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Why bicycle helmets are not effective in the reduction of injuries of cyclists.

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Translated from Dutch

Summary

New studies show that the effectiveness of bicycle helmets have been hugely overestimated in the past. At this moment, it is not even certain that there is a positive effect at all: an upper limit of its effectiveness is currently 6%. Promotion of the bicycle helmet is counterproductive from a health point of view.

Introduction

For years a debate has been going on about the usefulness and necessity of requiring or promoting bicycle helmets. This debate finds its roots in conflicting results between on the one hand research of practice on the street and on the other hand model studies and casualty research. This led to two different schools of thought with two different views on the issue of promoting or requiring helmets for cyclists: do not or do respectively. This contribution will bridge the differences in the supporting figures between the two schools largely or completely[1].

School of thought 1: Street Practice

Nothing can be more relevant than the actual situation on the street: the real experiment in full glory. It is striking that there is only one thoroughly investigated case of compulsory helmet introduction for cyclists: in Australia[2]. Summarized in three key figures the results of the Australian law are: an increase in bicycle helmet use from 40 to 90%, a decrease in bicycle use by 29% and a decrease in the number of cycling casualties by 22% (Figure 1). The result is that the risk to cyclists actually increased by 10%[3].

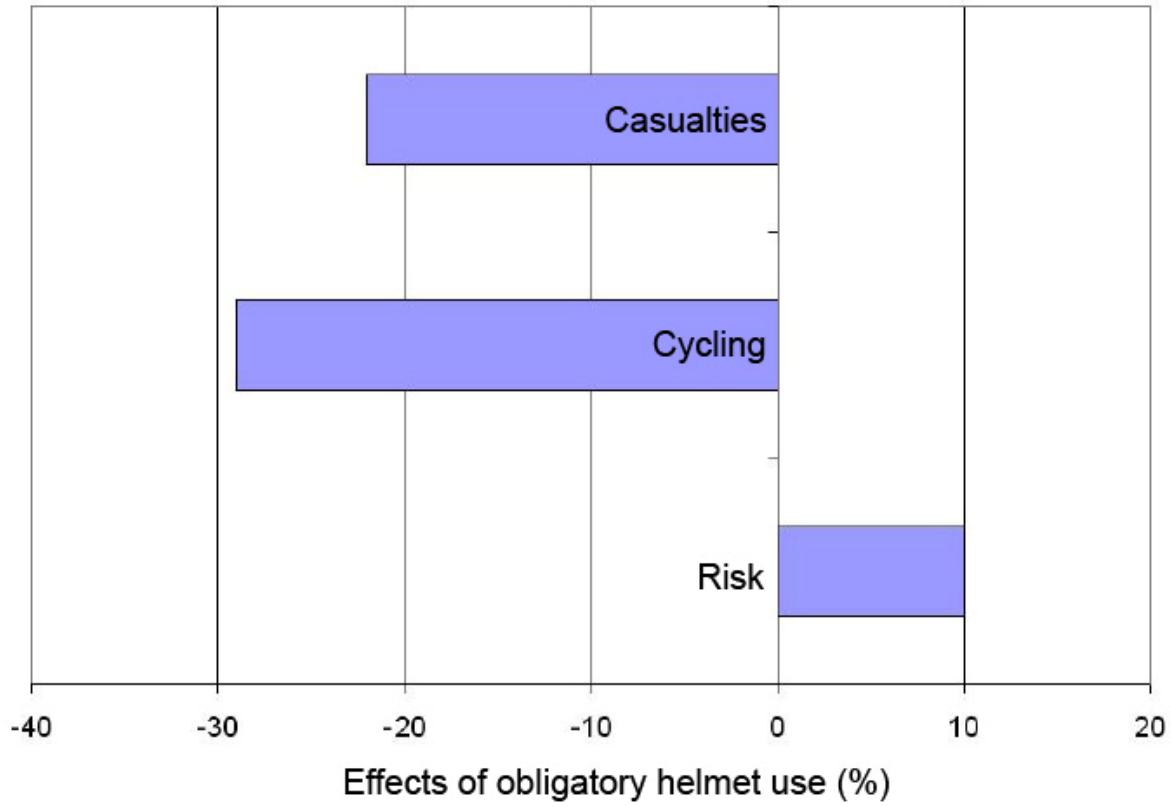

Figure 1: Effects of the legal obligation to wear bicycle helmets in Australia. Casualties are cyclists with head injuries

