‘Spinning’ Helmet-Law Statistics

The examples below show how information seems to have been distorted to create a favourable ‘spin’ on reality, and avoid embarrassment about the true effects of bicycle helmet laws.

Brief summary

1) ‘Spin’ injury reductions from reduced cycling into a “benefit” of helmet laws!

Official reports showed 43% and 46% reductions in teenage cycling in the 1st & 2nd years of the helmet law in Melbourne, Victoria, plus reductions of 3% and 11% for children up to 11 years.[6] Despite a bicycle rally at one site in the second year, numbers of adult cyclists were also 29% and 5% below pre-law levels.[1]

With fewer cyclists (especially teenagers who generally have a higher risk of injury than adults) there should have been fewer cycling injuries, a fact demonstrated by the large reductions in *non-head* injuries (see Fig 1, below). Yet a newspaper article quoting Max Cameron, Monash University Accident Research Centre (**MUARC**) implied that the entire 40% reduction in head injuries was due to helmet wearing.[7]

With such a large and obvious reduction in *non-head* injuries, most likely because of reduced cycling, it seems highly inappropriate to claim that the entire 40% reduction in head injuries was due to helmets.

2) ‘Spin’ injury reductions from improved road safety into a “benefit” of helmet laws!

Campaigns against speeding and drink-driving commenced about the same time as Victoria’s bicycle helmet law. Pedestrian deaths fell from 159 (1989) to 93 (in 1990, the year the helmet law was introduced).[8] The British Medical Journal reported that road accident costs were reduced by an estimated 100 million for an outlay of 2.5 million.[9] Table 1 (below, in section 2, Details) shows that deaths and serious head injuries (**DSHI**) to *pedestrians* fell by 26% and other serious injuries (**OSI**) fell by 17%. Accounting for improved pedestrian safety, the reduction in cyclist DSHI was just 23%, which is less than the 36% reduction in numbers of cyclists counted in the 1991 survey.[1] This suggests the risk of injury per cyclist *increased*. Helmets do not prevent other serious injuries, *yet the reduction in OSI* (26%, after accounting for improved pedestrian safety) *was better than the reduction in deaths and serious head injuries*.

The ‘spin’ that the 40% reduction in head injuries was due to helmets bears little or no relationship to the reality that the entire effect can be explained by safer roads and reduced cycling.

3) Hide key information on numbers of adults counted in the pre-law survey

In Melbourne, Monash University Accident Research Centre (**MUARC**) conducted 3 surveys of cycling, in May 1990 (before the law) and post-law in May 1991 and May 1992. In 1990, 1567 adult cyclists were counted, but only 1106 (29% less) in 1991. In 1992, when counts were inflated by a bicycle rally passing through one site, there were 1484 adult cyclists (still 5% less than 1990). Numbers counted are a good indicator of cycle use, yet MUARC ignored the 1990 adult count and used a much earlier survey at a different time of year (Dec/Jan 1987/88, that counted only 1079 adult cyclists) as the pre-law ‘baseline’. So instead of reductions from 29% to 5% in adult cycling, based on actual numbers counted, MUARC claimed that there was an “estimated increase in adult use of 44%”.[6] A later report by CARRS-Q made an even more dramatic claim: “In Melbourne adult cyclist numbers doubled after the helmet legislation was introduced”.[10] MUARC researchers muddied the waters even further by claiming: “Because the 1990 survey did not cover adult bicyclists, it was not possible to fully examine the change in their bicycle use”.[6]

Pretending there was no information on adult cyclists, or that adult cycle use could not have been predicted from the numbers of adults counted in 1990, and so claim an ‘increase’ in adult cycling from an non-comparable ‘baseline’, is another example of misleading and deceptive ‘spin’.

4) Ignore obvious warning signs that helmets couldn’t possibly be as effective as claimed

MUARC researchers noted that their models predicted head injury rates would fall to zero before helmet wearing reached 100%[2]! This impossible result should have warned them to look for other factors affecting head injury rates, e.g. that head injury percentages for cyclists and pedestrians show remarkably similar trends (see graph below, in section 4, Details). If they had looked at the data for pedestrians, MUARC researchers would have seen that numbers of *pedestrians* with concussion fell by 29% and 75% respectively in the first and second years of the helmet law.[11] Investigating these factors might have led to more balanced reporting of the effect of helmet laws, instead of ‘spin’ that failed to distinguish between any real benefits of helmet laws and injury reductions due to improved road safety and reduced cycling. And then even more ‘spin’ to hide information on numbers of adults counted in the main pre-law survey and avoid admitting that injury rates per cyclist had actually increased.

5) Ignore risk compensation & safety in numbers

When children ran an obstacle course wearing a helmet and wrist guards, tripping, falling and bumping into things increased by 51%.[12] There would be little point of making helmets compulsory if the increased helmet wearing encouraged cyclists or drivers[13] to take more risks, resulting in increased injuries per cyclist, counteracting any benefits of helmets. Similarly, increased injury rates because of reduced safety in numbers would also be counterproductive.[4,14] Several jurisdictions introduced helmet laws, but few measured cycle use reliably enough to compare the change in injury rates with the change in cycling. The information that is available suggests that helmet laws *increased* injury rates. When Alberta, Canada made helmets mandatory for children, numbers of child cyclists halved, but injuries increased, suggesting the risk of injury more than doubled.[15] In NSW, head injuries to child cyclists fell by 29%, but numbers counted in observational surveys fell by 36% and 44%% in the first and second years of the helmet law, suggesting an 11-27% increase in the risk of head injury per child cyclist.[1] In Victoria, child cycling was estimated to have fallen by 33% and 36% in the first and second years of the helmet law, but child cycling injuries fell by only 22% and 25% respectively, suggesting that the risk of injury increased by 16-17%.[1]

The apparent increase in the risk of injury per cyclist suggests that, even ignoring the lost health and environmental benefits of reduced cycling, helmet laws were detrimental to public health because of risk compensation and reduced safety in numbers.

6) Ignore the health & environmental costs of reduced cycling & reduced safety in numbers

After allowing for injury costs, an Australian government report estimated the net health benefits of cycling at 0.75 cents per kilometre in 2013. For transport trips, there were additional savings per km in vehicle operating costs (35 cents), reduced congestion (20.7 cents), infrastructure (5.2 cents) and environmental benefits (5.9 cents).[16] In 1985/86, bicycle travel accounted for 3.9% of all trips in Australia, including 1.6% in Sydney and 5.0% in the rest of NSW.[17] The same amount of cycling today (2.24 km per person per week, about 85% for transport purposes) would generate estimated health, environmental and other benefits of $2.4 billion per year.

As noted above, in Victoria, after accounting for the improvement in pedestrian injuries, the fall in head injuries to cyclists was *less than the fall in cycling*, implying that *injuries per cyclist increased* compared to what would have been expected without the law. The lost health and environmental benefits from even a 25% fall in cycling – over half a billion dollars per year according to the above estimates – is a totally unacceptable price to pay for a law that did not achieve its stated objective of making cycling safer.

7) Why would non-enforced laws with no long-term effect on helmet wearing be beneficial?

In Ontario, Canada, the helmet law for children was not enforced. After a temporary increase, helmet wearing fell back to pre-law levels by 1999. In contrast, head injury rates trended downward (see graph below, in section 7, Details), and were much lower in 2001/02 than in the peak helmet-wearing years of 1996-97. Yet a paper discussing the effects of helmet laws, published in 2003, omitted the key data for 1999 that showed helmet wearing had returned to pre-law levels, instead reporting helmet wearing rates only until 1997.[18]

Omitting this information misled people into believing the law was effective, yet had not discouraged cycling. It's hard to imagine how a non-enforced law with no long-term effect on helmet wearing could possibly have been effective. Lying by omission, to hide the ineffectiveness of a law, seems like another unacceptable form of 'spin'.

DETAILS

1) 'Spin' injury reductions from reduced cycling as a "benefit" of helmet laws!

