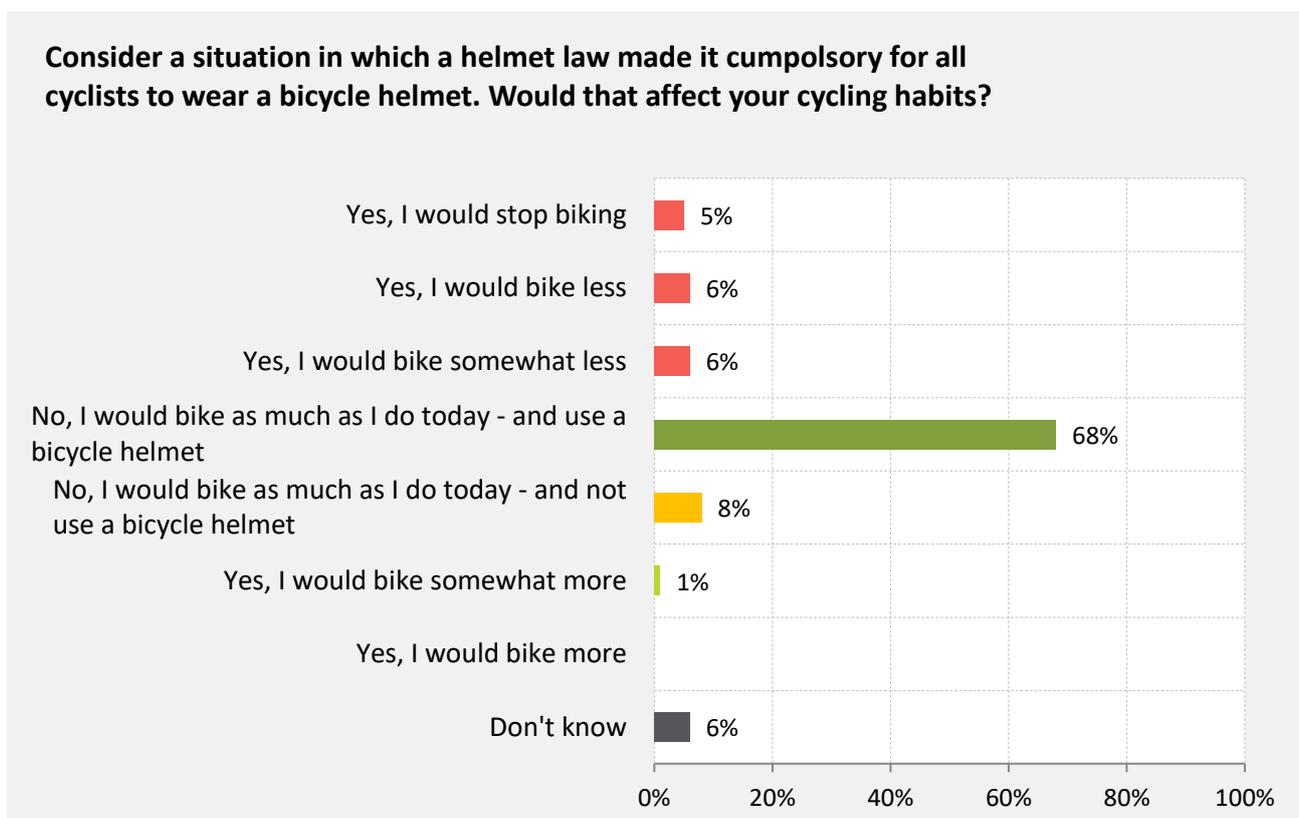


Figure 8: *n* = 1506. Source: Epinion (2016).

In light of this, it is the opinion of the Danish Road Safety Council that campaigns and incentives rather than legislation is the way forward in Denmark. The argument that such campaigns lead to a decline in the number of cyclists has also been put forward. However, in the survey bicyclists 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.

One could discuss whether Denmark should make bicycle helmets compulsory for children below the age 15. In fact, 84% of the Danes thinks this is a good idea (Epinion, 2016). However, bicycle helmet counts from Denmark and Sweden shows 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 is not the best mean 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 the infrastructure in 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 (Lahrman 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 the safety of cyclists, 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, such as the Danish Cyclist's Federation and TrygFonden, that cover the safety aspect of bicycling.

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 habit 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 decreases 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, is persistent throughout adulthood. All these factors motivates the Danish Road Safety Council's and TrygFonden's campaign, "Nederen Forældre" (see <https://www.sikkertrafik.dk/kampagner/nederen-foraeldre>)

Second, young students is 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 thinks 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 the fact that friends do not use a bicycle helmet (Danish Road Safety Council, 2015). At the same time, surveys finds that 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". 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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