First conclusion is that, given the increased risk, the helmet does not actually protect the cyclist.

This also follows from a comparison of helmet use and risk to cyclists from eight countries (Figure 2): Countries with higher helmet use have on average a higher risk of a fatal accident for cyclists. The helmet therefore is not effective.

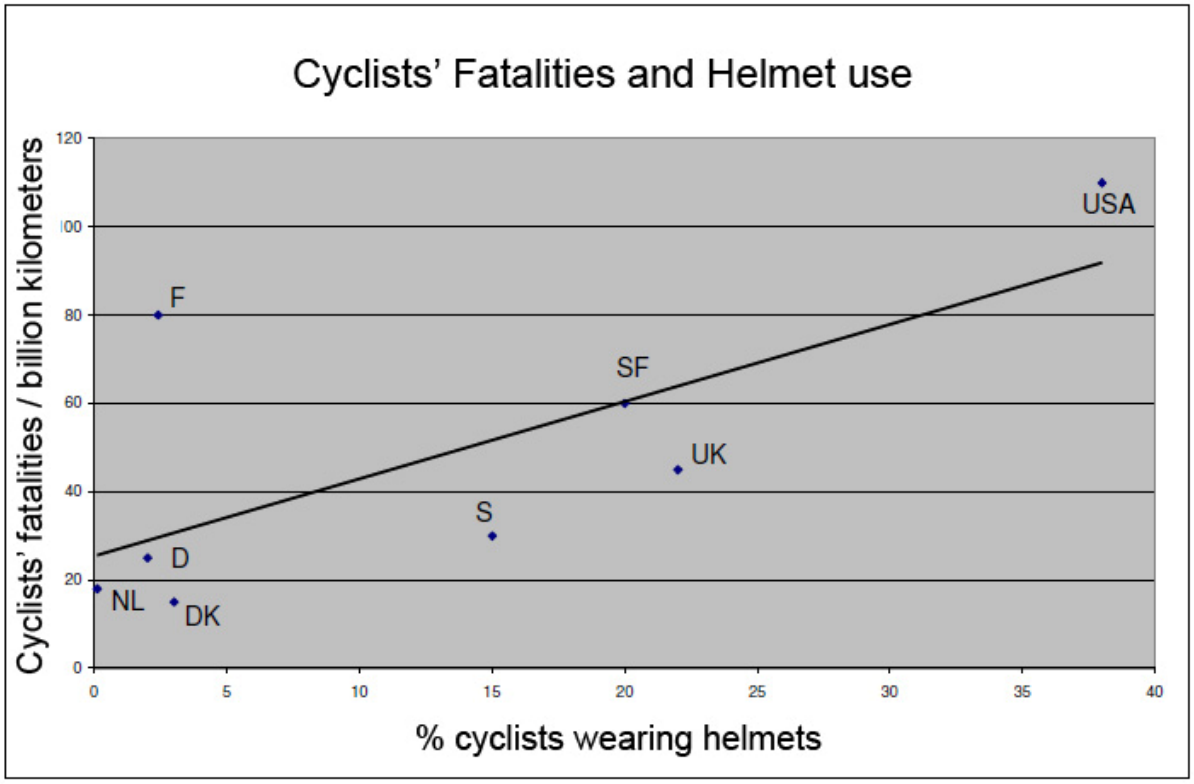

Figure 2: a cyclists' risk of a fatality versus the use of bicycle helmets in eight countries.

