New Zealand bicycle helmet law—do the costs outweigh the benefits?

M Taylor, P Scuffham

Objectives: This paper examines the cost effectiveness of the compulsory bicycle helmet wearing law (HWL) introduced in New Zealand on 1 January 1994. The societal perspective of costs is used for the purchase of helmets and the value of injuries averted. This is augmented with healthcare costs averted from reduced head injuries.

Methods: Three age groups were examined: cyclists aged 5–12 years, 13–18 years, and ≥19 years. The number of head and non-head injuries averted were obtained from epidemiological studies. Estimates of the numbers of cyclists and the costs of helmets are used to derive the total spending on new bicycle helmets. Healthcare costs were obtained from national hospitalisation database, and the value of injuries averted was obtained directly from a willingness-to-pay survey undertaken by the Land Transport Safety Authority. Cost effectiveness ratios, benefit:cost ratios, and the value of net benefits were estimated.

Results: The net benefit (benefit:cost ratios) of the HWL for the 5–12, 13–18, and ≥19 year age groups was $0.3 m (2.6), –$0.2 m (0.8), and –$1.5 m (0.7) (in NZ $, 2000 prices; NZ $1.00 = US $0.47 = UK £0.31 approx). These results were most sensitive to the cost and life of helmets, helmet purchasing rates before the HWL, and the effectiveness of helmets in preventing head injuries.

Conclusions: The HWL was cost saving in the youngest age group but large costs from the law were imposed on adult (≥19 years) cyclists.

The willingness-to-pay values included indirect costs (loss of productive output due to temporary incapacitation and permanent disability), property damage, legal/court costs, and medical costs (including emergency treatment). We revised the costs for hospital inpatient treatment with the estimates described below. These willingness-to-pay values applied to all age groups for all traffic related injuries. We assumed the percentage of head injuries requiring more than seven days hospital treatment was constant in the pre-HWL and post-HWL periods.

Direct medical costs for cyclists admitted to hospital were estimated from diagnostic related groupings recorded by the New Zealand Health Information Service (NZHIS). Diagnostic related groupings are based on the resources associated with the primary diagnosis, complications, comorbidities, age, and gender. From this data we calculated the average cost of a head injury for each of the three age groups (table 1).

Costs of the HWL
The HWL imposed a cost on cyclists, who had not purchased a helmet before the HWL, equal to the minimum cost of a new helmet (that is, NZ $19.95, personal communication, Pacific Helmets, New Zealand Ltd). The cost to society of a helmet is this price less 12.5% goods and services tax (that is, NZ $17.73 per helmet). This cost was multiplied by the numbers of unhelmeted cyclists before the law. The helmet wearing rate was recorded by the Land Transport Safety Authority and the numbers of unhelmeted cyclists were estimated in a previous study. Data on the costs of enforcing the HWL were not available; however, these costs were likely to be small because enforcing the HWL is part of general traffic enforcement.
Table 1  Age group specific parameters used in the model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Base value</th>
<th>Maximum value</th>
<th>Minimum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cyclists (1993)</td>
<td>85702</td>
<td>202985</td>
<td>596808</td>
</tr>
<tr>
<td>Helmet wearing rate in September 1993 (%)</td>
<td>86.8</td>
<td>55.9</td>
<td>38.9</td>
</tr>
<tr>
<td>Helmet wearing rate in March 1994 (%)</td>
<td>98.6</td>
<td>97.1</td>
<td>92.9</td>
</tr>
<tr>
<td>Mean hospital treatment costs for cyclists head injuries ($)†</td>
<td>1569</td>
<td>1607</td>
<td>1351</td>
</tr>
<tr>
<td>Mean hospital stay in head injured cyclists (bed days)†</td>
<td>2.8</td>
<td>3.2</td>
<td>4.2</td>
</tr>
<tr>
<td>&gt;7 days stay in head injured cyclists (%)</td>
<td>6.4</td>
<td>7.1</td>
<td>10.7</td>
</tr>
</tbody>
</table>

*Mean hospital treatment costs for non-head injured cyclists: $19.19 5–12 years, $29.09 13–18 years, and $28.49 adults.
†Percentage >7 days stay (non-head injured cyclists): 16.2% 5–12 years, 19.8% 13–18 years, and 25.3% adults.

