Dear Senate Committee

Supplementary Part 2

Concerns about ACRS/AIPN/RACS Joint Submission No 257 are listed below.

1) The submission states:

By the time we reach the final year of Australia's National Road Safety Strategy 2011-2020, and assuming the 30% target reduction is reached, ***road trauma will still have cost the Australian economy a staggering $264 billion dollars over this 10 year period****.*

… and …

Traumatic brain injury *(TBI) refers to brain injury acquired through a traumatic event, such as a traffic accident or a blow to the head (AIHW, 2008). The leading causes of TBI in Australia are transport accidents, falls, collisions with objects and water related accidents.*

… and …

Conservative federal government estimates put the annual cost of road trauma to our economy at $27b (Australian Transport Council, 2011) – similar in size to our annual defence budget.

The above information being foremost in the submission supporting cycle helmet laws gives the impression that keeping the helmet law is probably justified on a cost basis. My submission No 4 page 28 provides a cost ratio calculation of 109 to 1 against the law providing a societal health benefit.

With reference to:

Helps Y, Henley G & Harrison JE. 2008. Hospital separations due to traumatic brain injury, Australia 2004–05. Injury research and statistics series number 45. (Cat no. INJCAT 116) Adelaide: AIHW http://www.aihw.gov.au/workarea/downloadasset.aspx?id=6442458806

The executive summary on TBI states:

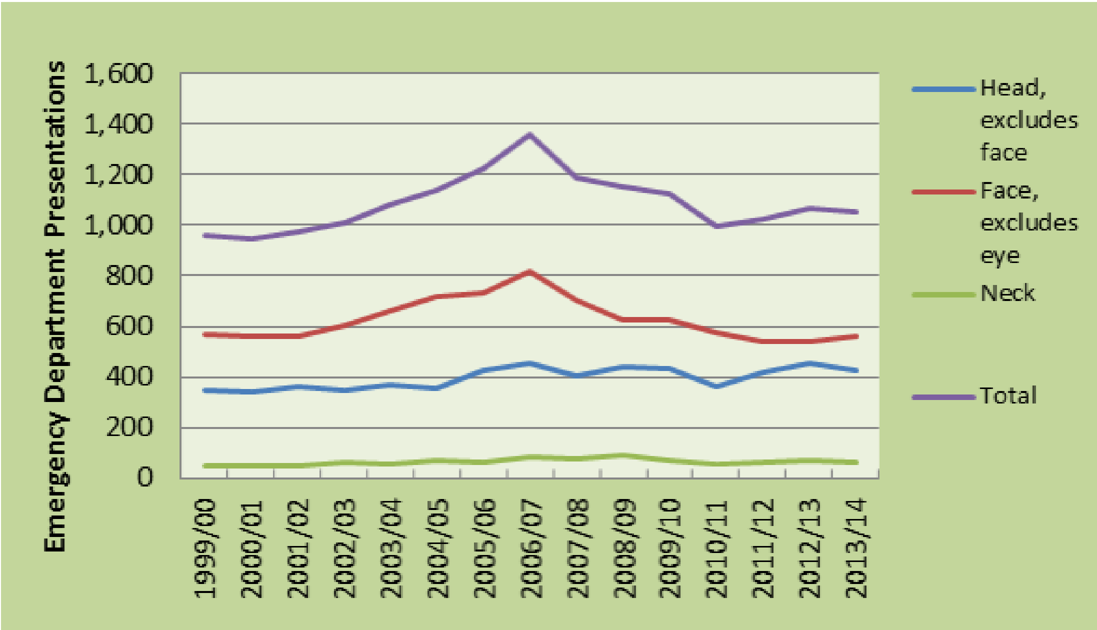
There were an estimated 22,710 hospitalisations involving traumatic brain injury in Australia in 2004–05. These hospitalisations resulted in over 26,000 episodes of inpatient care totalling nearly 206,000 days, and estimated direct costs of hospital care of $184 million.