The decrease of cycling associated with increased helmet use (by obligation or promotion) is repeatedly investigated and established[4]. This is always of the following order of magnitude:

Every 5 percent point increased helmet use is consistent with 4 percent points decreased bicycle use

School of thought 2: Theoretical research

Opposite there is a long tradition of casualty surveys and laboratory experiments (virtual or not) which in large majority find an overwhelmingly positive effect of bicycle helmets. The extent of the reported effect does however vary strongly from zero to + 85%. That last figure comes from an older but very influential study, of which it has since been established that it is untenable (also according to the authors!). This number however is impossible to retract from the Internet[5]. In a recent fact sheet SWOV puts it at +45%[6]. In June, in a previous fact sheet, it was still +15%. No explanation was given for this significant adjustment. The figure of +45% is based on an influential meta-study of traffic fatalities[7].

Recently, this meta-study was subjected to scrutiny again by the Norwegian Elvik[8]. Elvik found two methodological errors in the previous meta-study. Correcting these and adding new studies to the

meta-study, Elvik establishes an effectiveness of 15%. He also notes that the effectiveness in the reported studies decreases over time. When limited to the studies of the last decade, Elvik finds there is no effect (0% effectiveness).

The author of this contribution can add the following, there is an additional methodological error that Elvik overlooked[9]. Unjustly all studies use wrong odds ratios to estimate the risk ratios. The effects are very difficult to map due to lack of relevant data, but in all cases it leads to an overestimation of the effectiveness of bicycle helmets. A first indicative estimate is that the effectiveness of bicycle helmets is overestimated by at least 11 percent points, possibly considerably more. With this correction the alleged difference between theory and practice has in fact practically disappeared.
To summarize, the current best estimate based on meta-studies for the effectiveness of bicycle helmets has an upper limit of 6%[10] and no effect (0%) lies within the unreliability interval.

Lessons of crash tests

Statistics give little insight into why things work or not. Here, experiments in a lab or a computer can bring a solution. The first important observation is that the bicycle helmet is designed to protect the cyclist from impacts of 20 km/h[11], exactly the speed of a cyclist's head if he rides slowly and falls off his bicycle on his head. In a collision with a car driving 40 km/h the force of the impact is ten times higher than the norm. From theoretical considerations based on the Head Injury Criterion it is shown that bicycle helmets with conventional thickness cannot possibly protect against serious injury in an impact greater than 30 km/h[12]. So bicycle helmets offer no protection in collisions with motorized traffic (where the speed is almost always higher). These are precisely the accidents with on average more severe injuries. Furthermore, it becomes increasingly clear that besides linear forces (measured in HIC) precisely rotational forces can also lead to severe head injuries. This dimension however remained completely unexposed in model studies to date, partly due to the lack of appropriate standards and thresholds (similar to HIC).

Lessons from practice

“In theory there is no difference between theory and practice ... .. but in practice there often is!”

Risk studies tend to grossly overestimate the effectiveness of instruments, because they are based on optimal use in an ideal environment. Reality is nonetheless filled with all kinds of noise and foreseeable misuse. This is certainly plays a role in the bicycle helmet case.

The following factors stand between theory and practice

-1) Most cyclists wear their helmets incorrectly. Australian research shows that the majority of cyclists wears a helmet that is too large, and on top of that the majority of them does not wear it correctly[13].
-2) The helmet should not be too old and may not have experienced a previous impact.
-3) There is a positive correlation between wearing a helmet and having a higher risk of an accident with injuries. For racing cyclists that is not so surprising, but there are also studies that found this effect with cyclists who cycle slowly for utility reasons[14].
-4) Another reason for the increased risk is that motorists overtaking cyclists do so at a closer distance. Cyclists wearing a helmet are more often hit than cyclists who don’t![15]

Disease or patient?

