Assessment of Australia's Bicycle Helmet Laws

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The issue of bicycle helmets has been under discussion for about 20 years. Many aspects are involved – health, safety, environment, civil liberties, injury compensation, law enforcement, fines and court costs. Enforced helmet laws have discouraged cycling even though the health benefits of cycling are considered to outweigh the risks. Per million population, approximately 2 cyclist deaths occur annually compared with 2000+ from cardiovascular disease. With fewer cyclists due to legislation, a key question is whether society benefits from such measures.

Cycling activity assessment

In 1990 bicycle helmet legislation in Victoria resulted in a drop of 36% in the numbers cycling in Melbourne[1], see Figure 1. Post law 10% extra wore helmets compared to 36% fewer people cycling. This result of discouraging people was in sharp contrast to seat belts, which did not discourage driving.

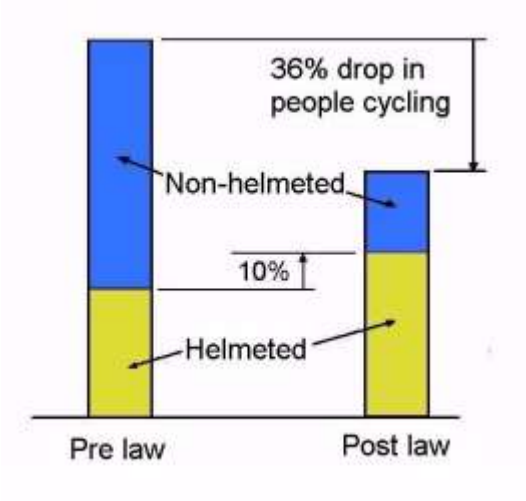

Fig. 1

A before-law survey showed that 272 out of 1,293 teenagers in Victoria wore helmets. After the law, 302 wore helmets out of 670.

The law resulted in 30 more teenagers wearing helmets compared with 623 fewer cycling

In New South Wales the largest recorded reduction in cycling was among secondary female students in Sydney[2]: 214 in 1991 down to 20 in 1993, a drop of 90.6%. (Girls especially require exercise in their younger years in order to foster strong bones in later life).

Western Australia survey data shows cycling reduced by more than 30% following legislation[3]. Prior to legislation as helmets were being promoted, cycling to school in WA also reduced[4].

Census data on cycling to work

Prior to helmet legislation from 1986-1989, the proportion of people cycling in general, was increasing by 10% -12% per year[5]. In Sydney it increased 250% during the 1980s[6]. In Victoria and Western Australia it increased by 47%[7] and 33%[8] respectively from 1986 -1989. With Government support for cycling and concerns about 'The Greenhouse Challenge', plus schools providing bike education and rising fuel costs, cycling should have increased substantially thereafter. Census data[9] below shows the percentage cycle to work and an estimate for 1989 is provided in order to compare later data. A 'trend' estimate is provided showing the levels that cycling may have reached or exceeded without helmet legislation. The result show that the law failed to increase cycling and levels in 2001 to 2006 were less than half what could have been achieved, see Table 1. Sales of bicycles have increased substantially but the actual use of bicycles in Australia has not kept pace with population growth.

Year	Census % cycling to work in bold	% 'Trend' if no helmet law	% drop from 1989 value	% drop from growth 'Trend'
1976	**1.12**			
1981	**1.56**			
1986	**1.68**			
1989*	2.00			
1991	**1.56**	2.15	22	27
1996	**1.24**	2.50	38	50
2001	**1.21**	2.85	39	57
2006	**1.24**	3.20	38	61

Table 1

* No census in 1989, the 2.0% figure is estimated from published information. Refer survey details at www.cyclehelmets.org and www.cycle-helmet.com for more information.

Fatality assessment

Helmet laws were introduced between 1990 and 1992. A four year period 1986 -1989 can be compared to 1993 –1996 to assess the outcome. Peds – pedestrians, Mcyc- motorcyclists, MVO – motor vehicle occupants.

