Submission
No 54

INQUIRY INTO VULNERABLE ROAD USERS

Organisation: NSW Injury Risk Management Research Centre (IRMRC)

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Submission to Staysafe Committee on Research Relating to Vulnerable Road Users.

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Overview

This submission is made on behalf of the NSW Injury Risk Management Research Centre (UNSW) in response to a request from the Staysafe Committee. It is based on research relating to Vulnerable Road Users that has been conducted at the Centre over the past few years. The two areas of research that the IRMRC have been involved in that may be of use to the committee relate to motorcycle into roadside barrier fatalities and cyclist injuries and fatalities. Part 1, which presents material concerning motorcycle fatalities resulting from impacts into roadside barriers and motorcycle safety in general, was prepared by Prof. Raphael Grzebieta, Dr Michael Bambach and Ms Rena Friswell. Part 2 presents material relating to cyclist injuries and fatalities and was prepared by Dr. Julie Hatfield, Dr. Shanley Chong and Prof. Raphael Grzebieta.

PART 1: NSW IRMRC SUBMISSION ON MOTORCYCLE SAFETY AND IMPACTS INTO SAFETY BARRIERS

General Motorcycle Fatality and Injury Data:

After dramatic reduction in the late 1980's and early 1990's, motorcycle fatalities in Australia have been rising over the past decade as shown in Figure 1. They are increasing at an average of 5.7% per annum[1]. Of particular alarm is the rise in single vehicle motorcycle crashes. They have almost doubled between 2003 and 2008, rising from 61 to 110 deaths[2]. Single vehicle motorcycle crashes include impacts into roadside barriers.

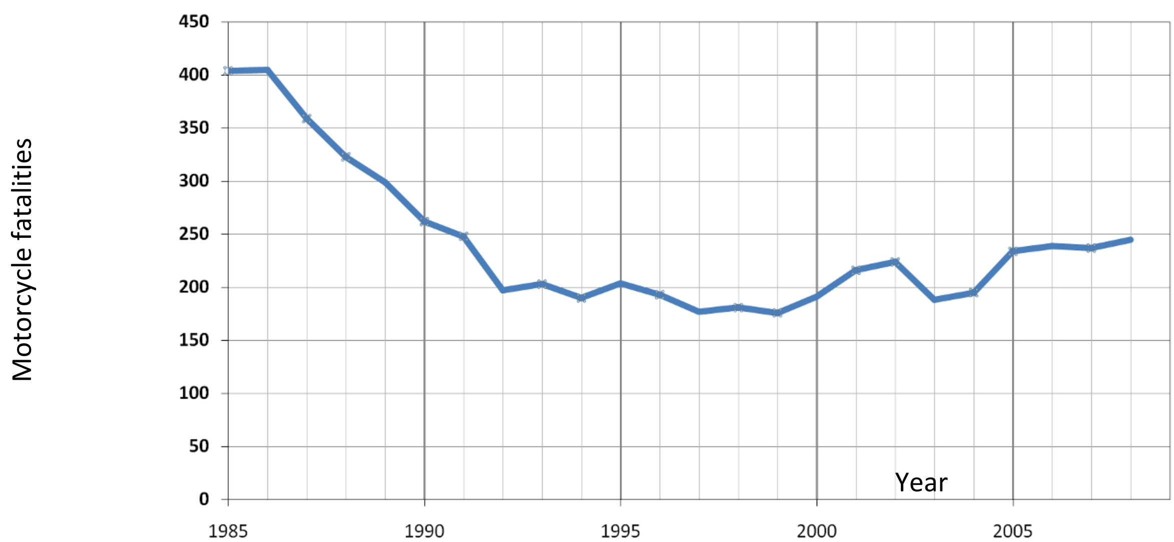

Figure 1: Motorcycle fatalities[2]

[1] Australian Bureau of Statistics. Motor Vehicle Census Australia, Census data: Oct 1999 and each year from March 2001 to March 2007. [Accessed 15 May, 2009]; Available from: www.abs.gov.au.