Table 2  Global parameters used in the model and sensitivity analysis. All costs are in NZ $ for 2000 (NZ $1.00 = US $0.45, UK £0.31, €0.50)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Base value</th>
<th>Maximum value</th>
<th>Minimum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of helmet (all age groups) ($)</td>
<td>17.73</td>
<td>44.44</td>
<td>8.89</td>
</tr>
<tr>
<td>Life of helmet (years)</td>
<td>5</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Discount rate (%)</td>
<td>5</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Social costs of injury with &lt;7 days hospital treatment ($)‡</td>
<td>13309</td>
<td>15970</td>
<td>10647</td>
</tr>
<tr>
<td>Social costs of injury with &gt;7 days hospital treatment ($)‡</td>
<td>196360</td>
<td>235632</td>
<td>157088</td>
</tr>
<tr>
<td>Law enforcement costs ($)†</td>
<td>Nil</td>
<td>200000</td>
<td>Nil</td>
</tr>
<tr>
<td>Head injuries averted per year due to the HWL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5–12 years</td>
<td>4.0</td>
<td>10.0</td>
<td>Nil</td>
</tr>
<tr>
<td>13–18 years</td>
<td>10.3</td>
<td>14.0</td>
<td>6.7</td>
</tr>
<tr>
<td>Adults</td>
<td>28.3</td>
<td>35.0</td>
<td>22.0</td>
</tr>
<tr>
<td>Number of cyclists quitting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5–12 years</td>
<td>Nil</td>
<td>5870</td>
<td>–</td>
</tr>
<tr>
<td>13–18 years</td>
<td>Nil</td>
<td>47173</td>
<td>–</td>
</tr>
<tr>
<td>Adults</td>
<td>Nil</td>
<td>82890</td>
<td>–</td>
</tr>
<tr>
<td>Costs of quitting cycling ($)</td>
<td>0.00</td>
<td>19.95‡</td>
<td>–</td>
</tr>
</tbody>
</table>

*The social cost of a fatality was $22880000 in December 2000 currency. From the willingness-to-pay survey, preventing one permanently disabling head injury was at least as important as preventing one fatality.‡
†In the first year of the law (1994) we assumed law enforcement costs would be double the costs of subsequent years (that is, $400000). This cost was pro rated over the percentage of cyclists in each age group (table 1).
‡Also, including an additional $30 “other” costs of quitting cycling.

Cost effectiveness, cost benefit, and net benefit
Cost effectiveness was calculated as the additional costs per head injury averted from the HWL compared with a no law policy, where costs appearing in the numerator are the costs of the HWL (that is, cost of helmets) and the benefits (denominator) are the number of serious head injuries averted over the life of a helmet (five years).

A cost benefit analysis was undertaken to indicate the rate of return on the investment. The benefit:cost ratio indicates the expected benefits if the same policy was implemented in other countries. The numerator (benefits) is the value in monetary units of head injuries averted. The cost is as above. We also calculated the net benefit (benefits minus costs) of the HWL.

A discount rate of 5% has been used for costs and outcomes. All money values are reported in New Zealand dollars (NZ $) converted to 2000 prices using the New Zealand Consumer Price Index (NZ $1.00 = US $0.45, UK £0.31, €0.50).

Sensitivity analysis and “quitters”
A one way sensitivity analysis was performed to determine the robustness of the results with respect to changes in parameter values (table 2). Helmet effectiveness was varied between the upper and lower 90% confidence intervals reported by Scuffham et al. Nominal costs for law enforcement were pro rated based on the numbers of cyclists in each age group (table 1), and in the first year of the law we assumed law enforcement costs would be double the costs of subsequent years.

In addition, we undertook an analysis with the assumption that some cyclists might have quit cycling due to the HWL rather than purchase a helmet (“quitters”). In this event, there would be a reduction in the number of both head and non-head injuries due to the reduction in number of cyclists. The number of quitters is the reduction in number of cyclists between the years 1993 and 1994 (when the law was introduced), estimated as the same percentage reduction in non-head injuries in that period. Injury data for head and non-head injuries, obtained from the NZHIS, is described elsewhere. We analysed three scenarios: (i) there were no costs associated with quitting; (ii) a cost of quitting equal to the price of a helmet ($19.95) where quitters value cycling at no more than this amount otherwise they would purchase a helmet; and (iii) an additional $30 societal cost on top of the $19.95 to account for additional costs from reduced exercise and increased motorcar use. This cost was incurred when the HWL was introduced, but the benefits (injuries averted) observed throughout the time horizon of the study.

RESULTS
The costs of the HWL cost for 5–12 year old children was relatively low because relatively few helmets for this age group were required (helmet wearing rates were 87% before the HWL) (table 3). In contrast, the cost of the law for adult without use of additional police resources. We address this point in the sensitivity analysis.
cyclists was large due to the relatively large number of helmets required under the law (39% pre-law wearing rate).

The helmet wearing law was most cost effective for 5–12 year olds and least cost effective for adults. The benefit:cost ratio was greater than one for the 5–12, 13–18, and adults respectively.

A key parameter was the number of cyclists who quit cycling (table 4). Increased numbers of quitters reduced the numbers of both head and non-head injuries and, because fewer cyclists purchase helmets, the costs of the HWL decreased. Even when other costs of quitting were included at a substantially higher cost than a helmet, the HWL continued to be cost saving for all age groups.

