Age gradient in the cost-effectiveness of bicycle helmets
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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The wearing of a properly fitted, protective, hard shell helmet, used in order to protect cyclists from getting upper head injuries following a bicycle accident. The helmet would be worn at all times whilst the cyclist was on a bicycle.

Type of intervention
Primary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
A hypothetical cyclist population in Norway, aged between 3 years and 70 years.

Setting
Community, Norway. The economic study was carried out in Oslo, Norway.

Dates to which data relate
The majority of the effectiveness data on cyclists were taken from the National Bicycle Survey made in Oslo in 1992. The source of the resource use was not stated (assumption). The price year was 1998.

Source of effectiveness data
The effectiveness evidence was derived from a review of the literature and authors’ assumptions.

Modelling
A simple probability model was developed to predict the expected number of head injuries averted, and the costs/savings associated with this reduction. The number of cyclists required to wear a bicycle helmet for five years in order to prevent one head injury was calculated. This was known as the Number Needed to Treat (NNT).

Outcomes assessed in the review
The incidence rate of upper head injuries per 1000 bicycle riders, and the protective effect of bicycle helmets were assessed in the review.

Study designs and other criteria for inclusion in the review
No specific inclusion criteria were reported by the authors. It was reported that some of the effectiveness evidence was derived from the Norwegian National Injury Sample Register, which collects information about all cases of injuries.
occurring in a defined population of 41 communities and referred to all 1775 cases of upper head injuries to bicycle riders occurring from 1990 to 1996. In addition, another 4 case-control studies were used to derive information regarding the protective effect of helmets.

Sources searched to identify primary studies
Not stated.

Criteria used to ensure the validity of primary studies
Not stated.

Methods used to judge relevance and validity, and for extracting data
Not stated.

Number of primary studies included
One cohort study and four case-control studies.

Methods of combining primary studies
Not stated.

Investigation of differences between primary studies
Not stated.

Results of the review
The authors only reported that helmet use reduced risk of bicycle-related injury by 60-90%.

Methods used to derive estimates of effectiveness
The authors made assumptions about the effectiveness of a bicycle helmet in preventing head injury. No details were provided as to how the exact value was chosen.

Estimates of effectiveness and key assumptions
It was estimated that wearing a bicycle helmet reduced the risk of incurring a head injury following an accident by 70%. A key assumption made here, was that the effective life of a bicycle helmet is 5 years.

Measure of benefits used in the economic analysis
The outcome measure used in the study was 'head injuries avoided'. Two different types of head injury were accounted for: 'emergency room', and 'hospitalisations'. The number of newly helmeted cyclists for 5 years needed to prevent one head injury was reported as the Number Needed to Treat (NNT). The number of deaths averted was not measured. Future benefits were discounted at an annual rate of 3%.

Direct costs
The cost of purchasing the helmet was considered in the study. The average cost of a helmet was used. In addition, patients were grouped in charge categories, which were used to estimate the reimbursement costs (according to the Norwegian DRG-based payment system for inpatient care and the fee-for-service-based system for outpatient care). Quantities were not reported separately from costs. Some item costs were reported separately. Discounting was not
applied as costs were incurred in a short time frame (less than 2 years). The price year was 1998.

**Indirect Costs**
No indirect costs were considered.

**Currency**
The currency was measured in Norwegian Kroner (NOK) and has been converted to US dollars ($) at an exchange rate of $1 = 7.8 NOK.

**Sensitivity analysis**
One way sensitivity analysis was performed, on the following parameters:

- helmet price (baseline $30, sensitivity analysis $25 - $35);
- helmet effectiveness (70%, 60% - 90%);
- helmet lifetime (5 years, 3 - 5);
- helmet use rate (100% to 150% of baseline values, each age);
- and the cost of acute medical treatment (100% to 200% of original baseline estimates, each age).

**Estimated benefits used in the economic analysis**
It was estimated that the absolute reduction in risk of upper head injury (over five years) was between 1% and 1.4% for those aged 3 to 13 years, and around 0.2% for those over 27 years of age. The number of cyclists required to wear a helmet for five years in order to prevent one head injury was less than 100 for those aged 3 to 13, and was between 300 to 700 for adults. These benefits have been discounted annually at a rate of 3%.

**Cost results**
No cost results were reported.

**Synthesis of costs and benefits**
The number of cyclists required to wear a helmet for 5 years in order to prevent one upper head injury was reported. This allowed the author to then state the expected cost per head injury avoided (with benefits discounted at 3%). For children aged between 3 and 13 years, this was estimated to be $2,200, whilst, for adults over 25 years, it ranged from $10,000 to $25,000 per upper head injury averted. For hospitalised injuries, these figures were $7,000 for children, whilst adults ranged from $35,000 to $65,000. These cost per injury averted figures were directly and proportionally related to the cost of a bicycle helmet (i.e. if the price of a helmet doubled, then the cost per head injury averted would also double). The price of the helmet was a key parameter, and sensitivity analyses showed that changes in this had a direct and proportional effect on the cost-effectiveness ratios. All other parameters had fairly significant effects on the cost-effectiveness results.

**Authors’ conclusions**
The authors concluded that protective bicycle helmets were several times more cost-effective for children than for adults, and as such, programmes designed to promote the use of helmet wearing should be aimed towards younger individuals.
CRD COMMENTARY - Selection of comparators

Wearing a protective bicycle helmet was the only method considered in order to reduce the number of head injuries, and was compared to not using a helmet. In practice, many other policies are often used, such as increasing road safety education, or the design of better and safer cycle paths.

Validity of estimate of measure of benefit

Benefits were estimated using modelling techniques. Data for the model were obtained from a detailed and comprehensive injury registration system in Norway and also from the literature, and authors' assumptions. It would have been helpful to report the methods used to identify the studies from the literature. Deaths averted were not considered as a measure of benefit due to the low number of deaths per year as a result of bicycle accident related head injuries (usually 4 or 5 each year in Norway). The authors defend this by stating that the effectiveness of bicycle helmets in preventing death is unknown. However, if this had been taken into consideration, then it would have favoured better cost-effectiveness results. The measure of benefits (number of head injuries) was also unable to capture any small effects in the severity of injury. It may be that wearing a bicycle helmet also lessens the extent of the damage. Health benefits were discounted at 3%, which might differ from discount rates, applied in other countries.

Validity of estimate of costs

Costs refer to the Norwegian health care setting and might not be applicable to other countries. Some costs appear not to have been included in the study. Examples of these are the side-effects resulting from people choosing to stop cycling, the education required in order to advise people on the correct method of wearing a properly fitted helmet and the costs associated with promoting the use of bicycle helmets. The authors pointed out that they did not have the estimates for long-term costs and these should also be included in future analyses.

Other issues

It was assumed in the study that wearing a bicycle helmet reduced the probability of a head injury. It has also been shown in other studies however, that wearing a bicycle helmet may have significant effects upon the behaviour of a cyclist, and therefore change the probability of receiving injuries to parts of the body other than the head. A further consideration is the assumption that helmets are 70% effective in reducing head injuries. It was assumed that this was consistent for all age groups. However, many studies have shown that helmets are significantly more effective for young children. This would further strengthen the authors' claim that helmet wearing was more cost effective for young children. However, it was also assumed that the lifetime of a helmet (5 years) was the same for all age groups. It may be the case that children, due to the growth in size of their heads, may have to replace their helmets more frequently, thus incurring higher costs.

Implications of the study

The study implies that in Norway (and indeed any other country with similar incidence of bicycle accident related head injury, such as the USA), it is more cost-effective when promoting helmet wearing, to target younger age groups.

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