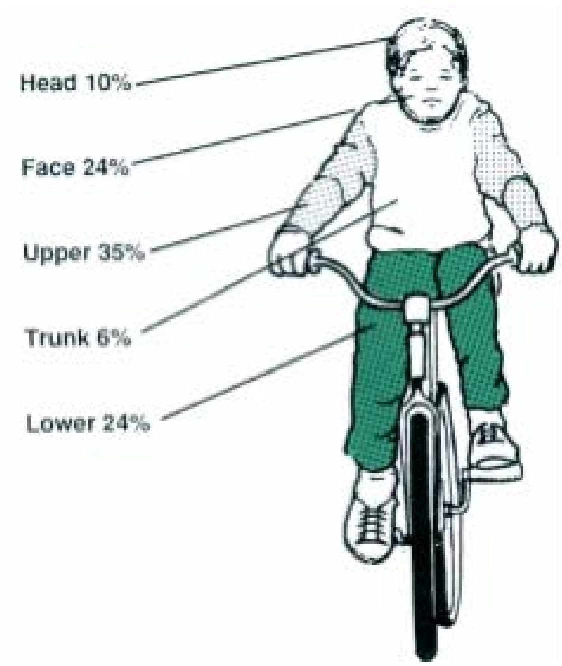
From primary diagnosis the most common causes of TBI were falls, transportation and assault. The $27 billion annual cost of road trauma appears to be approximately 147 higher than the estimated cost of TBI due to all causes. Page 26 of submission No 4 states:

2013 - the rising number of overweight Australians costs $120 billion a year ref 140 *(approximately $5200 per Australian per year).*

The $120 billion cost due to people being overweight is approximately 600 times the estimated cost of TBI due to all causes. Submission 257 presents data on costs, $27b, refers to TBI without total cost figures and ignores other costs where discouraging cycling could have an effect. Submission 257 fails to properly convey the proportional significance of the data.

2) Submission 257, part 2.2, shows data in Fig 3 *(Figure 3:* Annual Emergency Department Presentations for Cyclist Head, Face and Neck injuries, copied below). For year 2006/07, head injuries roughly comprise 470 cases (blue line) and face 810 (red line). Data from Victoria for children prior to legislation shows head to be approximately 10% of injuries and face 24% (head to face ratio 10/24=0.417 see submission No 4 page 4). By proportion from 810 face injuries, head injuries would be expected to be approximately 337 (0.417 x 810=337) but are higher at 470. For year 2012/13, head injuries are approximately 470 to face 550, a much higher proportion than VISS reported in 1990 (0.854 v 0.417). Submission 257 fails to display the proportions of head/face/neck injuries prior to legislation. The ratio of head to face seems to have increased.





3) Submission 257, Part 2.2 includes:
*This is significant research evidence from respected researchers, in essence finding that crashes relating to non-helmet cyclists are costing **three times** as much in terms of resultant medical care as for those crashes relating to cyclists who were wearing a helmet.*

The claim comes from a letter by Dinh et al **(2013, May 6** *Medical Journal of Australia letter to the editor*. Retrieved August 21, 2015, from [http://acrs.org.au/wp-content/uploads/Dinh-Curtis-Iversletters_060513_fm-41.pdf)](http://acrs.org.au/wp-content/uploads/Dinh-Curtis-Iversletters_060513_fm-41.pdf) and refers to Sydney/NSW data.

In the table provided it shows the costs for helmeted v non-helmet (median cost (IQR), AU$1000 6.5 (2.8–10.7) 5.6 (2.5–15.2)). The medium cost was lower at $5600 for non-helmeted cyclist compared with $6500 for helmeted. Therefore, the above claim is incorrect.