Fatalities	Peds	Mcyc	Bicyclist	MVO	Total
1986 - 1989	2079	1386	342	7519	11348
1993 - 1996	1447	790	209	5415	7868
% reduction	30.4	43	38.9(**13**)	28	30.7

Cycling was discouraged by approximately 30%+ due to the helmet law. Allowing for the reduction in cycling gives only a 13% reduction for cyclists, the smallest reduction of all road users.

The fatality risk per million hours of cycling is 0.41 compared with 0.8 pedestrians, 0.46 motor vehicle occupants and 7.66 motorcyclists[10]. Cycling is beneficial because the health benefits are substantial and the fatality risk is low, see Figure 2. Assessing the risk level per road type and introducing suitable measures, together with improved training, can lower the risk for cyclists.

Fig. 2

Injury assessment

In 2003-04 there were approximately 6.8 million hospital admissions in total with about 50,000 (0.7%) due to land transport injury. There were 7929 hospitalisations for cyclists compared to 3716 for pedestrians[11], a ratio of 2.13 to 1. In 1990 there were 7520 hospitalised cyclists compared to 5048 pedestrians[12], a ratio of 1.49 to 1. The ratio change from 1.49 to 2.13 suggests cyclists are more at risk, that is 2.13/1.49 = 1.43.
Note: Adjusting for the reduced cycling and other factors roughly indicates a 50% drop in safety for cyclists, compared to pedestrians.

For 2003-04, road vehicle traffic data for head injury shows the mean 'length of stay' (total patient days) in hospital were:

Cyclists …….. 3.0 days...(2597)
Pedestrians…… 8.8 days...(6791)
Motorcyclists…….. 5.4 days ..(3264)
Car passengers….. 5.2 days...(6982)
Car drivers……..... 4.9 days.(10350)

The ratio of patient days for car occupants to cyclists is about 7 to 1. By comparison, Australians spend about 24 million days in hospital each year[13].

For the UK, Mills[14] reported that 66% of cyclist admissions were detained for just one night and most of the casualties with cranium injuries were admitted for overnight observation.

For injury to children, the analysis by Robinson 1996[10] of Victoria and NSW data suggests a drop in safety of between 16% and 68%.

In Western Australia, head injuries fell by 11% to 21% but cycle use fell by 30% or more[3]. The risk of head injury for those who continued to cycle increased. Data of hospitalised WA cyclists[15] shows an average 641 for the three years prior to helmet law enforcement. Allowing for an estimated 30% fall in the number cycling, hospital admissions should have fallen to about 449 cases. The actual average was 633.

The European Cycling Federation stated[16]

"… **the evidence from Australia and New Zealand suggests that the wearing of helmets might even make cycling more dangerous."**

Refer references 41 for more details.

A helmet petition to the Victorian Parliament expressed concerns that helmet wearing would increase the accident rate[17]. The petition mentions accidents increased by 117% for cyclists aged 17-50 years, as helmet use was increasing in Victoria from 1984 to 1989.

Health assessment

The principal threats to children and adult's lives are obesity, heart disease and other illnesses resulting in large part from inactivity[18,19]. Changes from 1989 to 2007 shows the scale of the problem.

1989 – 90, 36% of Australians aged 15 years and over were overweight or obese.

1990 –1992, helmet laws introduced.

2001, 8% increase to 44% or approximately 1,680,000 extra people were overweight or obese.

2000-2001, cardiovascular disease cost the Australian health system $5.4 billion[20].

2004, 47637 people died from cardiovascular disease and in 2004-05 approximately 3.5 million Australians reported having a long-term cardiovascular condition[19].

2006/07, the direct cost of physical inactivity is quoted as $1.49 billion for Australia[21].

In 1997, Dr Kennedy performed medical examinations on regular cyclists and non-cyclists who had died[22]. He reported that cyclists had a reduced risk of developing heart disease, providing convincing evidence of the benefits of cycling.