Modern medicine does not treat people (patients), but disease. This is even bureaucratically formalized with the introduction of the so-called Diagnosis - Treatment - Combination. This is understandable, because practitioners see sick people, not healthy ones. Yet there rightly is strong criticism of this approach as it would ultimately have to be about the welfare of a person, not treating a disease[16]. The current approach of medicine is in some cases not in the interest of the health of a person.

The health effects of cycling, particularly in the areas of heart lung condition, heart disease and obesity and diabetes, are much higher (estimated: 10 to 20 x) than the overall disadvantages of traffic risk and air pollution (Figure 3).

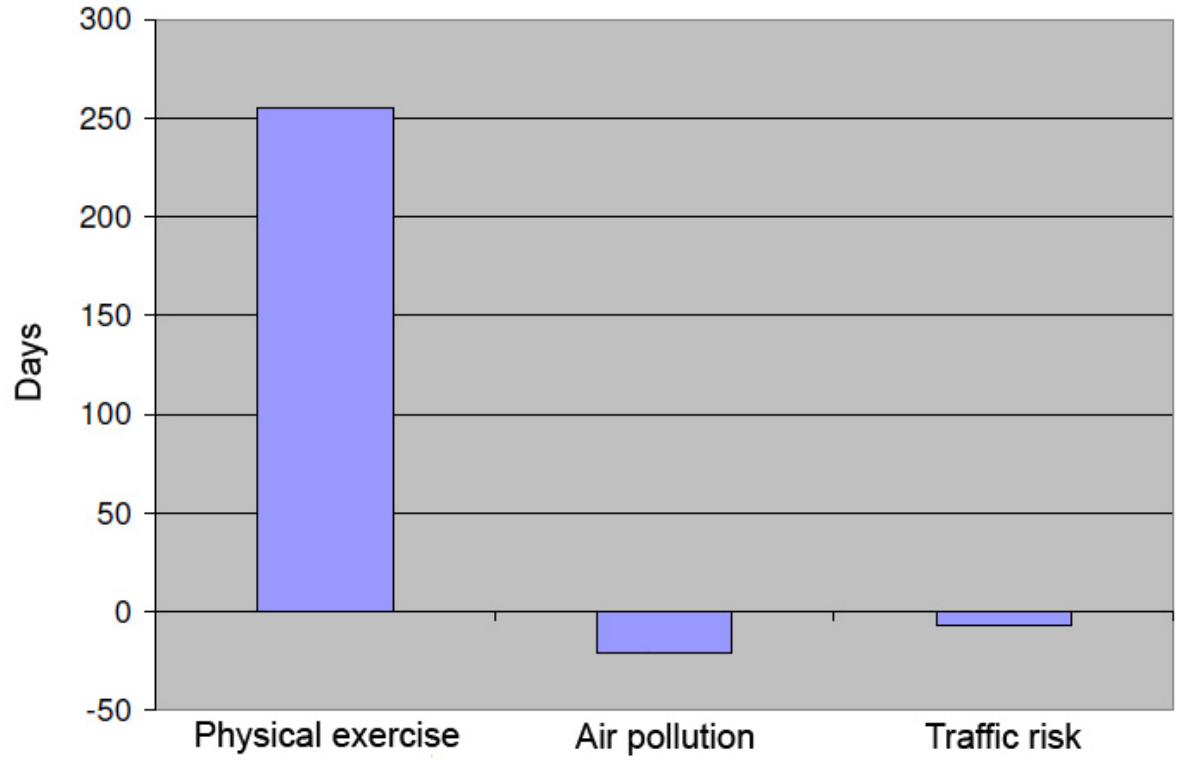

Figure 3: Impact of aspects of cycling on the life span (in days)[17].

Earlier, I outlined that the promotion of bicycle helmets or the obligation to wear them goes hand in hand with a decreased bicycle use. That is not in the interest of people.

The last part of the lament
"Ultimately, helmet laws save a few brains but destroy many hearts"[18]
is therefore justified.