A 1996 press article quotes Mr Max Cameron, a senior researcher at Monash University Accident Research Centre (**MUARC**) that his "*studies of bicycle-related hospital admissions showed conclusively that helmets worked. For four consecutive*

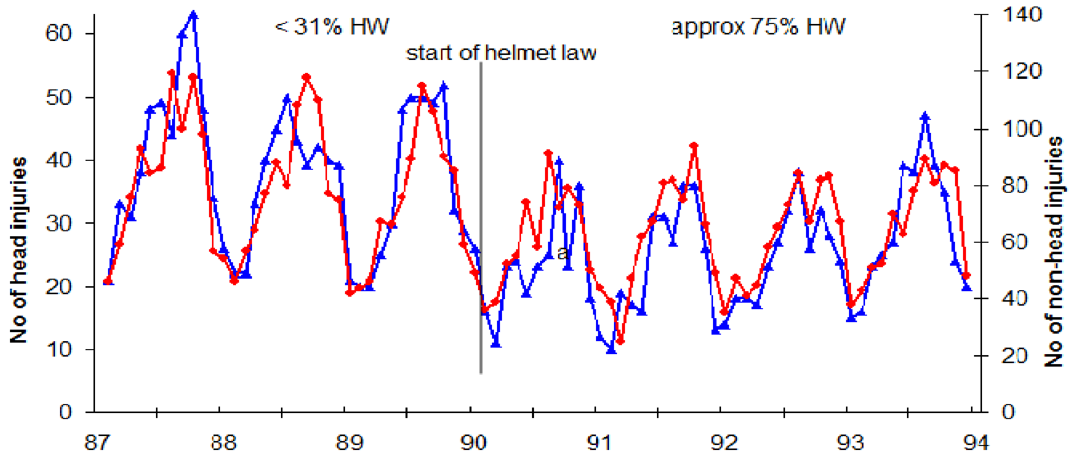


Fig 1. Numbers of head & non-head injuries to cyclists in Victoria

years after helmets became compulsory, we had a 40% drop in head injuries over what we had before."

Fig 1 (above, from Carr *et al.*[19]), shows a substantial fall in *non-head* injuries as well as the 40% reduction in head injuries. This implies that much of the so-called "benefit" must have been due to reduced cycling, not helmets. By not mentioning the fall in non-head injuries, people were misled into thinking that the entire effect was due to helmets, when this was obviously not the case. Pretending that the harm to public health from discouraging a healthy, environmentally-friendly activity was a good thing because fewer cyclists means fewer cycling injuries is an unhelpful case of "spin".

2) Misleadingly count other road safety improvements for cyclists as "benefits" of helmet laws

In Victoria, campaigns against speeding and drink-driving were introduced about the same time as the bicycle helmet law. The British Medical Journal reported that total accident costs were reduced by an estimated £100M for an outlay of £2.5M.[9] Fig 2 shows pedestrian deaths and the timing of the bike helmet law. The "benefits" for pedestrians seem more impressive than for cyclists!

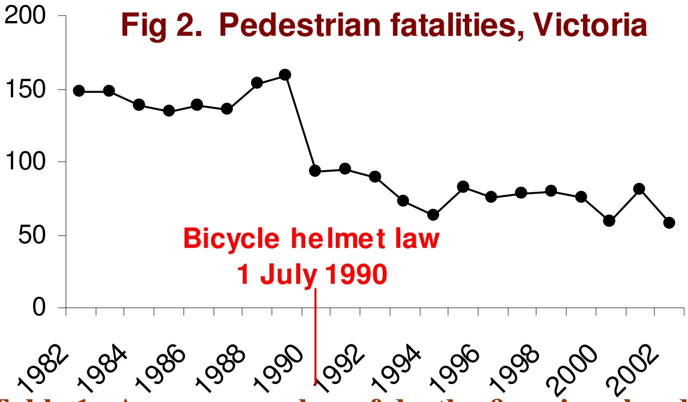


Fig 2. Pedestrian fatalities, Victoria

To see how much of the claimed benefits for cyclists were due to safer roads, Table 1 compares Victorian Transport Accident Commission data on deaths and serious head injuries (**DSHI**) and other serious injuries (**OSI**) before and after the bicycle helmet law. In the 2 post-law years, pedestrian DSHI fell to 74% of pre-law numbers and pedestrian OSI to 83%. Assuming the improved road safety would have generated similar benefits for cyclists, we'd expect 53.6 cyclist DSHI and 167 OSI without the helmet law (Table 1). The 'true' effect of the law was therefore to reduce DSHI to 77% of the expected number and OSI to 74%. Helmets don't prevent other serious injuries, so the fall in OSI must be due to the reduction in cycling. The marginally *lower* fall in DSHI than OSI implies there was no additional benefit of increased helmet wearing on serious head injuries, i.e. the main effect of the law was to discourage cycling.

Table 1. Average number of deaths & serious head injuries (DSHI), and other serious injuries (OSI) per year to cyclists and pedestrians in Victoria – Transport Accident Commission data[4]

	Pedestrians		Cyclists	
	DSHI	OSI	DSHI	OSI
Pre-law -July 1989 to June 1991	285.5	542.5	72.5	202
Post-law – July 1991 to June 1993	211	449	41	124
% of pre-law	74%	83%		
[A]Expected no of cyclist injuries, if, like pedestrians, cyclist DSHI fell to 74% of pre-law & OSH to 83% of pre-law			53.6	167
[B]Cyclist DSHI/OSHI as % of that expected without the law			77%	74%

[A] Expected post-law cyclist DSHI = 74% of 72.5 = 53.6;
Expected post-law cyclist OSI = 83% of 201 = 167.
[B] Cyclist DSHI/(Expected DSHI without the law) = 41/53.6 = 77%
[B] Cyclist OSHI/(Expected OSI without the law) = 124/167 = 74%

Table 2. Numbers counted and times to ride through marked areas in the MUARC surveys at 64 sites in Melbourne

	Dec/Jan 87/88	May-90 Pre-law	May-91 1st law yr	May-92 2nd law yr
Numbers of cyclists counted (N)				
Children under 12	467	261	235	281
Teenagers (12-17)	1199	1293	670	713
Adults	1079	1567	1106	1484
Total time (TT) to ride through marked areas				
Children under 12	4.9	4.7	4.6	4.2
Teenagers (12-17)	9.7	13.1	7.4	7.1
Adults	5.2		9.7	11.1
Average time (AT) to ride through marked areas[A]				
Children under 12	1.05	1.80	1.96	1.49
Teenagers (12-17)	0.81	1.01	1.10	1.00
Adults	0.48		0.88	0.75

[A] Calculated as 100*TT/N. TT was scaled up from the total recorded time to an estimate of total cycling in billions of seconds per week, so it is not possible to derive meaningful units for AT.

3) Hide important information on numbers of adult cyclists counted just before the law; instead compare surveys at different times of year

In Melbourne, Victoria, cyclists were counted in 3 annual surveys. The first was just before the helmet law in May 1990. It was followed by two post-law surveys, in May 1991 and May 1992, at the same 64 sites. Each site was counted for 10 hours per survey, covering the same time periods, including weekend and weekday use. All cyclists were counted and the times taken to cycle through marked areas also recorded, except for adults in May 1990. The 3 surveys in May used similar protocols to an earlier survey conducted at a different time of year – December & January 1987/88.

Cycling is seasonal – comparing surveys at different time of year is misleading

Cycling injuries vary substantially with time of year (Fig 1), indicating there are large seasonal differences in the amount of cycling. The Dec/Jan survey does not seem particularly comparable with the other 3 surveys, presumably because it was carried out at a different time of year. For example, the higher number of children under 12 might reflect the holiday period. Children and adults also cycled faster in 1987/88 (children: 1.05 in 1987/88 *vs* 1.80 in 1990; adults 0.48 in 1987/88 *vs* 0.88 in 1990, Table 2, above).

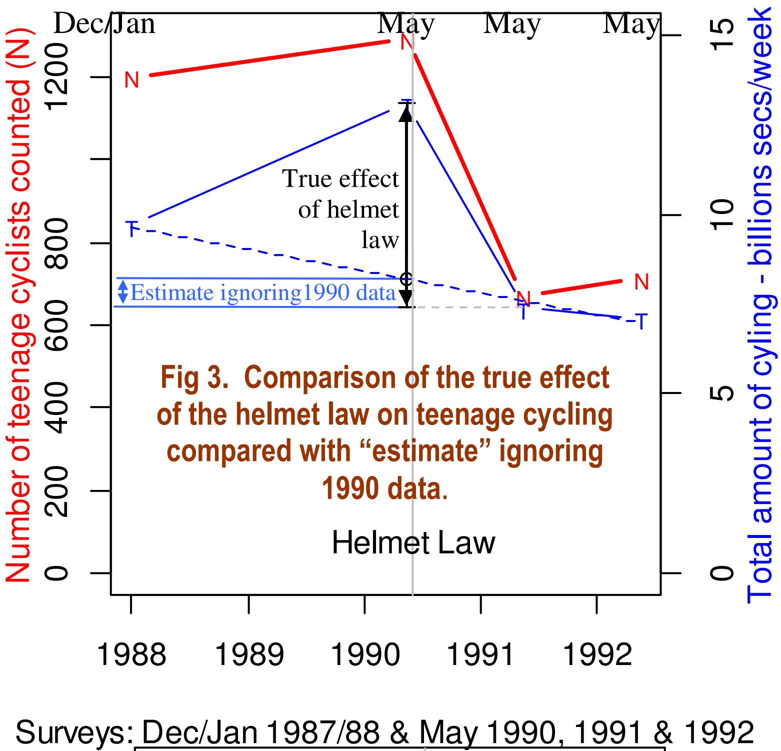


Fig 3. Comparison of the true effect of the helmet law on teenage cycling compared with "estimate" ignoring 1990 data.

