COMMENTARY

The health impact of mandatory bicycle helmet laws

de Jong P. Risk Analysis, 2012.
Similar paper published by Macquarie University NSW, 2009.

Original paper External Link

Author's summary

This article seeks to answer the question whether mandatory bicycle helmet laws deliver a net societal health benefit. The question is addressed using a simple model. The model recognizes a single health benefit – reduced head injuries – and a single health cost – increased morbidity due to foregone exercise from reduced cycling. Using estimates suggested in the literature on the effectiveness of helmets, the health benefits of cycling, head injury rates, and reductions in cycling leads to the following conclusions. In jurisdictions where cycling is safe, a helmet law is likely to have a large unintended negative health impact. In jurisdictions where cycling is relatively unsafe, helmets will do little to make it safer and a helmet law, under relatively extreme assumptions, may make a small positive contribution to net societal health. The model serves to focus the mandatory bicycle helmet law debate on overall health.

BHRF commentary

This paper presents a mathematical model for comparing the possible benefits of fewer head injuries as a result of helmet laws with the negative effects of less exercise due to fewer people cycling. It notes that the amount by which helmet laws reduce injuries and cycling is controversial. However, the author does not present any new data with regard to these factors or the health benefits of cycling. Instead, widely cited estimates are used as inputs to the model to arrive at the net implied benefit.

De Jong presents his central finding in the form of an equation, where a public health benefit can only arise if:

$$eq > \mu\beta$$

The injury costs of helmet-free cycling

In this equation, *e* and *q* are both fractions, i.e. their value lies between 0 and 1. *q* is the proportion of the health costs of helmet-free cycling which is due to head injuries, while *e* is the proportion of those costs which could be avoided if all cyclists wore helmets. So the left hand side of the equation *eq* represents the total injury costs of (helmet-free) cycling which would be avoided if all cyclists wore helmets. It is clearly less than 1, it is probably closer to 0 and it might even be negative.

The health benefits of cycling

The right hand side of the equation consists of two ratios. β is the ratio of the health benefits of (helmet-free) cycling relative to its risks. One widely quoted example of this ratio comes from Hillman, 1992, who estimated that the life-years gained due to cycling in Britain outweighed the loss of life due to cycling by a factor of around 20:1 (This estimate has been endorsed by the UK Department for Transport – DfT, 2010 – and Hansard, 2010). Figures from a more recent pan-European study (Rabl and de Nazelle, 2011) suggest a ratio of 24:1, while other estimates range from 13:1 to 415:1 (BHRF, 1015).

The other quantity on the right of the equation, μ, represents the ratio of cycle use lost following a helmet law to cycle use retained (NB: this is not quite the same as the percentage reduction – for instance a 33% reduction in cycle use can be thought of as 1 unit of cycling lost for every two that remain, hence the equivalent value of μ would be 0.5).

Balancing the benefits

It will be clear that, if there is to be a net health benefit, the two ratios μ and β need to counter-balance one another so that, when multiplied together, the result is less than the fractional quantity *eq*. In other words, if 20:1 is a correct value for β, then a helmet law can only yield a net health benefit if μ is less than 1:20 – i.e. there is no more than 1 unit of cycling lost for every 20 which remain – even if the remaining cyclists are 100% protected against <u>all</u> injuries, not just head injuries (i.e. if *e* and *q* both equal 1). So even under these implausible assumptions, a disbenefit occurs if the reduction in cycle use is any greater than 4.7% (i.e. 1/21).

This percentage then has to be reduced further still, in proportion to the values of *e* and *q*. *q* is surprisingly hard to quantify. It is assumed that it is about 0.5, given that c. 40% of cyclist injuries serious enough to merit admission to hospital and c. 80% of fatalities involve head injuries (although by no means all of these are head-only injuries, particularly in the case of fatalities – Knowles et al, 2009). Using this value of *q*, the allowable reduction in cycle use to avoid a net health disbenefit falls to just 2.4%, even if helmets are 100% effective at preventing all head injuries.

Outcomes for the most optimistic predictions of helmet effectiveness

That brings us to the much debated value of *e*. Even using the most optimistic (but widely criticised) figure of 85% (BHRF, 1068), helmet policies become counterproductive if the reduction in cycle use is more than 2.0% (1/21 x 0.5 x 0.85 = 0.02). On the basis of the entirely spurious prediction that helmets might reduce fatalities by 10-16% (Hynd, Cuerden, Reid and Adams, 2009), the limit falls to 0.0035, i.e. a net health disbenefit occurs if there is a reduction of 1 in 300 units of cycle use. Elvik, 2011 suggested a similar figure for the protective effect of helmets (c. 15%) but also suggested that this was outweighed by an increase in neck injuries. At this point, no reduction in cycle use is acceptable in public health terms.

The key point of this analysis, however, is that what really matters in public health terms is β, the ratio of cycling's health benefits to the risks involved. By contrast the value of *e* makes very little difference. Even if helmets are 85% effective (and assuming $q = 0.5$ as above), the number of cyclists' lives saved will still be outnumbered by deaths to non-cyclists if there is a reduction in cycle use of more than 2% – whereas if helmets have no net benefit or are actually counterproductive, then clearly even a 0% reduction in cycle use is unacceptable.

Shifting the focus

De Jong's equation shifts the focus of the helmet debate strongly onto the arguments about the degree to which the (large) health benefits of cycling outweigh the (far smaller) risks involved. By contrast the value of *e* (i.e. the effectiveness of helmets) makes very little difference. Assuming $\beta = 20$ and $q = 0.5$ as above, de Jong's equation shows us that helmet laws or promotion campaigns would shorten more lives than they could possibly save even if $e = 1$ (i.e. even if helmets were 100% effective at reducing head injuries) if there was a reduction in cycle use of more than about 2.4%. Lower values of e would reduce this threshold further still, and obviously if helmets have no net benefit or are actually counterproductive, then clearly even a 0% reduction in cycle use is unacceptable. But the threshold is bound to be low in any event, simply because the health benefits of cycling are so much greater than the (relatively low) risks involved.

Notes

1. The value of β will vary from place to place and country to country, depending on the safety of cycling conditions locally. It may also vary over time, depending not just in changes to cycling conditions, but also due to changes in the health of the population (the health benefits of getting people cycling will increase as the average health of the population declines).

2. With the exception of Hillman, 1992, the assessments of the health benefits and disbenefits of cycling reported at BHRF, 1015 include pollution-related impacts. Some of these merely cover the disbenefits of pollution to the

individual cyclist, while others also include the pollution benefits to society from reduced car use. Pollution-related impacts clearly form part of any overall evaluation of the net health effects of cycling, however they are not relevant when assessing the impact of helmet laws or policies using de Jong's equation, hence they have been omitted from the ratios derived from these studies as presented at BHRF, 1015. Alternatively, if values of β are used which included pollution or other costs and benefits, a corresponding adjustment would need to be made to the value of *q* on the other side of the equation, reflecting the proportion of the net disbenefits of cycling which are due to factors other than head injuries (in other words, to pollution effects as well as to non-head injuries).

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