Cycling helps to provide protection against[23]

- coronary heart disease
- stroke (brain damage)
- non-insulin dependent diabetes
- falls, fractures and injuries (through improved strength and co-ordination)
- colon cancer
- overweight and obesity

Obesity is reported to shorten lives by an average of nine years[24]

Cycling plays a key roll in preventing these illnesses. Less cycling due to helmet laws has aggravated the situation. Cycling gives a level of fitness equivalent to being 10 years younger and a life expectancy two years above the average[25]. The health benefits of cycling far outweigh any risks involved, by a factor of around 20:1, according to one estimate[26].

People who cycle regularly live longer than non-cyclists, with a 29% lower mortality rate and better health throughout their lives. Indeed, cycling regularly to work (and, by extension, to school) has been shown to be the most effective thing an individual can do to improve health and increase longevity[27].

In Australia, physical inactivity contributes to the risk of 6400 deaths per annum. In 2004-05, 70% of Australians aged 15 years and over were classified as sedentary or having low exercise levels[28].

A recent Australian report by Curnow in 2008[29] concluded that "Compulsion to wear a bicycle helmet is detrimental to public health" and there is considerable evidence to support this conclusion.

Environmental assessment

Bicycles use the least energy (kilojoules per person per kilometer) for general transport and have average values[30].

Cyclist…….…….. 150
Pedestrian…….....…..... 230
Tram…….....…...2000
Motorcyclist …….....2100
Bus……..…2500
Car (driver only.....5000
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Australia's per capita contribution to climate change is one of the highest in the world. Transport emissions rose 30% between 1990 and 2005 and this is expected to soar 67% above 1990 levels by 2020[31].

From the 1980s, oil shortages for Australia was foreseen and by 2015 it has been predicted that the trade deficit for petroleum products will be $25 billion[29]. Promoting cycling in all its forms is easier without helmet requirements. For example, bicycle hire in Paris has been a massive success without having to provide helmets[32]. In many of the smaller towns and cities across Australia, cycling into town may only take a few minutes and a helmet requirement adds inconvenience to cycling and detracts from enjoyment.

In addition to discouraging cycling and causing environmental harm, helmets use petroleum products in their manufacture - contributing to environmental damage.

Accident compensation assessment

Approximately six times more pedestrians and 20

times more motor vehicle occupants suffer lethal head injuries than cyclists[33]. Discrimination can occur in accident compensation cases where a cyclist was not wearing a helmet, compared to pedestrians or indeed motor vehicle occupants who received head injuries. The helmet laws result in unfair compensation and a biased legal process.

Law enforcement assessment

More than 200,000 fines have been issued in Victoria alone for not wearing helmets. The courts rapidly became overloaded with the prosecution of those who had not paid their fines. The Victorian Children's Court pleaded to the police to reduce the number of helmet fines being issued[34]. On other occasions, children faced detention for up to three months, tearing families apart[35].

It is unreasonable to prosecute children or their parents for cycling, which is beneficial to health, whilst encouraging through the same helmet law sedentary lifestyles which lead to worse health and greater costs for society.

Summary of assessments

With helmet laws removing the civil liberty of personal choice and helmet promotion as an option to increase helmet use, a positive outcome was required in all seven assessments to justify the principle of helmet laws. In six assessments the outcome was negative. Therefore, helmet laws are not justified.

- **Cycling activity assessment**– negative result
- **Fatality assessment** – negative result
- **Injury assessment** – negative result
- **Health assessment** – negative result
- **Environmental assessment** – negative result
- **Accident compensation assessment** – negative result
- **Law enforcement assessment** – reasonable enforcement but perverse outcome

The harm the helmet law has caused is considerable, affecting millions of people and the environment

The more people cycling, the safer it gets

One effective way to reduce the likelihood of any kind of injury when cycling is to increase the number of people who cycle. When cycle use doubles and motorists expect to encounter cyclists, the risk of injury per cyclist falls by 35% to 40%[36]. An international comparison shows that in those countries where cycle use is high, cycling is much safer yet very few people wear helmets. Moreover, the countries with highest cycle use (and low helmet wearing) also have the lowest levels of childhood obesity. Refer www.cyclehelmets.org for more details.