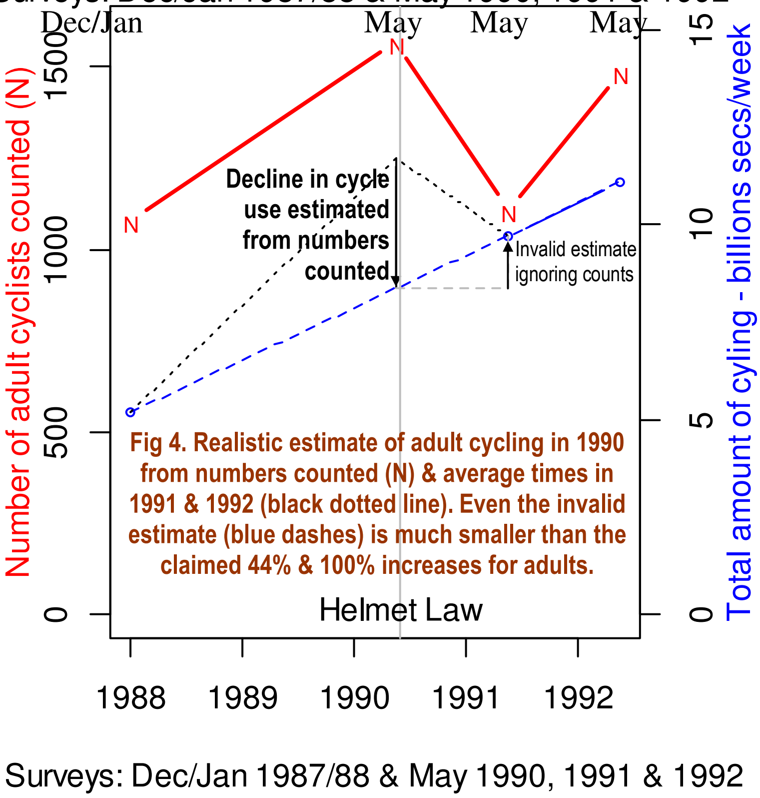


Fig 4. Realistic estimate of adult cycling in 1990 from numbers counted (N) & average times in 1991 & 1992 (black dotted line). Even the invalid estimate (blue dashes) is much smaller than the claimed 44% & 100% increases for adults.

Strong correlation between cyclists counted & total time to cycle through marked areas

The Melbourne surveys were unique in that, as well as counts, times taken to cycle through marked areas were recorded. Under the same conditions (e.g. the same time of year) total numbers were highly correlated with total times. Unless average speeds change dramatically, or are unduly affected by traffic conditions, both should reflect the change in cycling due to helmet laws.

This is demonstrated in Fig 3 (left) showing teenage cycling. Both numbers counted and total times increased substantially from Dec-Jan 87/88 to May 1990. This could be due to the different time of year, or perhaps cycling increased in popularity from Dec 1987 to May 1990. The helmet law resulted in a big decline in both numbers of teenagers counted and total time taken from 1990 to 1991 (Fig 3).

If times had not been recorded for teenagers in 1990, the total time could have been estimated from numbers counted in 1990 and average times to cycle through the marked areas in 1991 (1.10) and 1992 (1.00). Multiplying the count of 1293 teenage cyclists in 1990 (Table 2) by 1.05 (the average of 1.10 and 1.00) leads to a fairly similar estimate (13.6) to the actual value of 13.1 (Table 2). In contrast, as shown in Fig 3, drawing a straight line between the 1987/88 and 1990 surveys (blue dotted line in Fig 3) results in a ridiculous "estimate" of teenage cycling (8.2) that is nothing like the true value of 13.1!

Fig. 4 shows that a realistic estimate for adult cycling derived from numbers counted would have led to the conclusion that the helmet law discouraged adult cycling. Instead, a paper published by Max Cameron and colleagues claimed: "Surveys in Melbourne also indicated a 36% reduction in bicycle use by children during the first year of the law and an estimated increase in adult use of 44%."[6] Cameron's "estimated increase" is even larger than the invalid inflated estimate (Fig 4) obtained by ignoring numbers of adults counted in 1990.

A report by CARRS-Q[10] went even further and claimed: "In Melbourne adult cyclist numbers doubled after the helmet legislation was introduced." Despite inflated estimates due to a bicycle rally passing through one site 1992, fewer adult cyclists were counted in both post-law surveys than an identical survey just before the helmet law. How could any serious researcher claim that numbers of adult cyclists "doubled"? When counts provide almost as much information as times, why would any serious researcher claim: "Because the 1990 survey did not cover adult bicyclists, it was not possible to fully examine the change in their bicycle use"[6]?

Cameron's estimates (20 hours of cycling per week for every man, woman & child in Melbourne) simply don't add up!

The problem of simply drawing a straight line between the results from the Dec 87/Jan 88 survey and the 1991 and 1992 surveys is illustrated in Figure 7 of Cameron's AAP paper.[6] The 'estimate' of total cycle use in 1990 is much lower than the sum of the three age categories, indicating major errors in their methods. Another obvious error is the estimate of 60 million hours of cycling per week in Melbourne (reported in the paper to have a population of 3 million), an average of 20 hours cycle use per week for every man, woman and child in the city!

Such basic checks of plausibility (that the total is consistent with the sum of child, teenage and adult cycling, or the plausibility of an average of 20 hours cycle use person per week) appear to have omitted from Cameron's work!

Exaggerating the benefits of helmets laws by claiming reductions in cycling and effects of safer roads as "benefits" of helmet laws seem inappropriate. Counting adult fewer cyclists in the post-law surveys, but claiming the "number of adult cyclists doubled" might be considered even more inappropriate.