[2] Department of Infrastructure, Transport, Regional Development and Local Government, Road Deaths Australia : 2008 Statistical Summary, ISBN 978-0-642-25595-2, May 2009.

The increased numbers of motorcycle crashes are likely in part to be the result of an increase in motorcycle registrations. Australian Bureau of Statistics (ABS) data on motorcycle registrations in Figure 2 indicate the number of motorcycle over the past decade has almost doubled, a trend which can be expected to continue with increases in fuel costs, parking costs, and traffic density. Motorcycles, and more recently scooters, are perceived as a viable alternate mode of transport to cars. Thus, motorcycle safety is likely to become an increasingly important focus for road safety researchers and practitioners, particularly because motorcycle crashes are typically severe.

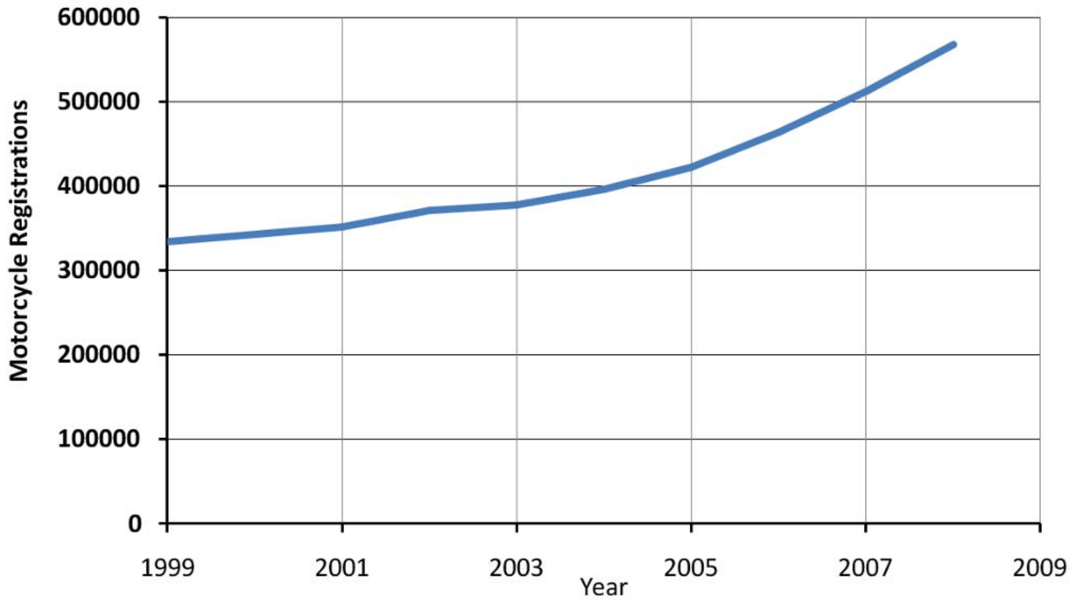

Figure 2: Motorcycle registrations in Australia

This submission presents the key results of research investigating in particular motorcycle crashes into roadside safety barriers. The material is extracted essentially from a research paper published last year in the Journal of the Australasian College of Road Safety.[3] Some of the statistics have also been extracted from a Flinders University report by Henley and Harrison.[4] It refers to Australia in general albeit there is a breakdown of some of the findings for NSW.

In 2007 in Australia:

- the proportion of registered vehicles on the road that were motorcycles was 4.5%, however the proportion of the total number of road user fatalities that were motorcyclists was 15%. Motorcycle fatalities are over represented in terms of road crash fatalities.