General helmet safety issues and concerns

Many of the early reports promoting helmets were based on comparing injuries of people who had chosen to wear helmets (possibly safety-conscious people) to those who had not. Even with legislation, this may apply. The 1986 Newcastle Bikesafe Conference papers[37] showed that the accident rate can vary by a factor of about 10 to 1, depending on the type of cyclist. Therefore, simple comparisons can be unreliable. Extensive claims of helmet benefits exist due to comparing injuries of helmeted and non-helmeted cyclists, as in the ATSB review[38]. This however is not a direct measure of safety per hour or distance of travel, it is only a guide. Many reports are much weaker than they first appear - refer Commentary at www.cyclehelmets.org for examples. Curnow explains that much of the evidence supporting helmets does not provide a reliable guide to the efficacy of helmets or scientific evidence that they provide protection from serious brain injury[39].

Clarke[40] detailed many of the mistakes made in Australia when assessing and introducing helmet legislation. The most important error was in not providing a full health and safety assessment if fewer people cycled due to legislation. The Australian people deserve to know how helmet legislation has affected accidents and the general health of the people. Census and other survey data show that cycling has been significantly reduced. Health indications showed a gain in weight with Australia now considered being one of the fattest nations on Earth. Thomas Krag[41] provided a means to relate the health benefits of cycling in 'lifetimes gained' compared to 'lifetimes lost' in cycling accidents. Based on 1986 data, approximately 50 lifetimes lost compare with a minimum of 235 lifetimes gained for Australia. Cycling has many health benefits and a key finding in 'Cycle safety' Monograph 17 states; "The overall community benefits gained from regular cycling are

likely to outweigh the loss of life through cycling accidents"[42].

The Australian Government believes that, to date, the international body of evidence overwhelmingly indicates that bicycle helmets help to protect the wearer against head and brain injury in the event of a fall or collision. However, Robinson's BMJ 2006 paper reported 'No clear evidence from countries that have enforced the wearing of helmets'[43]. Accident data suggests helmets may tend to increase the accident rate and this needs to be considered carefully. Refer 2007 Velocity paper for more information http://www.ctcyorkshirehumber.org.uk/campaigns/velo.htm

A primary issue is avoiding falls or head impacts. Being larger than the skull, helmets increase the number of impacts that could otherwise be near misses for a bare head. Dr. Hillman[44] reported "they do not protect the head from rotational trauma which can seriously damage the brain and brain stem and which is quite common when cyclists are hit a glancing blow from a motor vehicle rather than in direct collision with it". Lane reported "it has been recognised since the work of Holbourn (1943) that rotational acceleration of the head plays a major part in brain injury"[45]. Lane details the threshold limits suggested by Lowenhielm of 4500 rad/sec2 for AIS 5. (AIS 5 being critical injury level, survival uncertain). The estimated tolerance acceleration limits for children are lower than for adults and the 4500 rad/sec2 limit may be a safer criteria than the higher limits suggested for adults. Corner et al found by experiment that the addition of a helmet to the head can increase angular acceleration[46].

Further research by StClair and Chinn from the UK showed that out of 43 tests for rotational acceleration, 23 exceeded the 4,500 rad/sec2 level, three results were above 10,000 rad/sec2, and a maximum value of 20,642 rad/sec2 was obtained[47]. The test results were based on a nominal impact speed of 8.5m/s and in practice impact speeds can be much higher. Also, a limited range of helmet sizes, up to 57cm, was tested. This research confirms dangerous levels of angular acceleration can result from wearing a helmet and in some cases will be higher than that for a bare head. With helmets being larger than a bare head, it also means a helmeted head will be more likely to sustain an impact. Data on the impact location on helmets also confirms most impacts actually occur on the side areas rather than the top, front or rear. Consequently, rotational considerations become even more important. StClair and Chinn research data shows that in the majority of impacts, values obtained exceeded the safer limit. However, they also claim that "in the majority of cases, the levels of rotational acceleration of a helmeted head would be no more injurious than expected for a bare, non-helmeted head". Due to the increased size of helmeted head, in practice a bare head could avoid an impact and one helmeted could incur an impact. Therefore, the above claim is unsound.