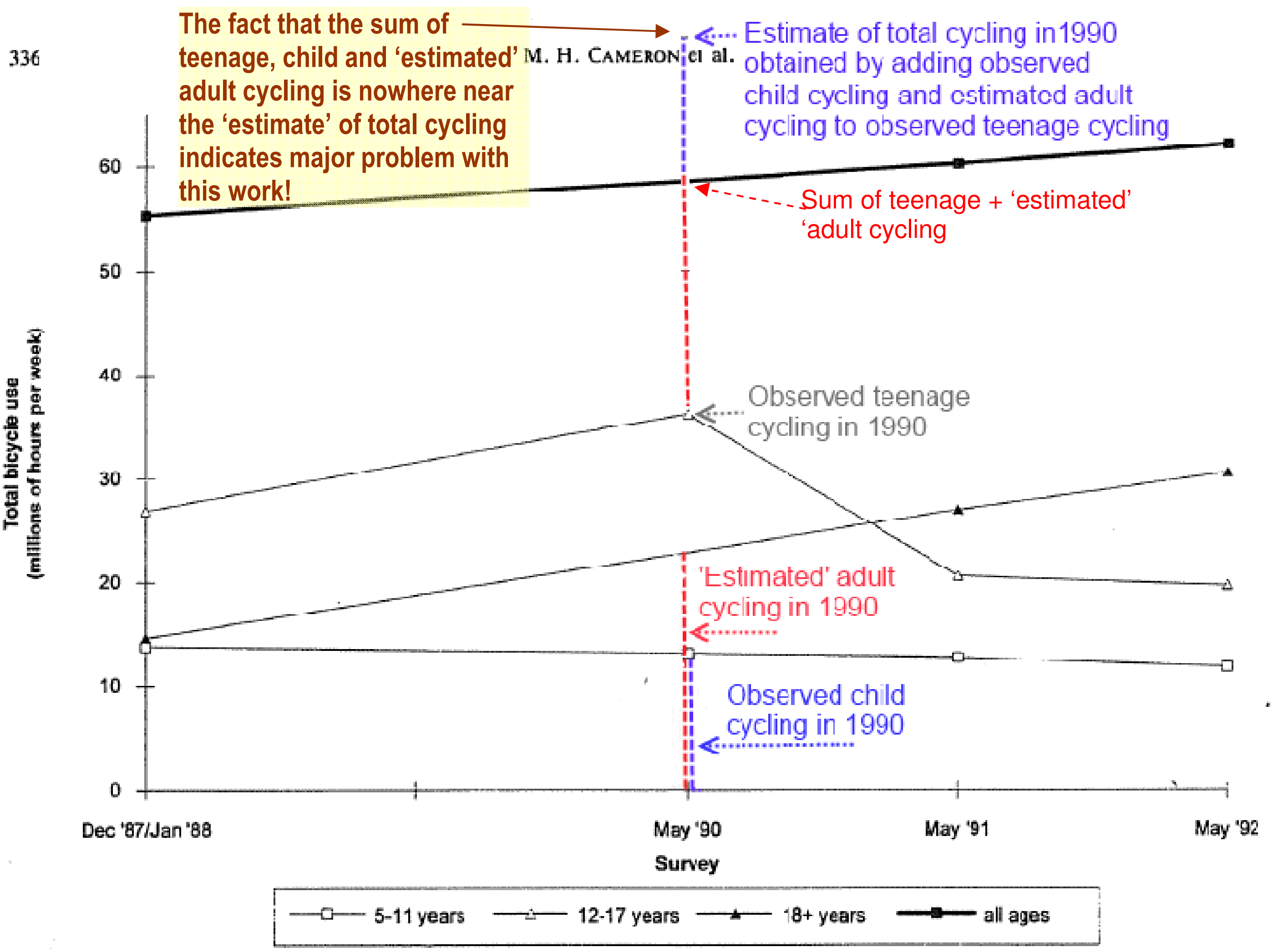


Figure 7 from Cameron et al.[6] shows estimated cycle use from the Melbourne surveys. It should have been obvious that the results from drawing a straight line between results from the Dec 87/Jan 88 and 1991 & 1992 surveys were invalid – the total cycle use of children, teenagers and the estimate for adults is considerably higher than the estimated all age cycle use! Cameron's estimate of 60 million hours of cycling per week (for a city he reported had a population of about 3 million[6]) – an average of 20 hours per week for every man, woman, child in the city seems just as unlikely as the claim that adult cycling increased by an estimated 44% when 29% fewer adults cyclists were counted in 1991 than 1990!

The results in section 2 imply that, after accounting for the improvement in road safety the reduction in deaths and serious head injuries was *less* than the reduction in other serious injuries to cyclists in collisions with motor vehicles and all plausible estimates of the reduction in cycling (discounting those noted in section 3 to be invalid). Instead of a public benefit, the law almost certainly caused public harm by discouraging a healthy, environmentally form of transport.

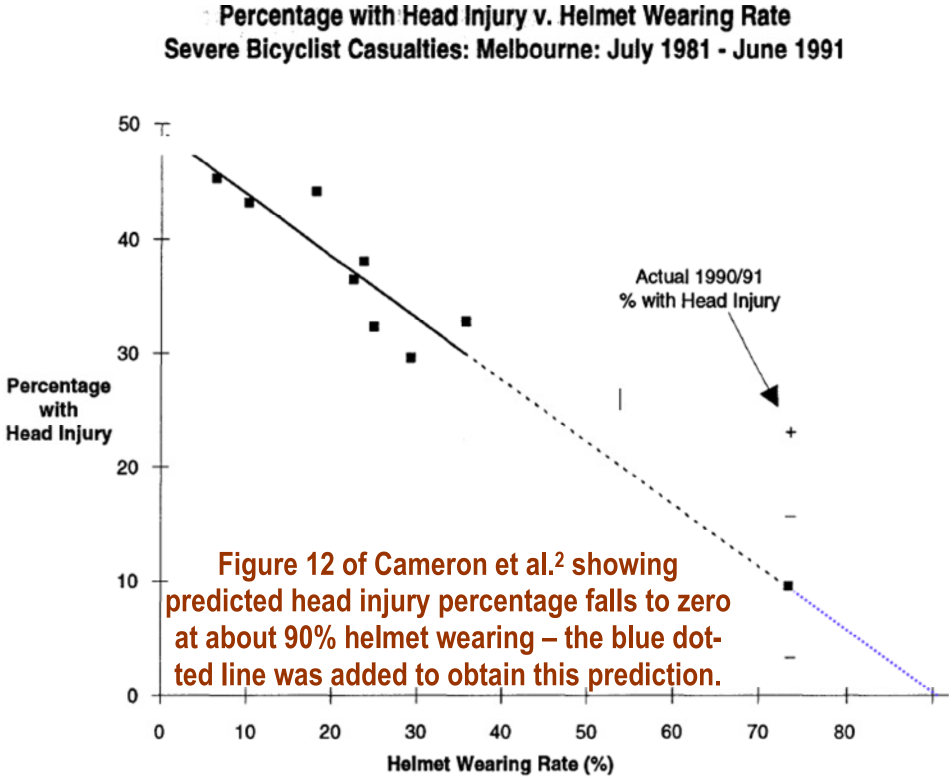


Figure 12 of Cameron et al.[2] showing predicted head injury percentage falls to zero at about 90% helmet wearing – the blue dotted line was added to obtain this prediction.

4) Ignore obvious signs helmet wearing wasn't the only reason for drops in percent head injury

MUARC's errors in evaluating the effect of helmet laws became evident in 1992 when they reported that their predictions showed that head injury rates would fall to zero before helmet wearing reached 100%! (see Figure 12 of Cameron *et al.*[2], left).

Such impossible results should have alerted the researchers to look for other factors affecting head injury rates, such as the remarkably similar trends in head injury rates of cyclists and pedestrians shown in Figure 2 of Robinson[1] (reproduced below left).

If MUARC had included both pedestrian injuries and the substantial (21% to 24%) reductions in severely injured cyclists who did not have head injuries[2] in a comprehensive model, perhaps they might have concluded that, after accounting for the 46% reduction in teenage cycling[6] and the improvements in road safety from reduced speeding and drink-driving, the increased helmet wearing achieved very little benefit, and perhaps substantial harm from the large reductions in teenage and therefore future adult cycling.

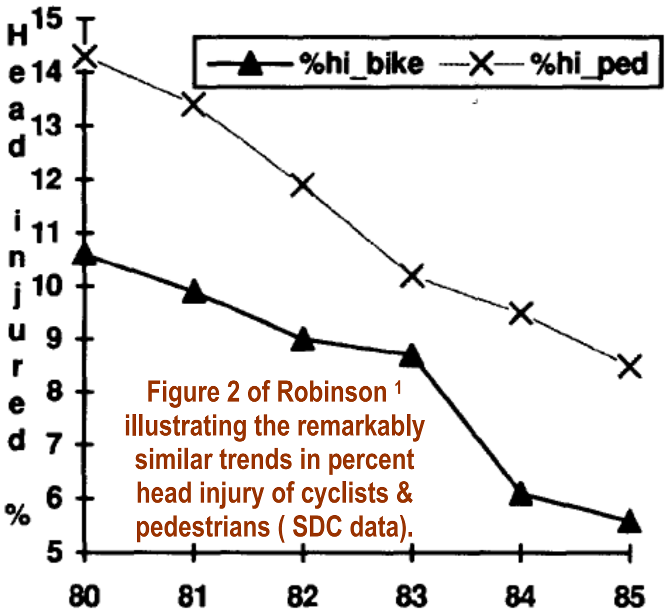


Figure 2 of Robinson [1] illustrating the remarkably similar trends in percent head injury of cyclists & pedestrians (SDC data).

'Solve' the problem by fitting models implying that helmets become less effective as more people wear them

It seems implausible that helmets would become less effective as more people wear them. In 1992, Cameron *et al.*[2] admitted this was the case, stating that a linear relationship was to be expected "if the effectiveness of helmets in reducing head injuries is constant, and the cyclists saved from head injury sustain other severe injuries requiring hospital admission."

Most evaluations of helmet wearing seem to have encountered this problem, which is illustrated in Table 3 (below). Before the law in New Zealand, helmet wearing increased from 30% to 43% of adults, and this was accompanied by a 9.7 percentage point reduction in percent head injury. But the increase from 43% to 93% of cyclists reduced head injuries by only 3.2 percentage points. So, an increase of 1 percentage point in helmet wearing before the law reduced the head injury percentage by 0.74 percentage points. In contrast, an increase of 1 percentage point in helmet wearing because of the law reduced the head injury percentage by 0.06 percentage points.

The most likely explanation is that, as is evident for helmet wearing and head injury rates in Ontario, Canada (see section 7), helmet laws were introduced when head injury rates were trending down for reasons unrelated to helmet wearing.