[3] Grzebieta R.H., Jama H., McIntosh A., Friswell R., Favand J., Attard M., Smith R., (2009) Overview of Motorcycle Crash Fatalities Involving Road Safety Barriers, Journal of the Australasian College of Road Safety, November, Vol. 20 No. 4, pp. 42 – 52. (also published in Proceedings Road Safety Research, Policing and Education Conference, Sydney, Australia, November 2009), http://www.acrs.org.au/srcfiles/ACRS-Journal-20No4Web.pdf

[4] AIHW: Henley G and Harrison J.E., 2009, Serious injury due to land transport accidents, Australia 2006-07, Injury and statistics series No. 53. Cat. N. INJCAT 129. Canberra: AIHW.

- the number of fatalities per billion vehicle kilometres travelled was 3.9 for cars and 116.9 for motorcycles - motorcyclists were 30 times more likely to be killed than car occupants per distance travelled;

- the number of serious injuries (non-fatal injury requiring hospital admission) per 100 million vehicle kilometres travelled was 10.3 for cars and 385 for motorcycles - motorcyclists were 37 times more likely to be seriously injured than car occupants per distance travelled;

- the serious injury rate per 100,000 population (age-standardised) for motorcyclists was 35.3, and has increased steadily from 24 in 2001. Actual case numbers of seriously injured motorcyclists increased from 4,642 in 2001 to 7,303 in 2007 (an increase of more than 50% in only 6 years).

In NSW,

- in 2007, the number of serious injuries per 100 million vehicle kilometres travelled was 10.8 for cars and 370 for motorcycles - motorcyclists were 34 times more likely to be seriously injured than car occupants per distance travelled;

- in 2006, the proportion of registered vehicles that were motorcycles was 2.86% as shown in Table 1;

State	Total Vehicle Population	Motorcycle Population	Proportion of motorcycles (%) [a]
Australian Capital Territory	224 076	8 022	3.58%
New South Wales	4 268 631	122 211	2.86%
Northern Territory	114 015	3 950	3.46%
Queensland	2 897 867	110 501	3.81%
South Australia	1 137 957	33 772	2.97%
Tasmania	374 846	10 488	2.80%
Victoria	3 740 726	114 438	3.06%
Western Australia	1 600 566	59 675	3.73%
New Zealand	3,308,142	49,283	1.49%
Total	**14 358 684**	**512, 340**	**2.90%**

[a] Motorcycles as a proportion of the population of registered motor vehicles

Table 1: Population of vehicles and motorcycles in Australian jurisdictions and New Zealand in 2006

The percentage of Australia's road fatalities that are motorcyclists has increased over the last decade and is much higher as a percentage of road users than in the USA and New Zealand as shown in Figure 3.

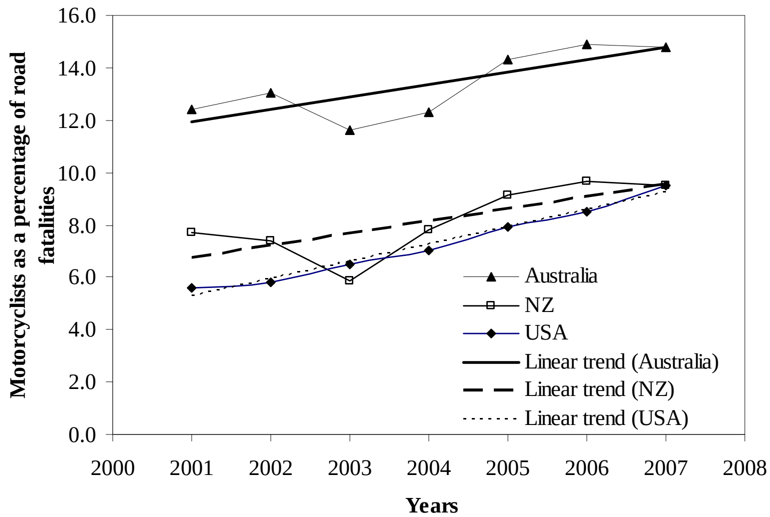

Figure 3: Motorcyclists as a percentage of all road fatalities in Australia, NZ and the USA
(Data sources: Australian Bureau of Statistics, NZ Crash Analysis System and US Fatality Analysis and Reporting System)

In NSW between 2001 and 2006, there were 335 motorcycle fatalities, of which 7.7% are known to have occurred as a result of a collision with a roadside barrier.