The resulting combination of increased probability of impact to a helmeted head and higher angular acceleration compares unfavourably with a bare head. Hence, there can be no confidence that wearing a bicycle helmet of current design can ensure protection against serious injury to the brain. The standard for helmets represents the Government's guarantee of their efficacy and absence of harmful effects. The advice to wear a helmet must therefore be judged to be unsafe because the current standard does not relate at all to angular acceleration. Particular caution is needed where the scientific knowledge is incomplete or shows harmful effects may result.

The UK's National Children's Bureau (NCB) provided a detailed review by Tim Gill in 2005 - 'Cycling and Children and Young People. The conclusions included: "There is widespread and growing agreement about the benefits of cycling for all sections of the population, and especially for children and young people." On helmets, the review found that "the case for helmets is far from sound", "the benefits of helmets need further investigation before even a policy supporting promotion can be unequivocally supported" and "the case has not yet been convincingly made for compulsory use or promotion of cycle helmets"[48].

The UK report RSRR30[49] reported 21 papers in favour of helmets or legislation compared with 22 against. The evidence supporting helmet use and legislation is clearly divided. Around the world, a few cycle helmet laws have been introduced for all ages, whilst others have been introduced for younger cyclists only, thus giving adults freedom of choice. In other areas, helmet laws have been rejected or at least not supported. Without legislation, helmet manufacturers and retailers promote helmets. The European Council of Ministers (ECMT) report on "National policies to promote cycling" (2004)[50], advises "leaving promotion to the manufacturers and shopkeepers".

Dr. Hillman[44] detailed his reasons for not promoting helmets after considering the evidence. He considered it could lead to fewer people cycling.

Benefits of allowing for choice

Voluntary helmet wearing rates in New Zealand prior to legislation were about 56% for teenagers and 86% for younger children[51]. It is therefore possible that a good proportion wear helmets without legislation. Voluntary use has benefits of:

- Health - by increasing cycle use
- Civil liberties – allowing a choice based on individual circumstances
- Allows the promotion of cycling as an everyday activity, rather than a high risk one
- Legal – cyclists with head injuries having the same rights as pedestrians and motorists for fair compensation
- Enforcement cost benefits by not taking up valuable police and courts time.
- Voluntary wearers are also more likely to wear their helmets correctly
- Safety benefits of fewer head impacts and lower accident rate
- Environmental benefits and cost savings

In practice, allowing choice has many benefits over helmet legislation. High quality cycle training and improvements to road safety can lower the accident rate, especially for children cycling. Therefore, helmet legislation is not the only option. New research into Safety in Numbers, published in 2003, shows that as cycling increases in popularity, the risk of injury per cyclist is substantially reduced. Countries with low helmet wearing have more cyclists and substantially fewer fatalities per km cycled than countries with higher helmet wearing rates. Repealing helmet laws will therefore not only result in substantial health benefits but also make cycling safer. Helmet legislation should be repealed and replaced with a program to improve safety and reduce falls for cyclists. In time, the benefits and disadvantages of helmets may be fully understood but this could take decades to achieve.

Misleading claims

Claim: “Cycle use has recovered in Australia”[52]: In many parts of Australia the number of people cycling has returned to or exceeded pre-law levels. However, there has been the loss of more than a decade of cycling growth (cycling levels were generally increasing before the law). In many places, the cycling increase is largely due to population growth and a reduction in law enforcement by police due to widespread community opposition. Furthermore, there have been shifts from regular utility cycling (which yields the greatest health benefits) to leisure cycling, and in the average age of cyclists, with considerably fewer children now riding.

Claim: “Cycle helmets could prevent 90% of fatalities”[53]. This prediction comes from a single source and is not reflected by real-world experience. Fatality trends in countries where helmet use has become significant give no reason to believe that helmets have saved lives. In 1985 Dr Dorsch, the report's principal author, told an Australian parliamentary committee that the conclusions of the study should be treated with care. She said, "That was a hypothetical procedure based largely on an adult group of cyclists".

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