Table 3. Numbers of head and limb injuries, head injuries as percent of total (%HI) and percentage helmet wearing (%HW) of adult cyclists in New Zealand (from Robinson[5])

Year	Head	Limb	%HI	%HW
1990	127	91	58%	30
1991	107	98	52%	36
1992	95	89	52%	41
1993	120	127	49%	43
1994	101	117	46%	92
1995	93	112	45%	93
1996	87	113	44%	87
Pre-law change (90-93)			-9.7	13
Change with law (1995-1993)			-3.2	50

5) Ignore risk compensation & safety in numbers

When children ran an obstacle course wearing a helmet and wrist guards, tripping, falling and bumping into things increased by 51% compared to without.[12] There would little point of making helmets compulsory if the increased in helmet wearing encouraged cyclists or drivers[13] to take more risks, resulting in increased injuries per cyclist, counteracting any benefits of helmets. For similar reasons, increased injury rates because of reduced safety in numbers would also be counterproductive.[4,14] Many jurisdictions introduced helmet laws, but few measured cycle use reliably enough to compare the change in injury rates with the change in cycling. When this was possible, evidence suggests that helmet laws increased injury rates. After Alberta, Canada made helmets mandatory for children, numbers of child cyclists halved, but injuries increased, suggesting the risk of injury more than doubled.[15] In NSW, head injuries to child cyclists fell by 29%, but numbers counted in observational surveys fell by 36% and 44%% in the first and second years of the helmet law, suggesting an 11-27% increase in the risk of head injury per child cyclist.[1] In Victoria, child cycling was estimated to have fallen by 33% and 36% in the first and second years of the helmet law, but injuries fell by only 22% and 25% respectively, suggesting that the risk of injury increased by 16-17%.[1]

The apparent increase in the risk of injury per cyclist suggests that, even ignoring the lost health and environmental benefits of reduced cycling, helmet laws were detrimental to public health because of risk compensation and reduced safety in numbers.

6) Ignore the health & environmental costs of reduced cycling & reduced safety in number

After accounting for injury costs, an Australian government report concluded that the net health benefits of cycling amounted to 0.75 cents per kilometre in 2013 For transport trips, there were additional savings per km of 35 cents in vehicle operating costs, 20.7 cents in reduced congestion, infrastructure savings of 5.2 cents and environmental benefit of 5.9 cents per kilometre.[16] In 1985/86, bicycle travel accounted for 3.9% of all trips in Australia, including 2.8% in NSW (1.6% in Sydney and 5.0% in the rest of NSW).[17] The same amount of cycling today (2.24 km per person per week, about 85% for transport purposes) has estimated health, environmental and other benefits of $2.4 billion per year.

In Victoria, after accounting for the improvements in pedestrian injuries, Table 1 (section 2, above) shows that the fall in head injuries for cyclists in motor vehicle crashes was less than the fall in cycling. This means that injuries per cyclist *increased,* compared to what would have been expected without the law. As noted in section 5 above, the risk of head injuries to child cyclists in NSW increased by 11-27% and the risk of all injuries to child cyclists in Victoria increased by 16-17%.

The lost health and environmental benefits from even a 25% fall in cycling – over half a billion dollars per year based on the value per km cycled from the recent government report[16] – is a totally unacceptable price to pay for a law that did not achieve its stated objective of making cycling safer.

7) Claim non-enforced laws with no long-term effect on helmet wearing are beneficial

The helmet law for children in Ontario, Canada was not enforced. After a temporary increase, helmet wearing rates fell back to pre-law levels by 1999. As shown below, head injury rates trended downward, and were much lower in 2001/02 than 1996-98, when helmet wearing peaked. Unfortunately, other researchers investigating helmet laws were not told about the return to pre-law wearing rates for many years. Indeed, a paper published in 2003 reported helmet wearing rates to 1997, with no mention of the all-important data for 1999.[18]

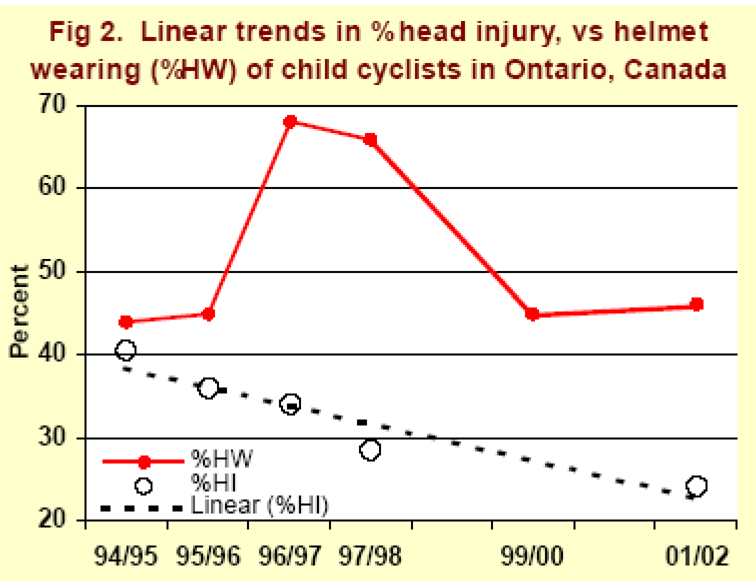


Fig 2 of the debate summary[3]

These problems were noted in a response published on the BMJ website on 14 January 2007[3] summing up the debate on the paper by Robinson.[20] Fig 2 of the published response (see copy, left) shows a declining rate of head injuries, which bears little relationship to helmet wearing rates. Given the lack of relationship between helmet wearing and head injury rates, it seems unlikely that the helmet law had any real benefit. Many years later a full analysis of the effects of helmet laws throughout Canada confirmed that "*injury rates were already decreasing before the implementation of legislation and the rate of decline*

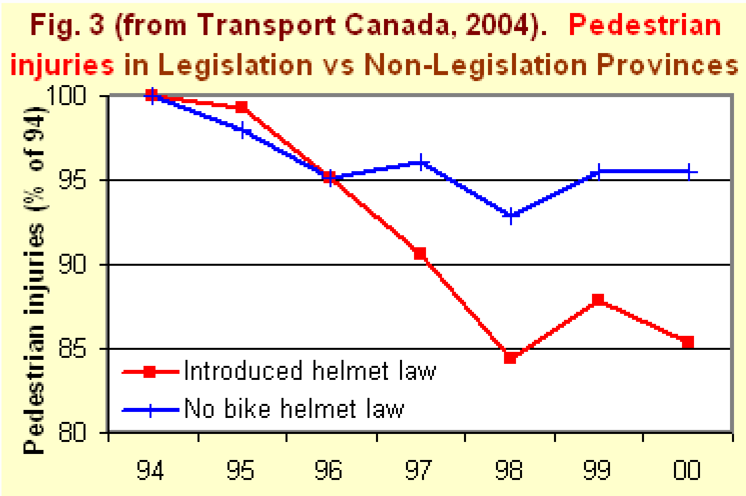


Fig 3 of the debate summary[3]

was not appreciably altered on introduction of legislation."[21]

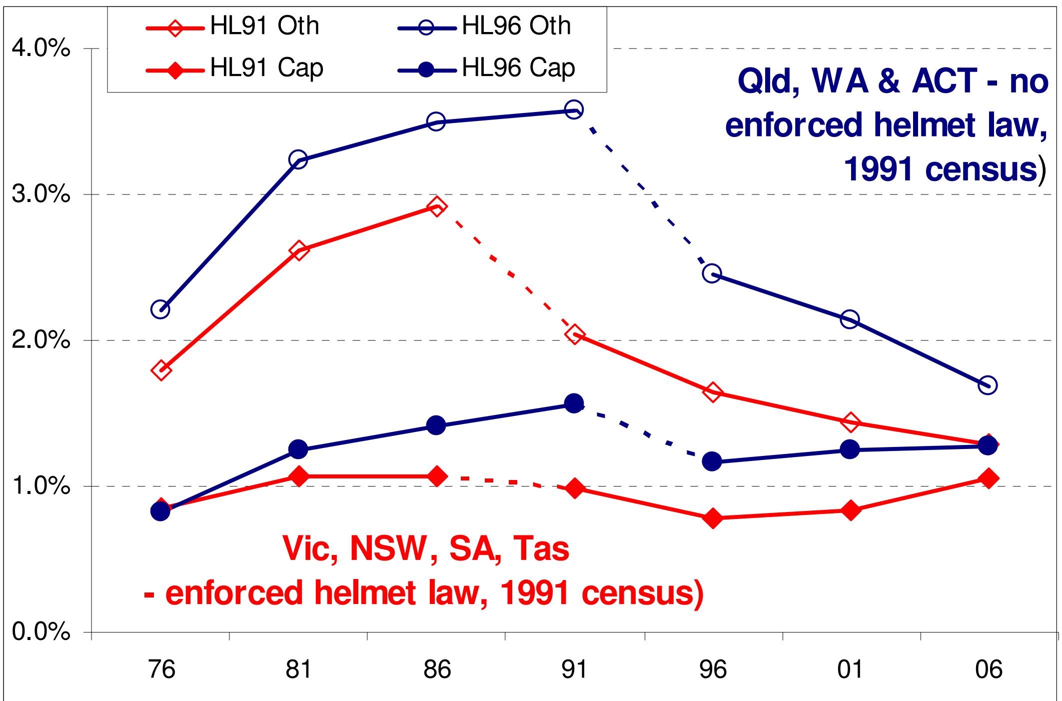
Disentangling the effect of different factors such as increased helmet wearing and safer roads is not easy. Fig 3 of the debate summary[3] (left) highlights the importance of considering the safety of other road users such as pedestrians. If this is not done, the Canadian researchers who naïvely claimed helmet laws were beneficial because there was a greater decline in head injuries in provinces that passed legislation[22] would also have to conclude the same was true for pedestrians!