State	Total MC fatalities	Barrier related MC fatalities	Non-barrier MC fatalities	Not known	Barrier/ Known (%)	CI 95%
Australian Capital Territory	21	4	17	0	19.0%	0.077 – 0.400
New South Wales	335	23	277	35	7.7%	0.052 – 0.112
North Territory	19	0	0	0	0%	----
Queensland	266	13	251	2	4.9%	0.029 – 0.082
South Australia	121	13	108	0	10.7%	0.064 – 0.175
Tasmania	48	8	40	0	16.7%	0.087 – 0.296
Victoria	309	10	299	0	3.2%	0.020 – 0.063
Western Australia	142	2	140	0	1.4%	0.003 – 0.049
Total Australia	**1261**	**73**	**1149**	**37**	**6.0%**	**0.052 – 0.080**
New Zealand	**201**	**4**	**196**	**1**	**2.0%**	**0.008 – 0.050**
Total	**1462**	**77**	**834**	**38**	**5.4%**	0.044 – 0.068

Table 2: Breakdown of motorcycle crashes in Australia and New Zealand

In Australia and New Zealand between 2001 and 2006, rider behaviour played a significant role in motorcyclist fatalities into roadside barriers. Alcohol, drugs or speed, or a combination thereof, played a role in 3 out of every 4 fatal barrier crashes as shown in Figure 4. No information has been analysed for motorcycle crashes in general for the whole of Australia, however, it is suspected that a similar trend will be observed in motorcycle crashes other than into road side barriers. Of particular note is the issue of speed as the major factor in fatalities which is not unexpected.

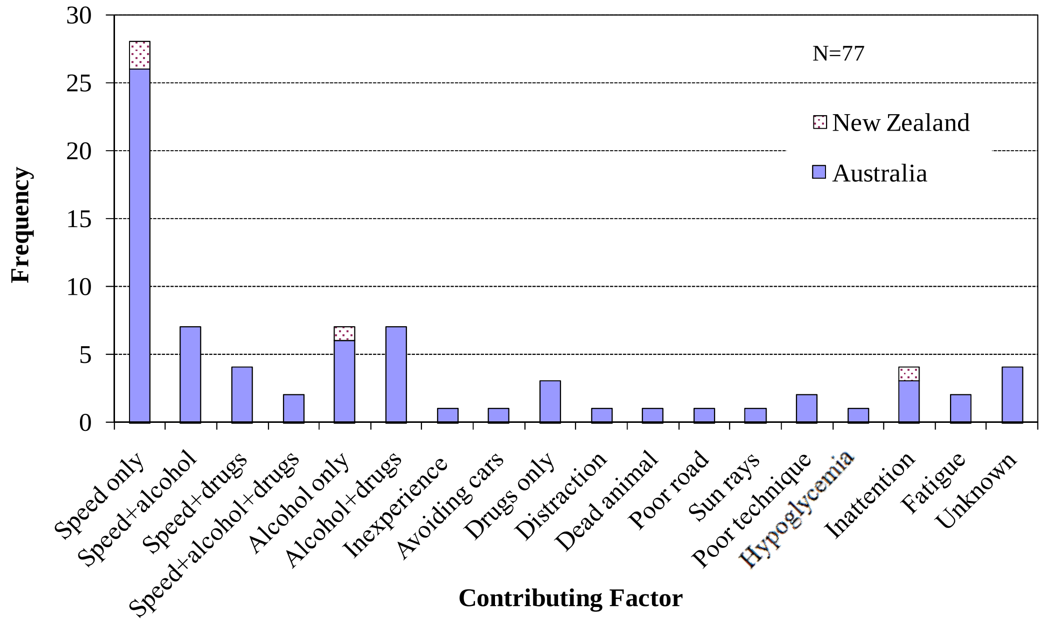

Figure 4: Crash contributory factors of motorcyclist fatalities involving a roadside safety barrier in Australia and New Zealand (2001 to 2006)

Amongst fatal motorcycle-barrier crashes in Australia and New Zealand between 2001 and 2006, the injury severity was found to be directly and linearly related to the pre-crash speed as shown in Figure 5.