Characteristics of cyclists and motorcyclists with head injuries, by helmet use

	Cyclist (*n* = 110)			Motorcyclist (*n* = 238)		
Characteristic	Helmet (*n* = 70)	Non-helmet (*n* = 40)	*P*	Helmet (*n* = 206)	Non-helmet (*n* = 32)	*P*
Demographic						
Median age (IQR), years	41 (29–53)	35 (23–44)	0.02	31 (24–43)	25 (21–38)	0.06
Male	64 (91%)	35 (88%)	0.51	194 (94%)	31 (97%)	0.53
Incident details						
After hours*	25 (36%)	14 (35%)	0.94	65 (32%)	14 (44%)	0.17
Location†						
Inner Sydney	21 (30%)	11 (28%)		40 (19%)	13 (41%)	
Suburban Sydney	26 (37%)	20 (50%)		76 (37%)	11 (34%)	
Regional/rural	23 (33%)	9 (23%)	0.37	91 (44%)	8 (25%)	0.02
Injury severity						
Median ISS (IQR)	9 (5–14)	9 (5–21)	1.0	9 (5–17)	15 (5–25)	0.15
Multiregion injury (%)	46 (66%)	29 (73%)	0.46	153 (74%)	21 (66%)	0.32
ICU	11 (16%)	7 (18%)	0.81	47 (23%)	12 (38%)	0.07
Outcomes						
Head injury	27 (39%)	30 (75%)	< 0.001	68 (33%)	14 (44%)	0.23
Severe head injury	6 (9%)	9 (23%)	0.04	26 (13%)	9 (28%)	0.02
Diffuse axonal injury	0	0	na	5 (2%)	3 (9%)	0.08
Rehabilitation‡	3 (4%)	6 (15%)	0.07	35 (17%)	4 (13%)	0.53
Median cost (IQR), AU$1000	6.5 (2.8–10.7)	5.6 (2.5–15.2)	0.91	7.7 (3.0–20.7)	11.4 (4.4–41.0)	0.05

ICU = intensive care unit admission required. IQR = interquartile range. ISS = Injury Severity Score. na = not applicable. * Recorded incident times between 19:00 and 07:00 hours. † Postcode of location of incident was used to classify incident locations in the inner Sydney (within 10 km of central business district), suburban Sydney (bounded by Hornsby to the north, Royal National Park to the south and Penrith to the west), and regional and rural regions of New South Wales. ‡ Discharge from hospital to a rehabilitation facility.

The letter states:
For the 50 patients with severe head injury, inhospital costs (AUD) were around three times higher in non-helmeted patients (median, $72 000; interquartile range, $33 000–$140 000) compared with helmeted patients (median, $24 000; interquartile range, $15 000–$60 000) (P =0.02).

The 50 cases included 15 cyclists and 35 motorcyclists. The median cost for non-helmeted motorcyclists is shown as $11,400, more than twice the cost of non-helmeted cyclist.

My submission No 4, Table 19 provides comparisons for no helmet to helmeted for NSW cyclists. Major differences can be seen in the age grouping, drinking alcohol (BAC over 0.5) and disobeying traffic controls. These differences affect both the accident rate and head injury rate. See http://www.cyclehelmets.org/1262.html#347

The letter mentions:
Limitations to our study include the small number of patients with severe head injury, and the inability to control for other incident factors such as speed, collision details and intoxication.

Submission No 4, page 18 mentions fatality information for NSW:
Between 1996 and 2011, of known cases who had been drinking alcohol, 10 were helmeted and 12 were without helmet [91]*. Nine of the 12 non-helmeted cyclists had a Blood Alcohol Content (BAC) of 0.150 or above and only one of the 10 helmeted had this level. Six of the 10 helmeted had low levels of between 0.001-0.019. Of known cases, 10% of helmeted and 29% of non-helmeted had been drinking. For pedestrians, around 30% of fatalities involve a pedestrian with a blood alcohol concentration of 0.05 or more* [92]*.*

Speed has also been found to be a significant factor in the risk of head injury - see page 21 Submission No 4, ref 110, Biegler P, Newstead S, Johnson M, Taylor J, Mitra B, Bullen S, Monash Alfred Cyclist Crash Study (MACCS), MUARC Report 311, 2012.
http://www.monash.edu.au/miri/research/reports/muarc311.html

Two important factors in head injury risk are alcohol and speed and information on both are not available. From circumstantial evidence it appears likely that factors other than helmet use may have influenced the head injury rates.