The Yes, buts

Yes, but cyclists have an increased risk of head injuries

The risk for pedestrians to sustain head injuries in traffic is one and a half times higher than that of cyclists[19]. Yet the idea of pedestrians wearing a helmet is - thankfully – from a social point of view ridiculous.

Yes, but head injuries are the dominant type of injury for cyclists

Head injuries are an important type of injury among cyclists, but not dominant[20]. In 2009 more than three out of five injuries of cyclists were of other body parts.

Yes, but head injuries are more serious than other types of injuries

Rather, head injuries resulting in hospitalization are characterized by a very short average time of stay. Among patients who have to be treated in hospital for one day, almost half has head injuries. Among patients having to stay hospitalized for one week or longer, that drops to about one in seven (Figure 4).

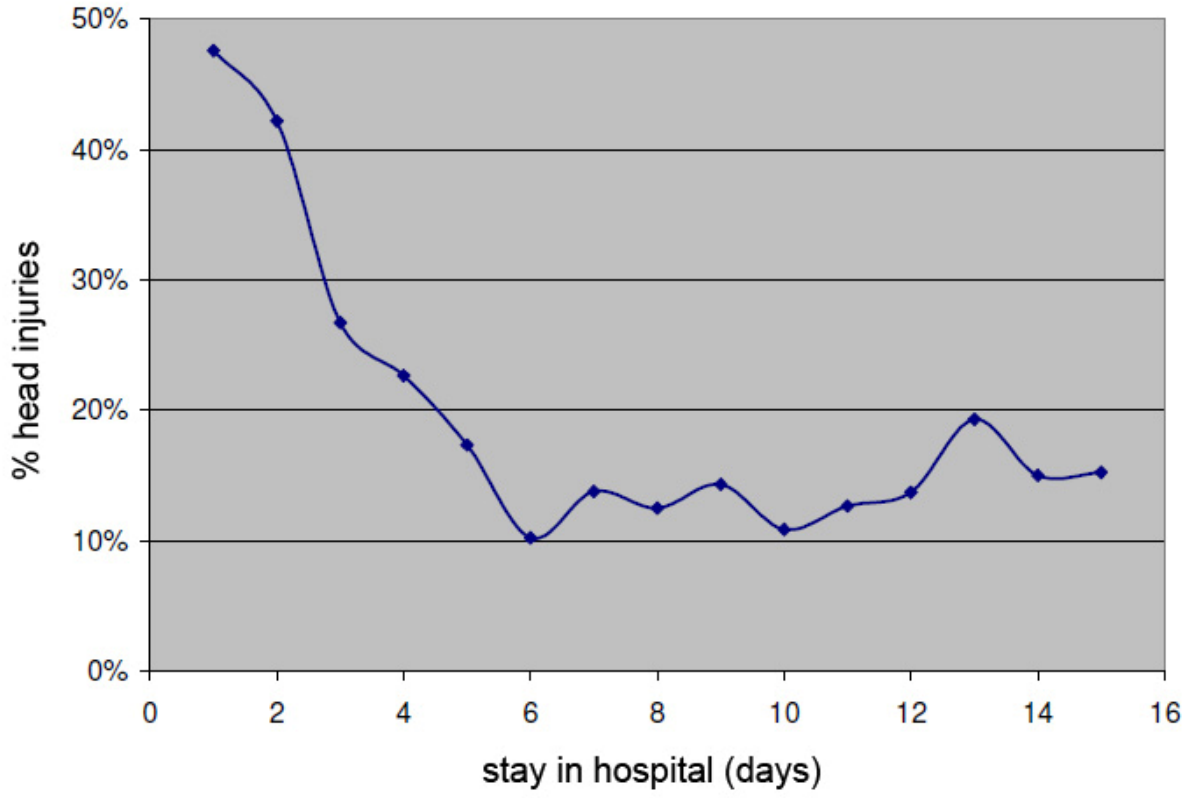

Figure 4: Proportion of head injuries, among seriously injured cyclists (MAIS2plus) to duration of stay.