**DISCUSSION**

This study shows that the costs associated with the HWL were far greater for adults than for children, and the HWL was cost saving in the youngest age group. The reasons were that more adults than children were required to purchase a bicycle helmet due to the law (table 3) and relatively fewer head injuries were averted in adults than children.

The important factors affecting cost effectiveness of a HWL were the cost and life of helmets (recommended replacement every five years), the effectiveness of helmets, helmet wearing rates before the HWL was introduced, and the effect on cyclist participation (quitting). However, the estimates from “quitters” may be overstated because of a general downward trend in cycling, both in New Zealand and internationally.

### Table 3 Cost effectiveness estimates by age group (five year outcomes and costs in NZ$ for 2000)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Number of Helmets Required</th>
<th>Costs of Helmets (a) ($)</th>
<th>Head Injuries Averted</th>
<th>Total Healthcare Costs Averted ($)</th>
<th>Total Societal Costs Averted (b) ($)</th>
<th>Cost per Head Injury Averted ($)</th>
<th>Benefit:Cost Ratio (b/a)</th>
<th>Net Benefit (societal perspective; b–a) ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5–12</td>
<td>10195</td>
<td>180792</td>
<td>16.9</td>
<td>18.1</td>
<td>471920</td>
<td>9990</td>
<td>2.61</td>
<td>291128</td>
</tr>
<tr>
<td>13–18</td>
<td>84999</td>
<td>1507312</td>
<td>43.4</td>
<td>46.8</td>
<td>1279050</td>
<td>32241</td>
<td>0.849</td>
<td>5819397</td>
</tr>
<tr>
<td>Adults</td>
<td>328162</td>
<td>5819397</td>
<td>114.4</td>
<td>128.2</td>
<td>4289602</td>
<td>45396</td>
<td>0.737</td>
<td>1529796</td>
</tr>
</tbody>
</table>

### Table 4 Results of sensitivity analysis: costs, benefits, and benefit:cost ratios (BCR)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Costs of Law ($)</th>
<th>Value of Benefits ($)</th>
<th>BCR</th>
<th>Costs of Law ($)</th>
<th>Value of Benefits ($)</th>
<th>BCR</th>
<th>Costs of Law ($)</th>
<th>Value of Benefits ($)</th>
<th>BCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>5–12</td>
<td>180792</td>
<td>453769</td>
<td>2.61</td>
<td>1507312</td>
<td>765110</td>
<td>1.15</td>
<td>5819397</td>
<td>756834</td>
<td>0.68</td>
</tr>
<tr>
<td>13–18</td>
<td>90580</td>
<td>471920</td>
<td>2.36</td>
<td>1507312</td>
<td>1160630</td>
<td>0.77</td>
<td>5819397</td>
<td>1416873</td>
<td>0.54</td>
</tr>
<tr>
<td>Adults</td>
<td>287727</td>
<td>9990</td>
<td>2.09</td>
<td>1507312</td>
<td>1416873</td>
<td>0.77</td>
<td>5819397</td>
<td>1507312</td>
<td>0.73</td>
</tr>
</tbody>
</table>

*Base case: cost of helmet = $19.95; life of helmet = 5 years; discount rate = 5%; no quitters; head injuries averted per year: 4.0 5–12 years, 10.3 13–18 years, 28.8 adults; treatment costs: $1569 5–12 years, $1607 13–18 years, $1351 adults; societal cost of serious head injury = $196360;
not affect the marginal costs of the HWL. In contrast, the social costs saved due to fewer head injuries are likely to understate the true costs—especially for cases involving fatality or neurobehavioural damage (where costs are incurred for potentially the rest of life). Preventing one permanently disabling head injury is at least as important as preventing one fatality. Consequently, the minimum value of preventing a permanently disabling head injury is $2 million—the value of preventing one fatality. 26 In this case, our estimates of the net benefit from helmet wearing are likely to be understated. Similarly, there are many other benefits of helmet wearing that were not included, such as the value of averting minor injuries, increased visibility to other road users, and increased (or reduced) cyclist caution. 26 Mandatory bicycle helmet wearing laws do go some way in reducing injuries to cyclists. However, bicycle helmets do have some limitations. For example, the effectiveness of helmets is reduced where collision forces are greater than 30 km per hour. Consequently, additional methods to reduce injuries to cyclists (and not only head injuries), such as cycle paths to separate cyclists from other traffic, require evaluation, including economic evaluation.

We have found that the introduction of the 1994 bicycle helmet law in New Zealand has been more cost effective when aimed at those cyclists in a younger age group. The cost effectiveness ratios between age groups differ substantially, and therefore, it is important that any future mandatory helmet wearing policies in other countries consider the costs and cost effectiveness of implementing the law to specific age groups before legislation is made.

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REFERENCES

14 Vukan P. Lane J. Bicycle helmets reduce head injuries and should be worn by all. Inj Prev 1996;2:251–2.
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M Taylor and P Scuffham

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