The same researchers also naively concluded that helmet laws did not discourage cycling, based on the results from wildly fluctuating surveys, that would have been incapable of detecting a 25% decline in the amount of cycling. The laws were later found to have no long-term effect on helmet wearing rates.[23] Perhaps the main effect of widely-ignored laws (such as Ontario's child helmet law) is to teach children to disregard road safety laws, another possible reason why injury rates might increase.

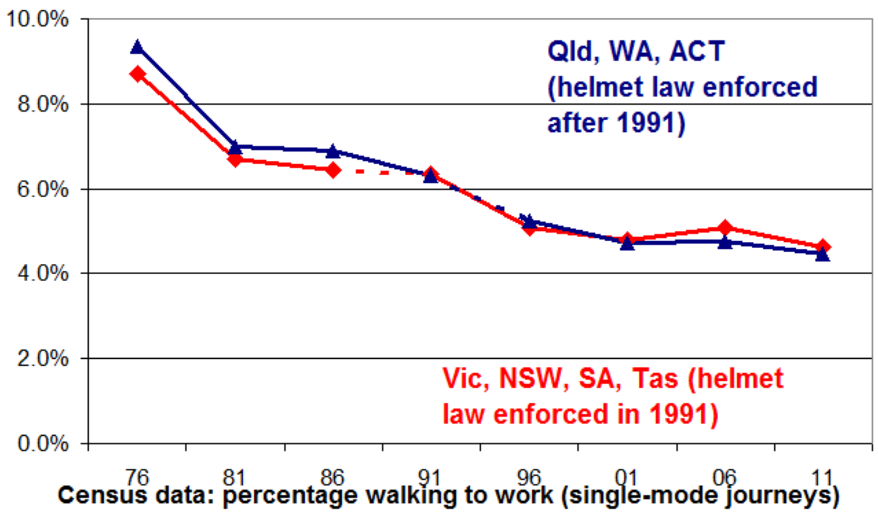
8) Measuring changes in cycle use

Although telephone surveys can provide information about cycle use, they are subject to large sampling variation, difficulty in recalling the exact number of bicycle trips in the past few months, or wishful thinking about how often people feel they ought to participate in a healthy activity. In Western Australia, responses to a specific questions about whether adults would cycle more if not legally required to wear a helmet produced a much higher estimate of the detrimental effect of helmet laws (the number who said they would was equal to 64% of current adult cyclists) than estimates of the effect of the law on the cycling of other people in their family.[1]

Similarly, in South Australia, a telephone survey found no significant decline in the amount people said they cycled (Tables 1a & 1b), but there was a large, significant drop in how much they had actually cycled in the past week.[24] In 1990 (pre-law), 17.5% of males aged at least 15 years reported cycling in the past week (210 out of 1201, Table 5a), compared to 13.2% (165 out of 1236) post-law in 1993. For females, 8.1% (102 out of 1357, Table 5b) has cycled in the past week in 1990 compared to 5.9% (98 out 1768) in 1993.[24] These reductions (24% for males, 26% for females aged at least 15 years) are statistically significant ($P < 0.005$ for males, $P = 0.025$ for females). Responses were also sought from one child in the household, but no information was provided on how the child was chosen, and information on children's cycling was available for only 25-26% of households. The survey did not reveal any significant change in children's cycling, but this might be explained by a sampling bias towards younger children, who were noted in Victoria to be much less affected by helmet laws than teenagers.[1] Destinations for children (but not adults) included 'own property', suggesting the intention was to cover riding in the backyard. The high proportion of children who listed this (47% of males, 59% of females) suggests a possible bias towards young children. Marshall and White also noted a 38.1% decline in children's cycling to school, but no



Percent cycling to work by year, capital cities vs all other areas



obvious reduction in commuter cycling.[24]

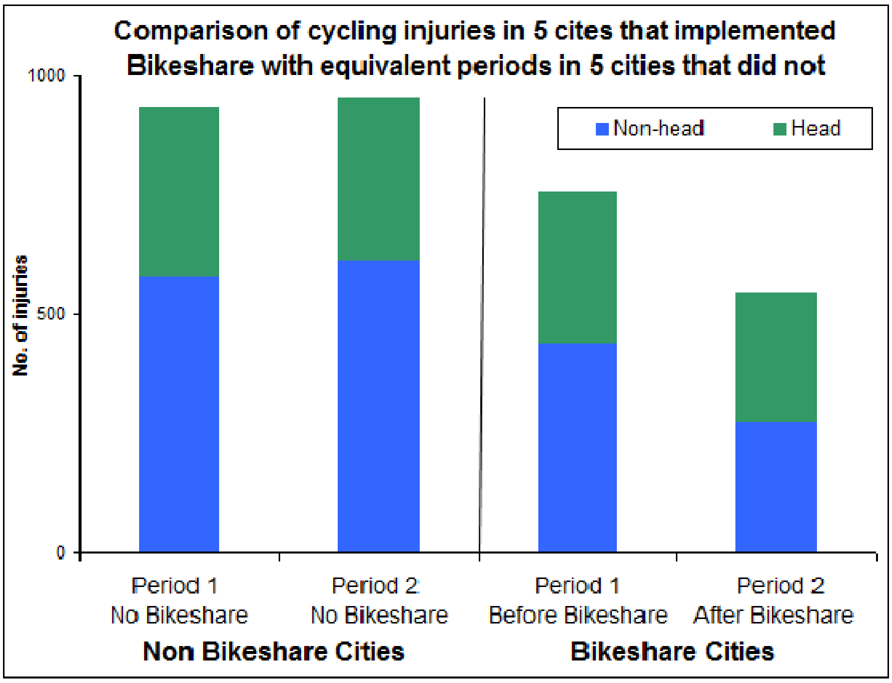
Commuter cycling, like cycling of young children, was probably less affected than teenage cycling, making the effect of laws harder to detect, especially in the presence of other trends. One useful way to examine the impact is to compare census data on cycling and walking to work in states with and without enforced helmet laws in 1991.[25] In states with enforced helmet laws (red lines) the 1991 census showed a reduction in cycling. In contrast, cycling to work increased on average in states without enforced laws (blue lines), with sharp declines evident in the next (1996) census, when helmet laws were enforced in these states. Walking to work showed almost identical declining trends irrespective of whether helmet laws were enforced at the time of the 1991 or 1996 census.

The results strongly suggest that helmet laws did indeed reduce cycling to work, more so in regional areas. The discrepancy between regional areas and capital cities might relate to perceived safety. In areas where cyclists are already wearing helmets because of perceived danger, the impact of helmet laws in discouraging cycling is likely to be less than in areas where helmet wearing is low and cycling is generally considered safe. For example, UK surveys show a much higher helmet wearing rates in London (69.5%) than elsewhere (29.9%).[26]

New Zealand also introduced helmet laws in January 1994. Cycling to work also declined in NZ (from 11.6% in 1989/90 to 7.3% in 1997/98 to 4.3% in 2004-08 and cycling to secondary school from 18.6% (1989/90) to 10.6% (1997/98) to 4.9% (2004-08).[27] The total amount of cycling fell from 15 minutes per person per week in 1989/90 to 9 minutes in 1997/98 then remained at this level (see Appendix).