Yes, but young children are an exception because of limited vehicle control

On the contrary, the casualty figures for children aged between 0 and 11 years show a remarkably low number of casualties (Figure 5). Rather, the highest number of victims are found in adolescents (12 to 18 years) and elderly. Accidents involving teens mainly involve collisions with motorized vehicles, so the type of accident where a helmet offers no protection. Moreover, this high number is largely explained by the high bicycle use in that age group (of school children).
The whole idea that children often sustain head injuries because they do not fully control their vehicle, is very attractive from a publicity point of view but it is contradicted by the statistics.

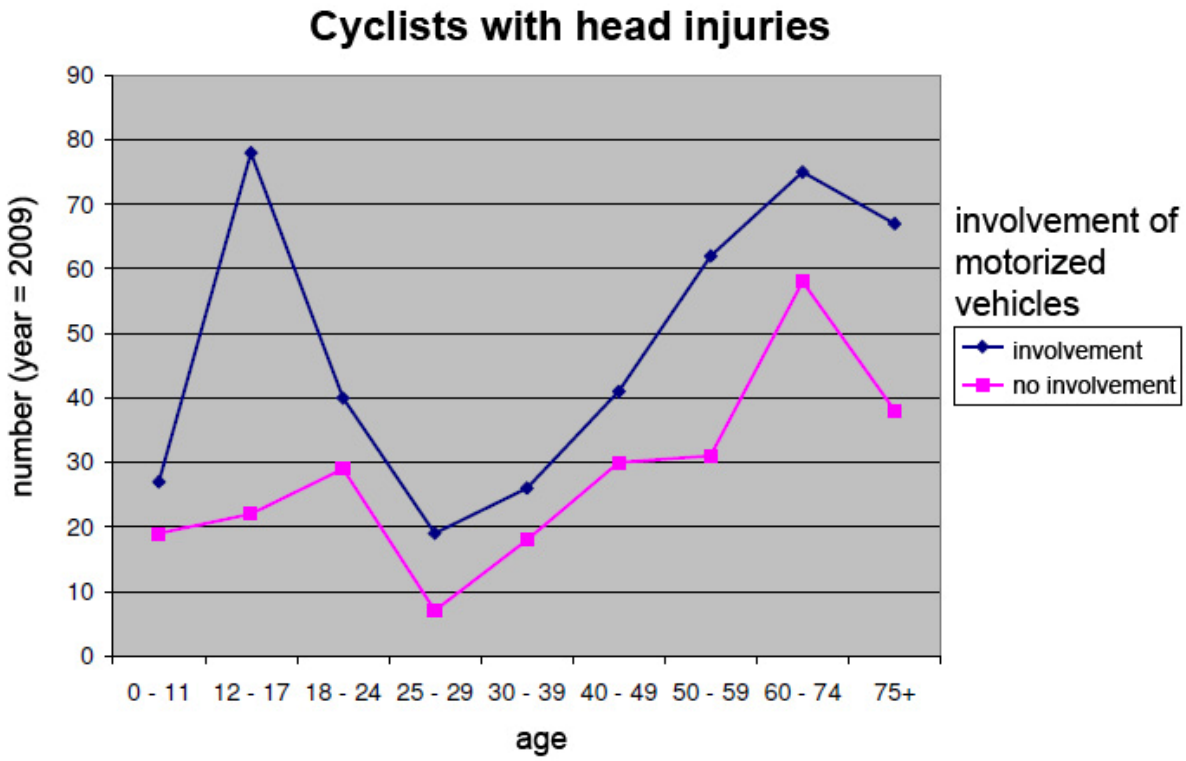

Figure 5: Number of cyclist casualties by age categories. Blue (upper) line: result of collision with motor vehicle; bottom (pink) line: other

Yes, but children sustain more severe head injuries due to their weaker bones

Injury Severity is commonly measured by a quantity called MAIS. the MAIS scale runs from 1 to 5: 2 corresponds approximately to hospital admission[21]. In chart 6, the proportion of severe injuries (MAIS3plus) for hospital admissions (MAIS2plus) is plotted by age. It is clear that severe injuries are more typical for older people and that they are very rare for young people.