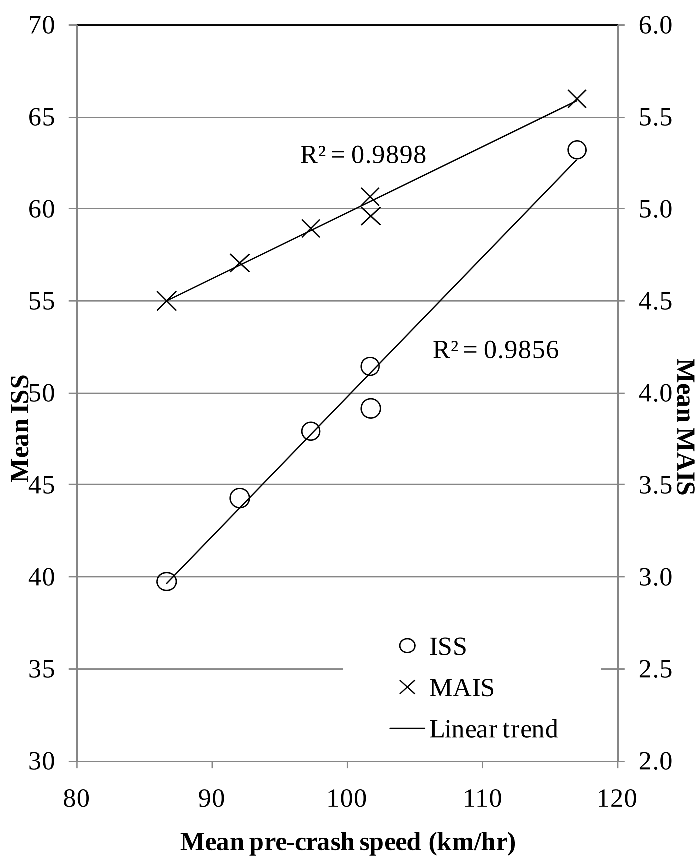

Figure 5: Mean pre-crash speeds and mean ISS (Injury Severity Score) and MAIS (Maximum Abbreviated Injury Score)

General Comments Concerning Motorcycle Impacts Into Roadside Barriers:

Wire-rope barriers appear to be a serious concern to motorcylists in Europe, US, Australia and New Zealand. The research questions that arose as a result of these recent motorcyclists' concerns regarding installation of wire-rope barriers was: 'What is the overall number of fatalities that occur involving any particular roadside barrier type and which barrier type is particularly hazardous and associated with the majority of Australian and New Zealand fatalities'. That study is ongoing in Australia and New Zealand as well as in the USA and Europe. Some published results are shown here for completeness of this submission.

Figure 6 shows the proportion of roadside barrier types struck where a motorcyclist was killed over the years 2000 to 2006. It shows that W-Beam barriers are over-represented in the impacts. There was approximately one fatality per year Australia wide in regards to wire-rope barriers, i.e. 0.4% of all motorcycle fatalities. W-beam related motorcycle fatalities constitute around 4.4% of all rider fatalities. It has been proposed by motorcycle advocates that the w-beam barriers be retrofitted with shrouds that reduce the severity of the impact. However, it is clear that any initiatives involving major design changes to roadside barriers to make them 'motorcycle friendly' when struck will be costly if applied to all roadside barriers in Australia and will have little effect on reducing motorcycle fatalities overall unless such countermeasures are targeted at specific black spots areas. For example, Figures 7, 8, 9 and 10 imply that the barrier impact fatalities are mostly the result of recreational riding, i.e. fatalities occurring on weekends, on bends, at around midday to early afternoon and on clear days. Indeed, it was noted that there were black spots at locations in windy mountainous regions where motorcycles like to enjoy their ride and apply their riding skills. Hence any countermeasures to reduce motorcycle fatalities should be targeted at black spot roads in known recreational riding areas.