9) Portray decreased risks as an "increase"

Exposure to Montreal's public bicycle share scheme (**PBS**) more than doubled the likelihood of cycling (odds ratio = 2.86) after the 2nd season of implementation.[28] Safety also improved substantially with a 50% reduction (from pre-implementation to season 2 of implementation) in the number of collisions per 100 person-days of cycling, although total numbers of collisions and near misses did not decrease.[29]



Another study considered Montreal and 4 other cities (Boston, Miami Beach, Minneapolis, Washington D.C.) that implemented PBS. Head injuries fell by 14% (from 319 to 273 per year) while moderate or severe head injuries fell by 27%. There was an ever larger reduction in other injuries, from 437.5 to 272 per year.[30] There was no similar improvement in 5 cities non-PBS cities, where head injuries decreased by 4% and those classed as moderate or severe increased by 6% (from 180.5 per year to 192). Non-head injuries also increased by 6% (see graph).[30]

Astonishingly, an article on the University of Washington's website discussed an analysis of the above data and a publication with lead author from the Harborview Injury Prevention and Research Center,[30] claiming the "risk of head injury among cyclists *increased* 14 percent". In response to letters pointing out that head injuries were actually 14% lower, the authors responded saying that the "conclusion that bike safety has improved after the institution of the PBS is not warranted without denominator data" (i.e. information on the amount of cycling).[31] However, as well as the published data showing substantially increased cycling in Montreal (and a halving of the number of collisions per 100-person days), a letter by Prof Kay Teschke[32] points out that cycling to work in PBS cities increased by an average of 33%, compared to 18% in non-PBS cities, again suggesting that cycling increased more in PBS cities, while head injuries decreased, leading to real improvements in safety, environmental gains and improved health.

Other evaluations have shown that PBS generate substantial benefits. In 2007, Velib was said to have driven Paris '*cycling mad*'.[33] Since then, many cities have successfully introduced public bikshare schemes and improved health. Compared to car users, the estimated annual change for Barcelona's 181,982 Bikeshare users was 10.5 to12.5 avoided deaths from increased physical activity offset by 0.03 deaths from road traffic incidents and 0.13 deaths from air pollution.[34]

In its first 12 months (to March 2012), 7.4 million trips were made on London's Bikeshare scheme. An evaluation in the BMJ estimated net health benefits (after subtracting losses from injuries sustained during those trips) of 72 additional years of healthy life for men (who accounted for 71% of cycling time) and 15 for women.[35]

Number of Bicycle Injuries Unrealistic

As a bicyclist and data analyst, I was interested to see the article by Thompson et al., "Incidence of Bicycle-Related Injuries in a Defined Population," in the November 1990 issue of the *American Journal of Public Health* (pp. 1388–1390). I write because I think Table 2 is either wrong or misleading.

What attracted my attention is the final column in Table 2 labeled "Injuries per 100 Miles Ridden Per Year." For adults, you show estimates of roughly 1 injury (requiring medical attention) per 100 miles ridden. On the basis of two pieces of personal evidence, however, this estimate seems incredibly high: (1) In the last several years I have bicycled a total of about 20 000 miles—Table 2 would predict some 200 injuries for me, but I have not experienced even one significant injury; (2) sometimes I participate in organized rides where perhaps 1000 riders each ride 50 to 100 miles on the day of the ride—Table 2 would predict 500 to 1000 injuries on such a day, but in reality even one significant injury is rare. Thus Table 2 seems off.

Your second paragraph promises "calculation of population-based rates", (p. 1388) and it would have been useful if Table 2 had presented injury rates per 100 miles ridden for your defined population—i.e., for the 223 298 members of the central and east regions of the Group Health Cooperative of Puget Sound. However, it is not clear to me how Table 2 was derived. Perhaps Table 2 is based only on the relatively few cyclists who experienced injuries. If so, this would result in a biased estimate of the population-based injury rate. Beyond this, however, the Table 2 numbers still remain problematic because it seems that you have not considered miles ridden since the previous injury (if any). Do you really believe—as Table 2 suggests—that a 5- to 9-year-old child who has had one injury should expect additional injuries approximately every 3.3 miles? It would be unfortunate if anyone were to use your Table 2 to estimate the incidence of bicycle-related injuries; however, the title of your article and the title of the table may tempt some to do so. □

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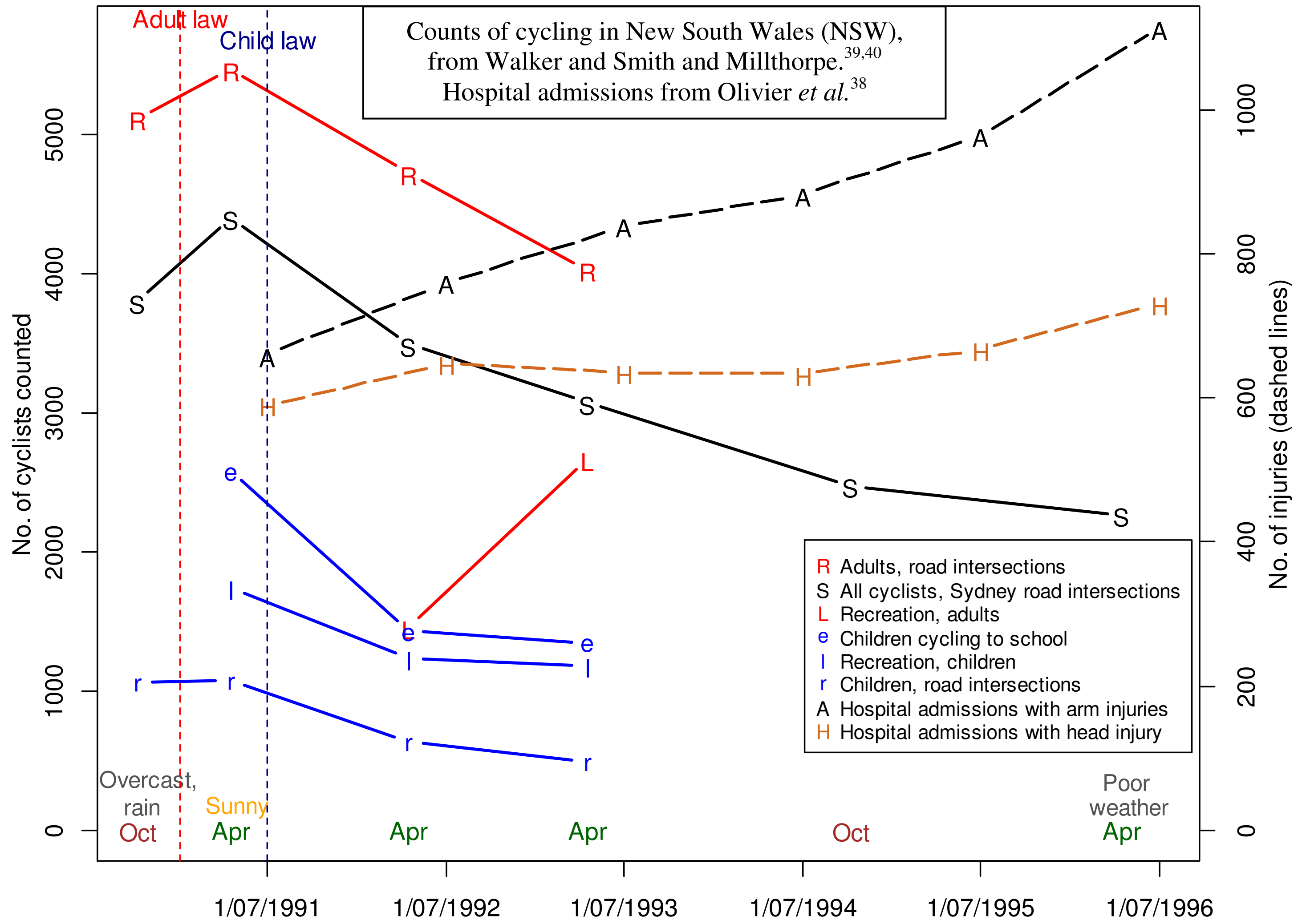
Letter (published in the American Journal of Public Health, August 1991) commenting on the unbelievable statistics in the paper by Diane Thompson and colleagues from the Harborview Injury Prevention and Research Center, e.g. that a 5-9 year old child who had one injury should expect additional injuries every 3.3 miles.

