Key Paper 1: A case-control study of the effectiveness of bicycle safety helmets

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Authors' abstract

Bicycling accidents cause many serious injuries and, in the United States, about 1300 deaths per year, mainly from head injuries. Safety helmets are widely recommended for cyclists, but convincing evidence of their effectiveness is lacking. Over one year we conducted a case-control study in which the case patients were 235 persons with head injuries received while bicycling, who sought emergency care at one of five hospitals. One control group consisted of 433 persons who received emergency care at the same hospitals for bicycling injuries not involving the head. A second control group consisted of 558 members of a large health maintenance organization who had had bicycling accidents during the previous year.

Seven percent of the case patients were wearing helmets at the time of their head injuries, as compared with 24 percent of the emergency room controls and 23 percent of the second control group. Of the 99 cyclists with serious brain injury only 4 percent wore helmets. In regression analyses to control for age, sex, income, education, cycling experience, and the severity of the accident, we found that riders with helmets had an 85 percent reduction in their risk of head injury (odds ratio, 0.15; 95 percent confidence interval, 0.07 to 0.29) and an 88 percent reduction in their risk of brain injury (odds ratio, 0.12; 95 percent confidence interval, 0.04 to 0.40).

We conclude that bicycle safety helmets are highly effective in preventing head injury. Helmets are particularly important for children, since they suffer the majority of serious head injuries from bicycling accidents.

General notes

The research upon which this paper is based took place in Seattle between December 1986 and November 1987.

This paper has been, and continues to be, by far the most influence research paper in support of the promotion of cycle helmets. It is cited in a considerable proportion of other research papers on helmets, to the extent that many other papers rely fundamentally upon its conclusions in the derivation of their own results.

The figures of 85% for head injury reduction and 88% for brain injury reduction come from only this source, yet are quoted far and wide as gospel by people who know nothing more about cycling, cyclist injuries or cycle helmets. Very few people who cite these figures have ever read the paper or assessed the validity of its conclusions. These two statistics are the keystones of helmet promotion campaigns in the UK by the Department for Transport Road Safety Unit, most local authorities, and the Bicycle Helmet Initiative Trust. In a similar way these statistics have been quoted in support of helmet promotion and mandatory helmet laws around the world.

Authors

The three authors, individually or as a team, are responsible for many other papers on cycle helmets, including meta anaylses of research (in which their own research has sometimes been dominant) including the influential Cochrane Review of helmet effectiveness *(see Key Paper 2)*.

The authors have a deep personal commitment to the wearing of cycle helmets, and have also written outspoken campaigning articles pressing for legislation in, for example, the British Medical Journal.

Critique

This paper has been severely criticised by a considerable number of people, both within and outside of the medical profession. At root, its methodology is seen as seriously flawed. In comparison with the paper itself, however, such criticism is scarcely known.

Control groups and helmet use

This paper used two control groups as comparison for the head-injured case group.

Group 1 comprised cyclists seeking emergency room treatment who did not suffer head injuries. There is no reason to suspect that this group differed from the case group in typical membership. Helmet wearing rates in this group were 5.9% for children under 15 and 39.4% for older cyclists.

Group 2 were from families that were members of a single large Seattle healthcare organisation, who filled out a survey form on cycle accidents. On average, these families had higher income and educational achievements than the Seattle population at large. The group was dominated by children under 15 (86%) – adults were too few to be significant. To be included, all members of the group had to do was fall off their bikes during the year. They didn't have to visit hospital and, indeed, only 12% sought medical care for any injuries sustained. The helmet wearing rate for children under 15 in this group was 21.1%.

It so happens that a third control group is also available as a result of a concurrent study in Seattle[1] in May 1987 (of which Rivara was also an author). This observed children under 15 riding around the town and recorded a helmet wearing rate for these children of only 3.1%. Moreover, children wearing helmets were much more often white than black or other races, and riding in parks or on cycle paths than on city streets.

Clearly the population control (Group 2) was nothing like the same as Group 3 in either membership or helmet wearing rates. If Group 2 is considered to represent child cyclists in Seattle, then it may be concluded that helmets prevent 85% of head injuries. However, if the children observed riding around Seattle (Group 3) are considered more typical of child cyclists, then the conclusion would be that helmets have no significant benefit because the helmet wearing rate of head injured child cyclists (2.1%) was well within sampling error of the rate seen on the streets.

Although 5.9% of children under 15 in Group 1 wore a helmet, there were only 12 of these as an absolute number and only 3 helmeted children under 15 in the case group. The numbers wearing helmets are much too small for a valid comparison of whether this control differs significantly from the street study Group 3 in wearing rates. That being so, no conclusion can be reached based on this group about the effectiveness of helmets in reducing head injury.

Sampling bias

The study is not randomised. The people included in both case and control groups are self-selecting samples, in that *they* choose whether to wear a helmet or not, how they cycle, their attitudes to risk, and many other variables that are therefore beyond the control of the researchers.

Types of injury

Of the 235 head injuries studied, 3 (1.2%) resulted in death and 6 (2.5%) were unconscious for more than 24 hours. Most of the other injuries were minor cuts and scratches.

The study does not distinguish facial injuries from other head injuries, although helmets would not prevent the former. 46% of head injuries were to the forehead only.

If facial injuries are excluded, the 85% reduction in head injuries comes down to 61%, but the number of cyclists wearing helmets is too small for this to be statistically significant[2]. In further re-working of Thompson's data, McDermott found that only 40% of head injuries would be reduced using approved helmets, though injury rates increased for the neck, extremities and pelvic region[2].

Crucially, the study did not include a single case of a helmeted cyclist in collision with a motor vehicle, yet the authors and others have promulgated the results as applicable to all types of cyclist crash.

Authors' acknowledgement of limitations

The authors acknowledged two sources of uncertainty: statistical error due to the fairly small sample, and bias in the sample: *"We cannot completely rule out the possibility that more cautious cyclists may have chosen to wear helmets and also had less severe accidents"*.

In 1996, the authors adjusted their own assessment of the reduction in head injury by helmets to 69% [3], but the original figure is still the one that is widely quoted.

References

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