Parts 2.1 and 2.2 of submission 257 give the impression of high national costs resulting from TBI to cyclists when less than 1/5000 of the total road trauma costs could be the actual cost.

4) Submission 257, Part 2.3 Australian National Cycling Strategy 2011-2016
Quality cycle training can lead to fewer accidents and could form an important part of educating cyclists and other road users in how to avoid dangers.

5) Submission 257, Part 2.5 includes *Effect of helmet legislation on head injury rates.* Reference to reports by Bambach, *et al* 2013, Newstead, *et al* 1994, Walter *et al* 2011, Olivier *et al* 2014 are provided and concludes with:

Australian and international research has demonstrated that introduction of bicycle helmet legislation was followed by a reduction in the number and severity of head injuries to cyclists (Haworth et al, 2010).

Details about the Haworth et al, 2010 report on pages 22, 35 and 43 of submission No 4 provides information that indicates helmet wearers may have a higher fall rate that results in less severe injuries on average than from motor vehicle accidents. Notably the proportion of arm injuries increases due to fall alone type accidents (Whately 1985, ref 10, No 4 submission).

In 1998 the European Cycling Federation [129] stated that "the evidence from Australia and New Zealand suggests that the wearing of helmets might even make cycling more dangerous". (ref 129 Submission No 4).

Erke and Elvik 2007 examined research from Australia and New Zealand and stated:
"There is evidence of increased accident risk per cycling-km for cyclists wearing a helmet. In Australia and New Zealand, the increase is estimated to be around 14 per cent." (ref 106 Submission No4)

The Newstead et al 1994 report provides details about serious injuries in Table 4 - see below and page 20 in Submission No 4, part (1)

TABLE 4
PERCENTAGE REDUCTIONS IN SEVERE BICYCLIST CASUALTIES RELATIVE TO 1989/90 FINANCIAL YEAR
MELBOURNE : TAC CLAIMS

Financial Year	Bicyclists with head injuries	Bicyclists without head injuries
1990/91	36%	4%
1991/92	64%	12%
1992/93	40%	35%

Cycling was generally reduced by 36% in Melbourne (Cameron 1992 http://www.monash.edu.au/miri/research/reports/muarc032.pdf) compared to the reported 4% reduction in serious injuries. The highest risk group for TAC cyclist claims were aged 12-17 years and their cycling levels reduced in Melbourne by approximately 45% - 48%. The data indicate there was an increase in risk of serious injury for Melbourne cyclists, relative to cycling levels. The 1994 report made no allowance for changes in cycling levels and no calculations on risk per km cycled. It provides no proof of a net safety benefit from the helmet law. By 1992/93 the reduction in bicyclists with head injuries at 40% was similar to bicyclists without head injuries at 35%. Data reported for Victoria shows that road fatalities reduced from 776 in 1989 to 396 in 1992. Serious injuries to pedestrians reduced from 1152 in 1989 to 799 in 1992. Major changes occurred that would also have affected injury rates for cycling.

The Walter *et al* 2011 report is considered at http://www.cyclehelmets.org/1228.html

Summary

According to its authors, this paper ends the debate about the effectiveness of cycle helmet legislation. Lead author Jake Olivier claims that this analysis shows that rates of head injuries reduced by almost a third after the New South Wales law was introduced.

However, the BHRF has identified flaws in the dataset and methods used by Walter et al. The legislation did not lead to a material reduction in serious head injuries to cyclists.

Other concerns are mentioned;

Rissel also criticises the authors for refusing to open up their data for independent scrutiny.

…and

In Victoria, surveys show that the reduction in teenage cycling (48%) was much greater than the decline in adult cycling (29%, Robinson, 1996) and the same appears to be true in NSW. Given that age (or age group) has a considerable influence on the risk of head injury, this should have been accounted for in the analysis of Walter et al.

The Bambach et al 2013 paper is considered on pages 21/22 of Submission No 4.

