Bicycle helmet efficacy: a meta-analysis
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Authors' objectives
To quantify the efficacy of helmet use in preventing serious injury to cyclists.

Searching
MEDLINE was searched from October 1998, and was regularly updated until August 1999. The keywords included 'bicycle helmet', 'efficacy' and 'head injury'. The references from review articles were used as additional sources.

Study selection
Study designs of evaluations included in the review
The inclusion criteria specified studies based on individual cyclists, with sufficient detail to complete a 2x2 table of injury by helmet use.

Specific interventions included in the review
The use of a bicycle helmet by individual cyclists.

Participants included in the review
Adult and child cyclists were included.

Outcomes assessed in the review
The outcomes stated in the original review protocol were head, brain and facial injury. However, several of the included studies contained information on neck and fatal injuries; these results were also presented.

How were decisions on the relevance of primary studies made?
The search produced 63 articles, all of which were obtained as full papers. Two independent reviewers assessed the papers for inclusion. The inclusion criteria restricted the papers to English language publications in peer-reviewed journals.

Assessment of study quality
The authors did not state that they assessed validity.

Data extraction
The data were extracted by two independent reviewers. The data presented included the following: the year and country of study; the years during which the data were gathered; the number of participants; whether the participants were adult or child cyclists, or both; and whether the studies included details of head, brain, face, neck and fatal injuries. In addition, the individual and combined estimates for helmet efficacy were provided for head, brain, facial, neck and fatal injury.

Methods of synthesis
How were the studies combined?
A meta-analysis was used to calculate the summary estimates of odds ratios (ORs) and 95% confidence intervals (CIs), using the method of DerSimonian and Laird (see Other Publications of Related Interest). Separate analyses were conducted for head, brain, facial, neck and fatal injury in helmet-wearers versus non-wearers. A random-effects model was used if a statistical test of heterogeneity was significant. The authors investigated publication bias through the use of funnel plots.
How were differences between studies investigated?
The chi-squared test was used to test for heterogeneity. The authors attempted to compensate for heterogeneity by using a random-effects model in the meta-analysis. They cited some possible sources of heterogeneity, including crash settings, the definition of injury, and the type of cyclist.

Results of the review
Sixteen studies (N=17,289) were included. There were 3 self-report surveys (N=409) and 13 case-control studies (N=16,880) of cyclists presenting at hospital emergency departments.

The results were significant for head injury, brain injury and facial injury, but not for neck and fatal injury.

Head injury: the results of the heterogeneity tests were significant (Q=52, d.f.=11, p<0.001). The use of helmets was found to reduce the risk of head injury. The OR was 0.40 (95% CI: 0.29, 0.55).

Brain injury: the results of the heterogeneity tests were significant (Q=22, d.f.=7, p=0.002). The use of helmets was found to reduce the risk of brain injury. The OR was 0.42 (95% CI: 0.26, 0.67).

Facial injury: the results of the heterogeneity tests were significant (Q=11, d.f.=5, p=0.04). The use of helmets was found to reduce the risk of facial injury. The OR was 0.53 (95% CI: 0.39, 0.73).

Neck injury: there was no strong evidence for heterogeneity in the 3 studies used to compute an efficacy estimate for neck injury (Q=2.5, d.f.=2, p=0.3). The combined estimate was not statistically significant. The OR was 1.36 (95% CI: 1.00, 1.86).

Fatal injury: there was no evidence for heterogeneity (Q=3.5, d.f.=5, p=0.6). The use of helmets was found to reduce the risk of fatal injury. The OR was 0.27 (95% CI: 0.10, 0.71).

The authors stated that there may be some publication bias for head injury, but not for brain injury. The number of studies relating to facial injury was small, but this also showed possible publication bias. The authors also stated there was no evidence of distortion for fatal injury and that neck injury cannot be adequately assessed due to the small number of studies. A sensitivity analysis was also conducted; this indicated that at least 11 large, non significant negative studies would be required to totally counteract the results for head injury (2 for facial injury).

Cost information
No

Authors' conclusions
The authors concluded that there were clear benefits to wearing a cycle helmet in terms of injury risk. They provided conservative risk reduction estimates of at least 45% for head injury, 33% for brain injury, 27% for facial injury and 29% for fatal injury. They believe that possible confounding factors, such as age and crash severity, did not influence the results. Despite possible publication bias, the authors stated that the strength of the association between helmet use and injury risk was compelling. They conducted a sensitivity analysis that indicated that at least 11 large, non significant negative studies would be required to totally counteract the results for head injury (2 for facial injury).

CRD commentary
The authors' inclusion criteria relating to the study design, participants and intervention were appropriate to the review question. The outcomes stated in the protocol were head, brain and facial injury. However, several of the included studies contained information on neck and fatal injuries; the authors analysed and reported this data. It is possible that the search strategy missed other papers on neck and fatal injuries, which would have provided a more comprehensive picture of results. The search was limited to published material, which could have resulted in publication bias, and only English language articles were included in the review.
There was no evidence to suggest that the validity of the studies was assessed; this is particularly important in observational studies which are generally of lower quality and are more prone to bias. The authors tested for heterogeneity using the chi-squared test, and then attempted to compensate for heterogeneity by using a random-effects model. The evidence seemed to point to the efficacy of bicycle helmets in reducing head, brain and facial injury. However, the evidence was unclear regarding neck injuries, and for fatal injuries it might have been compromised by missing research papers. The meta-analyses of head, brain and facial injury were inappropriate due to the heterogeneity, thus the summary ORs cannot be entirely relied upon.

**Implications of the review for practice and research**

Practice: Helmet use for all riders should be further encouraged, to the extent that it is uniformly accepted and analogous to the use of seatbelts by motor vehicle occupants. The authors state that their results are applicable to riders of all ages, both in less severe crashes and in collisions with motor vehicles.

Research: The authors have identified a need to determine whether helmet design increases the likelihood of neck injury to the wearer.

**Bibliographic details**


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**Other publications of related interest**


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