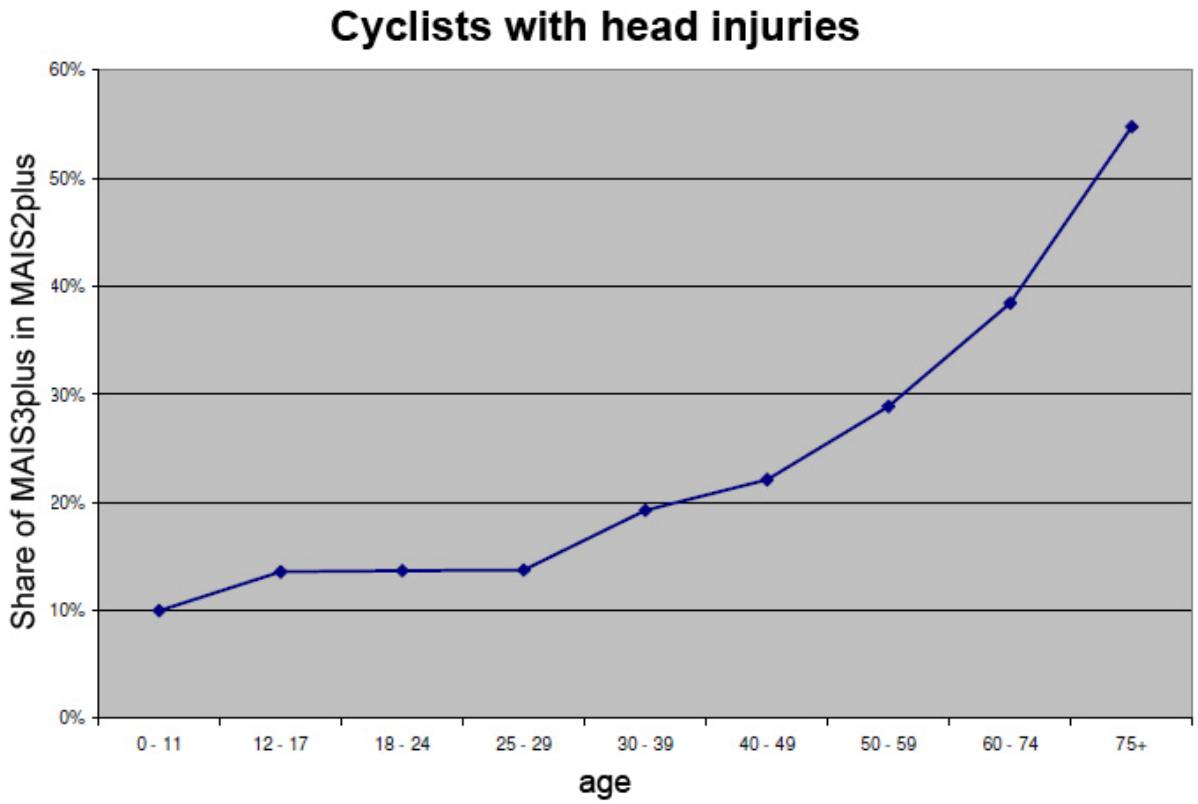

Figure 6: Proportion of severely injured cyclists (MAIS3plus) in hospital admissions (MAIS2plus) cyclists with head injuries by age

Yes, but we can't just do nothing?