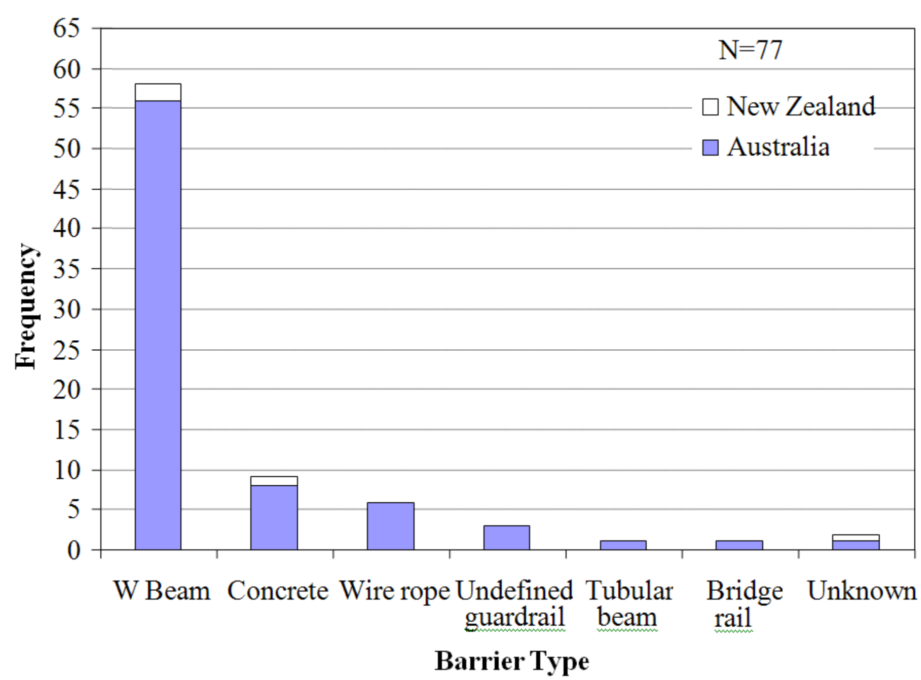

Figure 6: Roadside barrier types involved in motorcyclist fatalities in Australia and New Zealand (2000 to 2006)