The Olivier *et al* 2014 paper mentions *"The helmet is the most controversial topic in all of cycling"*. Olivier et al use methods that ignore the important details about weather and changes to counting criteria for adults at recreational sites to arrive at invalid comparisons in Table 1. Details in the 2014 paper are considered in Supplementary part 3.

The reports by Bambach et al 2013, Newstead et al 1994, Walter et al, 2011, Olivier et al 2014 and Haworth et al, 2010 use comparison methods that are based in large part on the proportion of head to other injuries and not the actual risk per km cycled.

On page 29 of submission 257 it refers to\;
Other research from the Monash University Accident Reasearch Centre identified that while there was an initial reduction in the number of people cycling in Victoria following the introduction of helmet legislation, within two years the number of bike riders had returned to levels similar to what had been observed prior to the legislation for adult and child cyclists (Finch et al, 1993).

Considering that the surveys published were for Melbourne and not the whole of Victoria and considering the details provided in the first part of supplementary submission No1, it shows the above statement is invalid.

6) Submission 257, Part 2.6 The importance of protecting children.

Robinson 1996 paper provides details of the equivalent number of injuries for pre law numbers of child cyclists, for NSW and Melbourne. See Tables 2 and 5 copied below.

Robinson DL; Head injuries and bicycle helmet laws; Accid Anal Prev, 28, 4: p 463-475, 1996 http://www.cycle-helmets.com/robinson-head-injuries.pdf

Table 2. Injuries of cyclists under 16 admitted to hospital in NSW (Source NSW Health Department) compared with estimated amount of cycling

Year to end June	No of head injuries (*H*)	No of non head injuries (*O*)	No of cyclists (Proportion of 1991) (*N*)	Equivalent no of injuries for pre law numbers of cyclists	
				Head injury (= *H*/*N*)	Other injury (=*O*/*N*)
1989	414	908			
1990	453	1053			
1991	384	926	1.00	384	926
1992	272	815	0.64	425	1273
1993	273	893	0.56	488	1595

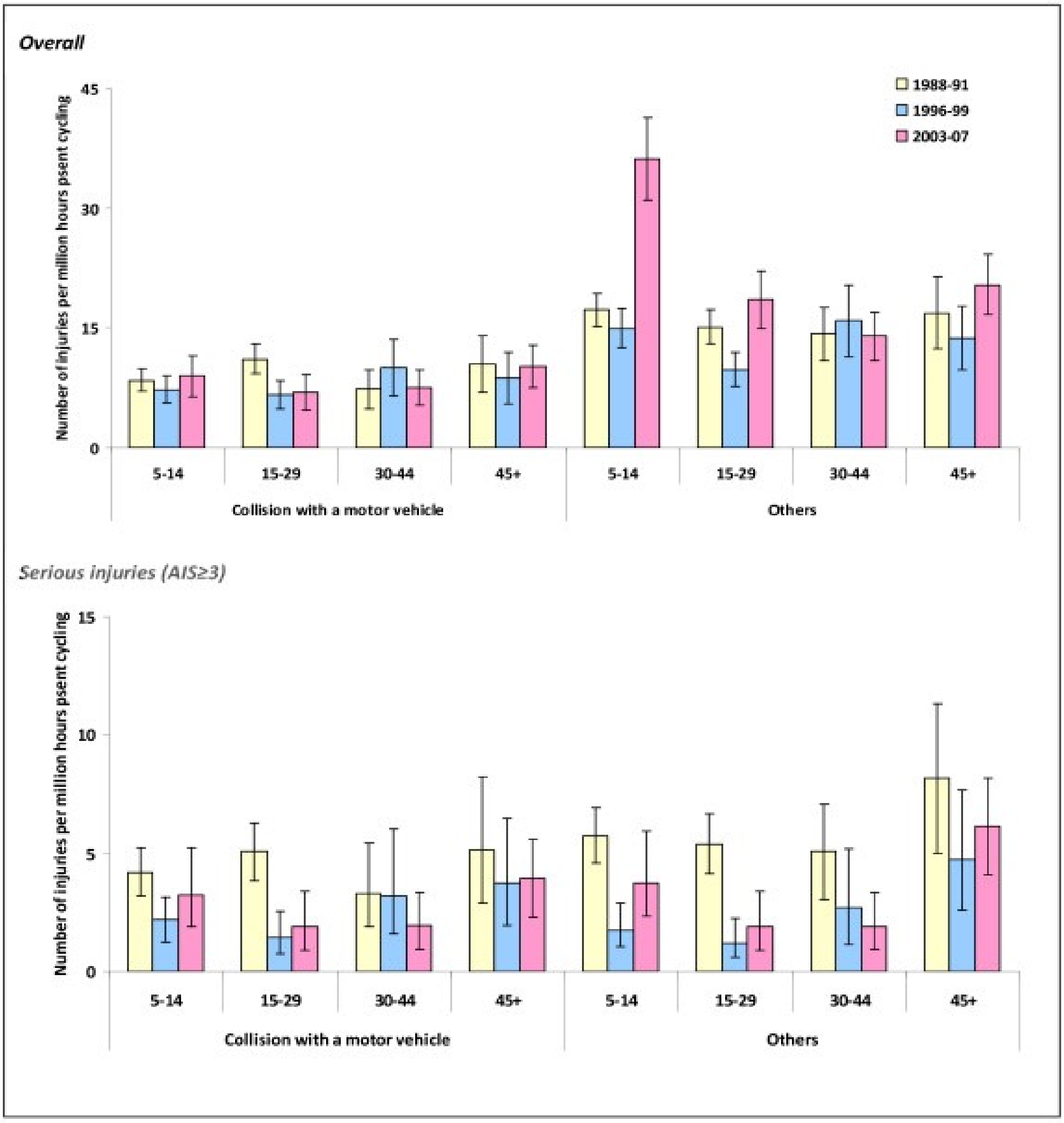
Table 5. Children's cycling activity and bicycle injuries, Melbourne (VISS injury data)

