Title: The alleged 20:1 benefit-to-cost ratio of cycling: missing analyses and
uncritical citations

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26   **Abstract**

27   In this commentary, we address the use of citations of papers that do not include data that
28   are verified. We base our discussion on an analysis that has been influential for over 25
29   years despite the absence of data. Three publications authored by one author stated that the
30   health benefits of cycling outweigh the risks by a ratio of 20:1; however, none provided
31   calculations in support of this conclusion. Uncritical and frequent citation of an unverified
32   source can have long-lasting negative consequences. This is especially true if such
33   published research is used in policy making. Public policy should always be evidence-
34   based.

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37   **Keywords:** Cycling; cost-benefit analysis; bicycle helmets; public policy

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51   **1. Introduction**

52   In this commentary, we address the consequences that follow from citing papers that do
53   not include verified data. The conclusions reached in published research are often used to
54   inform public policy on a variety of issues. When these decisions are unsupported they can
55   have long-lasting negative consequences. Therefore, it is essential the best available data
56   and research methods are utilized in policy making, especially with respect to public health
57   and transport (1).

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59   Cycling, as with other modes of physical exercise, can be a healthy activity but it is not,
60   without risk of injury. One way of addressing this risk is through the use of helmets to
61   reduce head injuries that can be fatal or lead to life-long-disability (2, 3). However, some
62   researchers and bicycle advocates believe that promoting or legislating helmet use can
63   make cycling less popular. They assert that any reduction in ridership may lead to a health
64   loss if cycling is not replaced by another physical activity (4).

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66   In this context, one topical, controversial example is the benefit-cost ratio of cycling
67   presented in three publications by the same author (5, 6, 7). These papers imply the
68   existence of conclusive evidence that the health benefits of cycling outweigh the risks by a
69   ratio of 20:1. However, as we reveal, none of these publications provide supporting data or
70   even a description of the methods used to derive this ratio. As well, we note several
71   instances where the ratio has been used uncritically in the research literature, often by
72   cycling advocates.

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74   The first report published in 1992 (5) was commissioned by the Board of Science and
75   Education of the British Medical Association. The second was a conference proceedings

76 paper (6), “Cycling and the promotion of health” and the third was a paper with an
77 identical title to the second, published in a peer-reviewed journal (7).

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79 It is important to note that although the disputed ratio is often quoted by some cycling
80 advocates as a basis for opposing helmet promotion, none of the reports examines helmet
81 use as such. Instead, they assume that helmet laws deter cycling, an assumption that
82 remains highly controversial.

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84 Hillman acknowledges difficulties in performing a cost-benefit analysis. In his 1992 report
85 he writes:

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87   ”During 1989 levels of injury and accident to cyclist can therefore be represented by 11,324 life-
88   years calculated as having been lost...Unfortunately, it is not possible to establish such quantifiable
89   evidence for life-year gained, although certain studies have indicated an increase in longevity for
90   those participating in regular exercise, such as cycling.” (p.113)

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92   “In this chapter a form of cost-benefit analysis of cycling has been attempted by comparing life-
93   years lost through cycle accidents to life-years gained through regular exercise. Although a direct
94   quantitative analysis is not possible due to a lack of conclusive data, existing evidence would
95   suggest that, even in the current hostile traffic environment, the benefits gained from regular cycling
96   are likely to outweigh the loss of life through cycling accidents for the current population of regular
97   cyclists.” (p.121)

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99 The 20:1 ratio, to our knowledge, is mentioned for the first time in the conference
100 proceedings paper (6). Although life-years lost were estimated in the 1992 report, there
101 were no estimations for life-years gained and, as with his other publications, no actual
102 calculation is presented in support of the ratio.

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“The life expectation of each cyclist killed can be established from road accident and actuarial data. The increased longevity likely to be attributable to those engaging in exercise regimes several times a week compared with those leading relatively sedentary lives was derived from studies in the UK and US and special OPCS tabulations. Relating these to the numbers in the population who currently cycle regularly, as revealed in the National Travel Survey, shows that, even in the current hostile traffic environment, the benefits gained from regular cycling outweigh the loss of life years in cycling fatalities by a factor of around 20 to 1.”

No new data are presented. Instead, Hillman bases his assertion on other studies but does not include data from those studies. It is also unclear which ‘exercise regimes’ referred to above were considered. Nor are any clear definitions provided for ‘several times a week’ or ‘relatively sedentary lives’. This is an important distinction because caloric expenditures greatly differ by activity, length of activity and the amount of energy consumed in an activity (8, 9). Hillman repeats the 1992 Proceedings text verbatim in the journal article published the following year (7, p. 55).

2. Examples of how the 20:1 ratio has been used

As stated earlier, despite the severe limitations of these publications, the ratio is often cited by opponents of helmet promotion or legislation. For example, the Finnish Cyclists' Federation uses it in their argument to repeal an existing bicycle helmet law (10):

“The helmet use regulation provides an image of cycling as a particularly risky activity, which reduces the attractiveness of cycling. However, cycling is not particularly dangerous compared to, for example, pedestrians, and because of the health benefits as it has been shown the benefits of cycling exceed the risks 20 times [Hillman M. Cycling and the Promotion of Health. Policy Studies Vol. 14, 49-58, 1993).” [Unofficial translation]

131 Similarly, de Jong (11), in an assessment of the societal health benefit of bicycle helmet
132 laws, used the 20:1 ratio as a reference point. He writes (p.787):

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134 “Cross-country comparisons are used to throw light on the likely size of the benefit-cost ratio of
135 bicycling β in different jurisdictions and in turn the likely values of the standardized health impact
136 Ψ . The likely size of β in different countries is established using two reference points: the country-
137 specific per kilometer death rate from bicycling injuries and the reference value $\beta = 20$ suggested
138 in Hillman report to the British Medical Association.”

