Effectiveness of bicycle helmet legislation to increase helmet use: a systematic review
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CRD summary
This review evaluated the effectiveness of legislation to increase bicycle helmet use. The authors concluded that legislative helmet wearing interventions can increase helmet use amongst cyclists, particularly in younger age groups and where low levels of pre-intervention behaviour exist. Given the potential limitations in synthesising variable studies of unknown quality, the extent to which these conclusions are reliable is unclear.

Authors' objectives
To evaluate the effectiveness of legislation to increase bicycle helmet use.

Searching
MEDLINE, EMBASE, CINAHL, Web of Science, British Education Index, LILACS, TRIS, the Cochrane Injuries Group's Specialised Register, the Cochrane CENTRAL Register and DARE were searched; the search terms were reported to be available on request. Grey literature and dissertations were sought through Google Scholar and University Microfilms. Conference proceedings and reference lists were screened, and authors were contacted for further relevant studies.

Study selection
Study designs of evaluations included in the review
Cohort studies, controlled before-and-after designs, interrupted time series, or non-equivalent control group studies were eligible for inclusion in the review. Telephone or mailing surveys and self-reported questionnaire-based studies were excluded.

Specific interventions included in the review
Studies of bicycle helmet wearing legislation at regional, state/province-wide, or municipal level compared with a pre-, or non-legislative time period in the same or a matched control community were eligible for inclusion. Legislation was aimed at children younger than 18 years of age in most of the included studies. The authors also reported on the implementation and context surrounding the intervention, where data were available.

Participants included in the review
Community-based studies involving children, adolescents and/or adult cyclists were eligible for inclusion. The majority of studies involved all ages; some studies included only children. Hospital-based studies were excluded. The included studies were located in the USA, Canada, Australia and New Zealand.

Outcomes assessed in the review
There were no specific outcome criteria. The primary outcome in the majority of included studies was the proportion of cyclists using helmets before and after legislation. In almost all studies, roadside observations were recorded in predefined sites by trained observers. The duration of follow-up ranged from 6 months to 11 years post-legislation.

How were decisions on the relevance of primary studies made?
Two independent reviewers selected studies for inclusion in the review. Any disagreements were resolved through consensus, or by referral to a third reviewer.

Assessment of study quality
Two independent reviewers used a modified version of a checklist designed for randomised and non-randomised studies to assess the methodological quality of the included studies.

Data extraction
Two reviewers extracted the data. Percentage changes in helmet use were calculated from rates recorded before and after legislation. Odds ratios (ORs) were also calculated, along with 95% confidence intervals (CIs), using population.
data from intervention and control groups, or pre and post-legislation studies.

**Methods of synthesis**

How were the studies combined?
Pooled ORs were calculated with 95% CIs using a random-effects model.

How were differences between studies investigated?
Study variation was explored using chi-squared and I-squared statistics. The effects of length of follow-up, age, gender and pre-intervention helmet wearing prevalence were explored.

**Results of the review**

Twelve studies were included in the review (69,617 observations). Two studies used non-equivalent control groups (2,193 observations) and 10 were interrupted time series or pre-post observational designs (47,424 observations).

The baseline rate of helmet use ranged from 4 to 59%, rising to 37 to 91% post-legislation. Seven studies reported an increase of over 30%, four an increase of 10 to 30%, and one an increase of less than 10%.

Pooled analysis of all studies showed that helmet use was significantly higher following legislation (OR 4.60, 95% CI: 2.87, 7.36). However, this result was based on substantially heterogeneous studies (OR range: 1.2 to 22; I-squared 99%), attributed largely to the inclusion of non-equivalent control group designs. A smaller, but statistically significant effect size was noted in the before-and-after designs (OR 4.13, 95% CI: 2.45, 6.97). There was no significant influence of gender on adherence to legislation, nor was there any statistically significant association between baseline and post-legislation rates of helmet use, although a trend was noted between high pre-intervention helmet wearing behaviour and lower rates of increase post-legislation. The authors stated that it was not possible to examine the influence of differential implementation, confounding activities, socioeconomic status, the role of elapsed time and potentially negative effects of legislation on cycling participation.

**Authors' conclusions**

Legislative helmet wearing interventions can increase helmet use amongst cyclists, particularly in younger age groups and in populations with low levels of pre-intervention behaviour.

**CRD commentary**

The review addressed a clear question and was supported by broad (but appropriate) inclusion criteria for the participants, interventions and study designs. The search strategy was extensive, appeared relevant to the topic area, and included attempts to retrieve unpublished material. Validity assessment criteria were reported, but the results of this assessment were not recorded; these would have been useful in support of the review's findings, which were necessarily based on non-experimental study designs. Adequate attempts were made to minimise error and bias in the review process.

The decision to pool heterogeneous data was (as the authors acknowledged) methodologically contentious. The authors' conclusion regarding particular effectiveness in younger age groups does not seem to be supported by the data as presented. This, together with the potential limitations of synthesising heterogeneous studies of unknown quality, means the extent to which the conclusions are reliable is unclear.

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

Practice: The authors stated that, although research suggests that intervention effects may be lower where baseline rates of helmet use are high, the effects of legislative interventions should not be disregarded in these cases.

Research: The authors stated that longitudinal studies are needed to explore the role of time in legislative periods, along with other implementation and contextual issues in operation. Further research is also needed to investigate the effects of individual intervention components; to compare similar communities; and to explore the transition effect of helmet law expansion from younger to all ages.
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