Five years ago the Cyclists' Union has taken the initiative to establish systems in cars that can reduce the severity of injuries of the cyclists in a collision.
Specifically, an airbag on the windscreen of private motor vehicles was considered[22]. In collaboration with TNO, Centraal Beheer Achmea and Autoliv, with financial support from the Dutch and Swedish governments, this concept was developed into a prototype[23]. Unlike bicycle helmets, model studies[24] show that a "bicycle airbag" offers a significant effective protection against head injuries, even at speeds of 50 km/h[25]. The number of deaths that this system could be saving after full introduction for just the Netherlands is an estimated 44[26]. Thus, this development is potentially one of the most effective and efficient means to achieve a reduction of road casualties.

Notes

1 For more background information, see also
http://www.fietsersbond.nl/fietsverkeer/veiligheid/fietshelmen

2 Robinson, D.L. 2006. Do enforced bicycle helmet laws improve public health ? No clear evidence from countries that enforced the wearing of helmets. British Medical Journal 322: 722-725.

3 Also see Elvik, R., 2009. Handbook of Road Safety Measures
4 Sources as mentioned before and http://www.copenhagenize.com/2010/05/fewerswedish-kids-cycling.html

5 The figure is still unabashedly used in the propaganda for bicycle helmets, even by the government: http://www.verkeersnet.nl/5794/fietshelm-voorkinderen-van-de-basisschool/

6 http://www.swov.nl/rapport/Factsheets/NL/Factsheet_Fietshelmen.pdf .

7 Attewall, R.G., Glase, K. and McFadden, M., 2001. Bicycle helmet efficacy: a meta-analysis. Accident Analysis and Prevention: 33: 345-352.

8 Elvik, R., 2011. Accident Analysis and Prevention 43: 1245-1251.

9 Yet to be published, anyone who is interested in details may report to the author.

10 Because of the conversion from odds ratios to effectiveness ratios it is not 15 -11% = 4%, but 5.5%, rounded 6%.

11 EN 1078 (1997), for children's helmets EN 1080, that only differ in the chin strap

12 Okamota, Y., Akiyama, A., Nagatomi, K. & Tsuruga, T., 1994. Concept of hood design for possible reduction in pedestrian head injury. 14th. International Technical Conference on the Enhanced Safety of Vehicles.

13 Thai, K.T., Pang, T.Y., McIntosh, A.S. & E.Schilter, 2009. Helmet stability and fit in Australian pedal en motor cyclist population.

14 Fyhri, A, T. Bjørnskau & A. Backer-Grøndahl, 2009. Syklister som bruker både hjelm og annet utstyr: Råest og farligst. http://samferdsel.toi.no/article27673-1153.html

15 Walker, I. 2007. Drivers overtaking bicyclists: Objective data on the effects of riding position, helmet use, vehicle type and apparent gender. Accident Analyses and Prevention, 39, 417-425.

16 Wolffers, I., 2011. Gezond, over de mens, zijn gezondheid en de gezondheidszorg.

17 Hartog, J.J. de, Boogaard, H., Nijland, H. & Hoek, G., 2010. Do the health benefits of cycling outweigh the risks ? Environmental health perspective doi: 10.1289/eph.0901747.

18 DeMarco, T. (2002). Butting heads over bicycle helmets. CMAJ 167 (4), 337.

19 Data from Great Britain and Norway. There is no reliable data available for the Netherlands.

20 All accident figures in this paper are based on DHD / LMR, as can be consulted via COGNOS/SWOV, year = 2009

21 see for example http://www.swov.nl/NL/Research/cijfers/Toelichtinggegevensbronnen/LMR.pdf

22 http://www.fietsersbond.nl/fiets-verkeer/veiligheid/autos/airbag-op-autoruit

23 www.savecap.org

24 Rodarius, C., Mordaka, J. & Versmissen, T., 2008. Bicycle safety in bicycle to car accidents. TNO.

25 A decrease in the Head Injury Criterion from 2030 to 428. The generally accepted threshold for seriously injured is a HIC of 1000.

26 Hair, S. de, Malone, K., Veen, J. van der, Versmissen, T. & Schijndel, M. van, 2010. VRU Airbag – Effectiveness Study. TNO.