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140 Robinson (12) also mentions the 20:1 ratio in her paper opposing helmet legislation.

141 Moreover, she cites another paper by Hillman in which he refers to the conference
142 proceedings paper as a source for the 20:1 ratio:

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144 "The benefits of cycling, even without a helmet, have been estimated to outweigh the hazards by a
145 factor of 20 to 1 (Hillman 1993; Cycle helmets—the case for and against. Policy Studies Institute,
146 London). "

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148 As well, the European Cyclists' Federation helmet factsheet (13) and the Wikipedia pages
149 on health benefits of cycling (14) quote the 20:1 ratio and it appears in several policy-
150 making discussions. For example, Rissel used it in his response to the Australian Senate
151 Standing Committee on Economics inquiry into Personal Choices and Community Impact
152 regarding bicycle helmet laws (15). Additionally, Hillman submitted a statement to a
153 Northern Ireland Committee for the Environment Report (16), where the focus was on
154 Cyclists (Protective Headgear). In his statement, he attached text entitled “The Cycle
155 Helmet: Friend or Foe?” and refers to his 1992 report:

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"The gain of 'life years' through improved fitness among regular cyclists, and thus their increased longevity exceeds the loss of 'life years' in cycle fatalities. An analysis based on the life expectancy of each cyclist killed in road accidents based on actuarial data, and the increased longevity of those engaging in exercise regimes several times a week compared with those leading relatively sedentary lives, has shown that, even in the current cycle-hostile environment in most of the UK, the benefits in terms of life years gained, outweigh life years lost in cycling fatalities by a factor of around 20 to 1 (Hillman, 1992). "

3. Discussion

In the scientific literature researchers often cite each other, usually after careful scrutiny of the methods and results. The media and laypersons, however, may be unable to judge these elements and instead assume that all journal articles are equally rigorous. Sometimes, after closer examination, it is apparent that some studies reach conclusions that are unjustified either because of later discovered errors or insufficient supporting data.

Alongside the risk benefit issue described above, there are several other such examples. One is the alleged connection between childhood vaccines and later autism published in the Lancet (17). In part, the distinguished reputation of the Lancet prompted widespread repetition of the conclusions in the lay press and in other reports by those opposing vaccine use.

A Letter to the Editor in the New England Journal of Medicine (18) asserted that there was little risk of addiction when opioids are used to treat chronic pain. The letter did not include any data. Subsequently, Leung et al (19) conducted a bibliometric analysis of 608 citations that followed. Of the articles that included a specific reference to the 1980 letter,

183 the authors of 439 (72.2%) cited the letter as evidence that addiction was rare in patients
184 treated with opioids.

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186 In the injury literature, a widely quoted and influential study concluded that rear-facing
187 child seats were more effective than forward-facing child seats in protecting restrained
188 children aged 0–23 months (20). Later analyses found an error and the report was
189 subsequently retracted (21). Although, it is worth noting that the original conclusion is still
190 endorsed by leading child injury prevention groups.

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192 Each of these studies has had an influence on both practice or policy. The proposed autism-
193 vaccine link is likely responsible for a decline in vaccine uptake for a considerable period
194 after its publication which, in turn, resulted in an increase in preventable childhood
195 diseases. The opioid letter prompted Leung et al. to speculate that it may have “contributed
196 to the North American opioid crisis”. It is not known whether any deaths or serious injuries
197 followed the recommendations in the Henary paper (20). As Johnston wrote in the
198 retraction notice (21) “This result, along with similar data from Swedish experience and
199 biomechanical studies, has been used as the basis for public education and policy
200 recommendations that favor a rear-facing position for children under age two in car seats.”
201 Although it is clear an error was made in the original paper, the rear facing position is now
202 widely supported for children under two (22).

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204 **4. Conclusion**

205 In this brief report, we have presented an example of an analysis that has been influential
206 for over 25 years in spite of the absence of supportive evidence. There is a danger that
207 when a claim is cited often enough, it tends to become the “truth”. More recent studies

208 show that health benefits of cycling do outweigh the risks (23, 24). A systematic review
209 found that “Estimated health benefit–risk or benefit–cost ratios of a mode shift to active
210 transportation ranged between –2 and 360 (median = 9) (25). Thus, some would argue that
211 Hillman’s pioneering work has had a historically important role and that no real damage
212 has been done because the 20:1 ratio falls within this very wide range between –2 and 360.
213 We resolutely reject such reasoning because clinical and policy decisions must be based on
214 solid evidence. The 20:1 ratio has been used and abused over the years and that should
215 have been avoided. Every study should provide sufficient information about employed data
216 and analytic methods. We hope the 20:1 ratio will no longer be used as an implied fact in
217 scientific publications and especially not in policy making discussions.

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