Year to end June	Proportion of 1990 cycle use (*N*)	Total cycling injuries, (*C*)	Total head injuries (*H*)	Equivalent no of injuries for pre law cycle use	
				All injuries (=*C*/*N*)	Head injury (=*H*/*N*)
1990	1.00	809	88	809	88
1991	0.67	628	60	937	90
1992	0.64	604	58	944	91
1993	n/a	633	63		

From NSW and Melbourne the combined accident and survey data indicates an increased risk to children compared with the cycling levels.

Results from New Zealand reported *"The highest rate of cycling injuries was observed among the 5-14 year olds (Figure 1). In this age group, from 1996-99 to 2003-07, there was a substantial increase in injury risk from crashes not involving a motor vehicle*. Figure 1 is copied below. (Injuries per million hours spent cycling). Additional NZ information about the increased risk are provided in supplement No 3.
Ref http://www.biomedcentral.com/1471-2458/10/655/figure/F1

Tin Tin S. Injuries to pedal cyclists on New Zealand roads, 1988-2007. BMC Public Health 2010;10:655. http://www.biomedcentral.com/1471-2458/10/655



Results for children from Australia and New Zealand are similar with a higher accident rate in proportion to cycling levels. One factor that may contribute is concerning balance and control. The control of head movements during human balance corrections has been considered by researchers:

Allum , J.H.J.; | Gresty , M. | Keshner , E. | Shupert , C. The control of head movements during human balance corrections http://content.iospress.com/articles/journal-of-vestibular-research/ves7-2-3-09

They reported:
"*Evidence consistent with a role for the vestibular system was found in other experimental paradigms in which the head was perturbed directly. In these paradigms the VCR modulates the amplitude of functionally stabilizing responses and damps mechanically induced instability of the head and neck*".

In brief, the steadier the head with better balance and control.