After New York launched its Citi-Bike scheme in May 2013, cycling in the Citi-Bike area spiked by 25% with over 5 million Citi-Bike rides to November 2013. Yet in November 2013, the number of cyclist fatalities in NYC, year to date, was lower than any year since record-keeping began in 1983.[36]

The extraordinary claim that head injuries increased when they decreases is not the first implausible claim from the Harborview Injury Prevention and Research Center. A letter to the editors of the AJPH in 1991 (see box, above) questioned their estimates of extraordinarily high injury rates, e.g. that a 5-9 year old child who has had one injury should expect additional injuries every 3.3 miles. Their claim that helmets prevent 85% of head injuries has also now been withdrawn by two US Federal Government Agencies.[45]

10) Probable increases in risk portrayed as decreases

The previous section provides evidence of increased cycling and improved safety after implementation of bikeshare schemes. This again raises the question of whether decreases in cycling because of helmet laws are likely to have the opposite effect of increasing injury rates. It certainly seems to be true in the long term. For example, in New Zealand, from 1989/90 to 2011, average time spent cycling (on roads and footpaths) fell by 79% for children aged 5-12 (from 28 to 6 minutes per person per week) and 81% for 13-17 year olds (52 to 10 mins/person/week). The decreasing trends in cycling were accompanied by large increases in hospital admissions per million hours of cycling from crashes not involving motor vehicles, quadrupling in 15-19 year olds (from 11.6 in 1989 to 45.9 injuries per million hours in 2011) and more than doubling for children (from 39.5 to 85.4 per million hours) and adults (from 15.9 to 32.3 per million hours.[37] The largest falls in cycling (reductions of 21 minutes per week for 13-17 year olds and 13 minutes per week for children) and increases in injury rates were from the pre-law survey in 1989/90 to the first survey (1997/98) after the helmet law.[37]



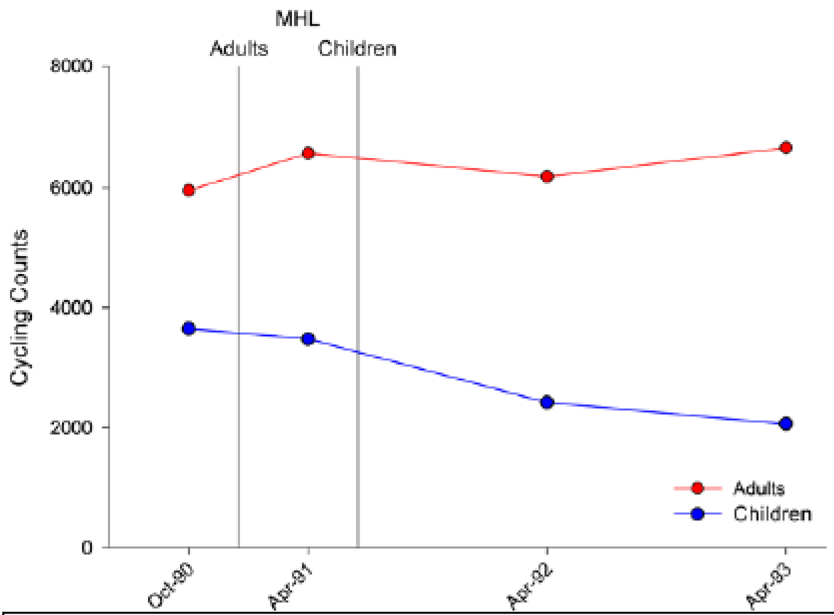
NSW, Australia: time series of numbers of cyclists counted and hospital admissions for arm and head injuries

A comparison of hospital admissions in NSW[38] with cyclists counted in surveys[39,40] also suggests that injury rates increased. The graph (below) shows a clear decrease in child cycling at road intersections (r), recreational areas (l) and schools (e) after helmets were made compulsory for children. In April 1993, 44% fewer child cyclists were counted than in April 1991. Yet head injuries fell by only 29%, suggesting that the risk of head injury to children increased.[1]

The data for adults are harder to interpret because the second survey (in April 1991) was in sunny conditions, but the pre-law survey was at a different time of year (October) and conditions were overcast in Sydney and interrupted by rain in some areas.[41] Increased cycling because of better weather, or other seasonal variation, may well have masked the effect of the introduction of a helmet law for adults.

The graph above shows all available observational data, including a longer time series of counts for cyclists of all ages at the same sites (25 road intersections) in Sydney,[40] compared to numbers of hospital admissions of cyclists with head and arm injuries.[38] Despite the downward trend from 1991 onwards in numbers of cyclists counted at the Sydney sites, head and arm injuries trended upwards, again suggesting the cycling became more dangerous after helmet laws were introduced.

Published claims do not always reflect this reality. For example, the graph (left)



Graph from Olivier *et al.*[43] in which pre-law values for both adults and children appear to have been calculated from post-law trends assuming that the law has no effect! The calculation of adult "trends" also appears to ignore the fact that adults over 20 were not counted at some sites in 1991.

shows how the survey data were represented by Jake Olivier and colleagues.[42] The only comparable data for children in 1990 and 1991 are the surveys at road intersections, where as shown on the detailed graph (above), counts were marginally higher in 1991 than 1990. In contrast, Olivier's graph shows a decrease in children's cycling which appears to have been calculated by "estimating" the amount of children's cycling in 1990. Yet a survey of NSW schoolchildren who owned bikes found that 51% of those but hadn't cycled in the past week said this was because of the helmet law.[20] This implies that post-law trends in children's cycling were strongly influenced by the helmet law, so there is no valid way of determining pre-law trends, let alone seasonal effects. It is both misleading and invalid to estimate the amount of cycling in 1990 assuming the helmet law did not affect trends, then use the results to demonstrate the effect of the law!

The graph of Olivier *et al.* for adults is even more misleading, because cyclists over 20 were not counted at some recreational areas in 1991.[43] Comparable counts were available only for 1992 and 1993. It is therefore not possible to determine whether the cause of the big increase from 1992 to 1993 was random variation or the continuation of a trend that started before the law. Other surveys (e.g. a figure equivalent to 64% of current adult cyclists in Western Australia saying they would cycle more if not legally required to wear a helmet[20]) suggests that helmets laws do indeed deter cycling. Using non-comparable data for 1991 and (as was pointed out for children) also assuming the helmet law did not affect trends in order to estimate the amount of cycling in 1990, in a graph to demonstrate the effect of the law, are both misleading and invalid.

Conclusions

Although many factors affect the decision to cycle, the bulk of evidence suggests that helmet laws, and portrayal of cycling as a dangerous activity in order to persuade cyclists to obey helmet laws, is an important factor that affects the amount of cycling. The evidence cited here also suggests that, in order to avoid embarrassment, some researchers exaggerated the benefits of helmet laws. This appears to be particularly true of the assessment by MUARC of Victoria's helmet law, where the law was claimed to have reduced head injuries by 40%, despite, as shown above, most of this reduction appearing to be due to reduced cycling and safer roads. In 1990, 1567 adult cyclists were counted, but only 1106 (29% less) in an identical survey 1991. In 1992, when counts were inflated by a bicycle rally passing through one site, there were 1484 adult cyclists (still 5% less than 1990). Although it would have been possible to estimate the total adult cycling time from the number of adults counted, MUARC chose instead to use a survey taken some years earlier at a different time of year (Dec/Jan 1987/88, that counted only 1079 adult cyclists) as the pre-law "baseline". So instead of the observed reductions on 29% and 5% in adult cycling, various inconsistent claims were made about increases in adult cycling, even that "In Melbourne adult cyclist numbers doubled after the helmet legislation was introduced."[10] This is a truly remarkable claim to make when both post-law surveys counted fewer adult cyclists than the identical pre-law survey in May 1990.

The evaluation of helmet laws in Canada was similarly problematical, in that the researchers delayed reporting the fact that child helmet wearing had fallen to pre-law levels by 1999 until 2006. Perhaps this information would have generated embarrassing questions about how a non-enforced law that had no long-term effect on helmet wearing could possibly have generated the claimed reductions in head injuries.

The ethics of such 'spin' are questionable. Strong justification is required for laws that deprive people of the freedom to cycle without a helmet, or have the potential to increase health costs by discouraging a healthy, environmentally-friendly form of transport, or increase the risk of injury because of risk compensation or reduced safety in numbers.

With evidence suggesting that the risk per cyclist is higher than would have been expected without the law, action should be taken to correct the problem.

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Apendix. NZ Household Travel Survey data[44] showing the decline in cycling. NZ's helmet law commenced in January 1994.

	Minutes cycling per week								
Age group	**1989/ 90**	**1997/ 98**	**2003–06**	**2004–07**	**2005–08**	**2006–09**	**2007–10**	**2008–11**	**2009–12**
5 - 12	28	15	11	9	8	7	9	8	6
13 -17	52	31	13	12	12	11	12	11	10
18+	8	5	5	6	7	6	8	8	8
Total 5 or over	15	9	7	7	7	7	8	8	8