Attaching details of a 1986 paper concerning bicycle helmet vibrations and relation to helmet dislodgement during normal road use. You will see in Table 1 vibrational accelerations of up to 100m/s^2 occurred (10g approximately) from riding speeds of 15-25km/hr and hitting deep potholes. Up to 30m/s^2 occurred (3g approx.) for other situations. A force of 65N is referred to and is about equivalent to 6.6kg under normal gravity, (1g = 9.81, x 6.6 = 65N, i.e. 1kg relates to a force of 9.81Newtons, http://www.convertunits.com/from/kg/to/N). Most helmets today are lighter than used in the 1986 tests and on average lower forces may occur.
Appendix A - Mathieson J D, and Coin C D A, 'Bicycle Helmet Vibrations and Relation to Helmet Dislodgement during normal road use'. Paper No 23, Bikesafe Conference, Newcastle, Australia, 1986.

When hitting an unseen pothole, say for example 300mm wide and travelling at 25 km/hr (6,9m/s), the wheel would cover the distance in 0.043s (0.3/6.9 = 0.043s). The wheel would be dropping and impacting in most cases the far edge/side of the pothole. A rider's reaction time may be about 0.15s, more than twice the time to cover the pothole width in the example. A helmeted rider will have extra forces that may be in random directions and may occur before they have time to react. For children often riding at lower speeds/smaller sized wheels and more often on unsealed surfaces, they could encounter more falls due to loss of balance and by wearing a helmet this is likely to increase the rate of falls. The Erke and Elvik 2007 report detailed a 14% increased risk per km cycled from helmet use.

The UK's National Children's Bureau (NCB) provided a detailed review in 2005 stating "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".

Reference:
Gill T, Cycling and Children and Young People - A review, National Children's Bureau, 2005.
http://www.cycle-helmets.com/cyclingreport_timgill.pdf accessed 25.9.2014

Imposing a legal requirement for children or adults to wear helmets and knowing there is a reasonable doubt and evidence showing that the accident rate may increase is offensive to human rights. Apart from helmet legislation discouraging many children from cycling and having health consequences, their safety appears to have been reduced by incurring a higher accident rate per km or per hour of cycling.

7) Submission 257, Part 2.7 Perceptions around cycle helmet regulation included:

Bicycle helmets are designed to mitigate head injury during a collision. In the early 1990s, Australia and New Zealand mandated helmet wearing for cyclists in an effort to increase helmet usage. Since that time, helmets and helmet laws have been portrayed as a failure in the peer-reviewed literature, by the media and various advocacy groups. Many of these *criticisms claim helmets are ineffective, helmet laws deter cycling, helmet wearing increases the risk of an accident, no evidence helmet laws reduce head injuries at a population level, and helmet laws result in a net health reduction.*

Whereas New Zealand provided details on average hours cycled pre law to post law, showing a reduction from 11.4 to 6.9, down by 39% (Table 3, http://www.cycle-helmets.com/nz-clarke-2012.pdf). Australia has not taken sufficient care to monitor the consequences. Many of the criticisms are supported by detailed research and are based on sound evidence.

8) Submission 257, Part 2.8 - Surveys of public attitudes around the wearing of helmets.

Some surveys indicate support for cycle helmet legislation but the Australian public has been subject to repetitive publicity promoting helmets using questionable claims since the early 1980s, approximately 35 years. The perception has always been that they may provide some protection in the event of an accident, so support might be expected and voluntary wearing rates suggest that many would wear helmets by choice. Helmet promotion by its nature involves focusing on serious risk and enforcement requires justifying the requirement, again by focusing on risk.

Submission 257 claimed;

Most importantly, the removal of helmet regulation would result in an increase cost to the nation and a decreased level of public health

The evidence from detailed reports shows that the overall risk of accident increased per km cycled with mandatory helmet use. Repealing the laws would result in both improved public health and potential safety improvements, together with a restoration of personal liberty. The cost ratio calculation of 109 to 1 against the law providing a societal health benefit uses a formula provided by Professor Piet de Jong and provides a reasonable estimate, except it does not relate to the increased risk element. The 20:1 health to risk ratio between earned and lost years from cycling (2 years life expectancy gained for the improvement of public health of the cyclists against 36 days lost due to accidents) indicates why it is far more important that cycling is not discouraged than having a legal requirement to wear helmets. Submission No 133 by Professor Chris Rissel provides many references concerning health and cycling, including details of the 20 to 1 factor in Table 2.

Cont.

Appendix A

SUBJECT BICYCLE HELMET VIBRATIONS AND RELATION TO HELMET DISLODGEMENT DURING NORMAL ROAD USE

AUTHORS J.G. MATHIESON and C.D.A. COIN

INTRODUCTION

Bicycles have very limited suspension in the normal sense of having springs and shock absorbers. Road vibrations and more major shocks from potholes, etc. are transmitted to the rider with little attenuation from the tyres, frame, seat and handlebars. In fact, it is quite likely that the vibrations transmitted to the head of a pedal cyclist may be greater than those to a motor cyclist.

It was the intention of this work to determine the forces acting on a bicycle safety helmet on a cyclist's head during normal use. Knowledge of these forces can then be used to determine the resistance to forward rotation which must be designed into helmet retention systems to prevent dislodgement to impede forward vision.

This study was initiated to provide information to the Standards Association of Australia and other bodies involved in designing tests of the effectiveness of bicycle helmet retention systems.

EXPERIMENTAL

Standard stainless steel accelerometer anchorage points were fixed to the top and rear of an MSR bicycle safety helmet using epoxy cement. A Bruel and Kjaer, Type 2513 portable Integrating Vibration Meter was used to display the peak accelerations (m/s^2) of the helmet.

In preliminary tests both accelerometer positions were used to assess the response, (i) while the head was shaken up and down, and (ii) during a test where the head was allowed to fall forward and then sharply retarded over 10 mm or less at a forward, horizontal position. These tests showed that both measurement positions gave similar peak acceleration readings in the range 20-30 m/s^2 for fairly vigorous head shaking and up to 100 m/s^2 in the retardation shock. For all subsequent tests the rear position was used since it is probably better related to forward rotation of the helmet.

For the on-bicycle tests, the Vibration Meter was strapped to the handlebars adjacent to a Cat-Eye bicycle computer. This allowed both bicycle speed and helmet acceleration to be measured simultaneously. The helmet retention system was optimally adjusted to give a secure but comfortable fit.

RESULTS

The results of the helmet acceleration measurements are summarised in Table 1.

TABLE 1

PEAK ACCELERATION OF A BICYCLE SAFETY HELMET UNDER NORMAL ROAD USE

Condition of Riding Surface	Speed (km/h)	Acceleration (m/s^2)
Smooth pavement	25	2 - 3
Rough flush seal (bitumen)	25	5 - 7
Pot-holed gravel	15	15 - 30
Speed hump (100 mm high)	20	10 - 30
Concrete kerb ramp (50 mm depression)	11	10
	25	20 - 30
Larger hazards (deep potholes, etc.)	15-25	100

CONCLUSIONS

The results indicate that bicycle safety helmets suffer accelerations up to 30 m/s^2 under normal riding conditions. The direction of these accelerations appears to be fairly random. During more major shocks, accelerations of 100 m/s^2 can be encountered.

In assessing the forces involved on the helmet, the worst case would consider the head in a forward horizontal position with gravitational acceleration aiding vibrational acceleration. Thus 9.8 m/s^2 can be added to the values obtained.

For the worst case, using 40 m/s^2 and 450 to 600 g as the typical range of helmet mass, the forces involved in moving the helmet under normal road vibrations are thus up to about 18 to 24 N. These are therefore the minimum forces to be considered in any test to ascertain the likelihood of forward helmet dislodgement to obscure the vision.

From the results for the more major shocks, it appears that 65 N should be set as the minimum force to be considered for a forward rotation test involving helmet removal.

At this stage measurements have been made only by a single rider using a single helmet model. It is recommended that this work be extended to cover a greater variety of riders and helmets. It is also recommended that the instantaneous vibrational waveforms be studied to separate action and reaction.

ACKNOWLEDGEMENT

The authors wish to thank Dr Lawrence Leung of BHP Central Research Laboratories for assistance with equipment and interpretation.