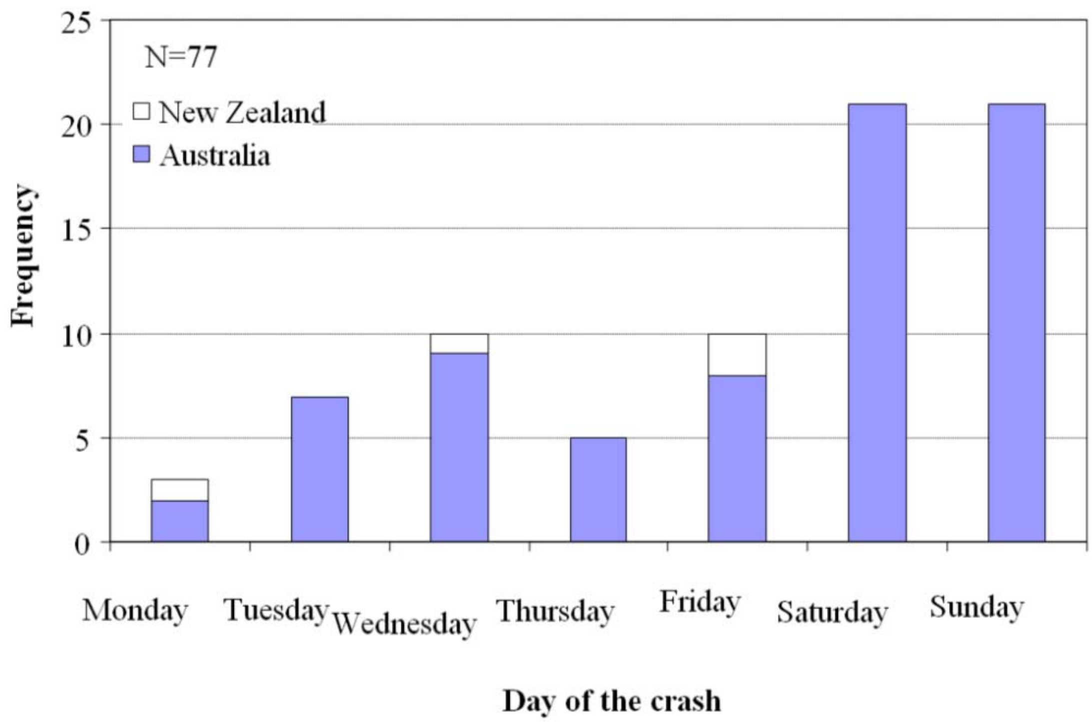

Figure 7: Day of the crash of motorcyclist fatalities involving impact into a roadside safety barrier in Australia and New Zealand (2001 to 2006)

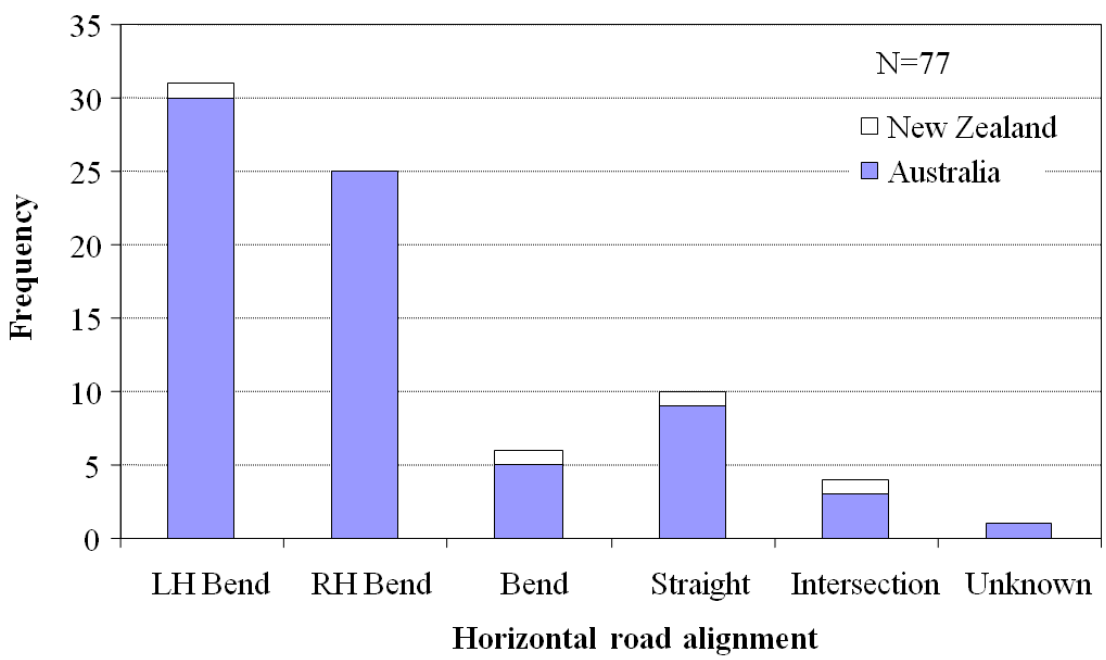

Figure 8: Horizontal alignment of roadside barrier impacted resulting in a fatality in Australia and New Zealand (2001 to 2006)

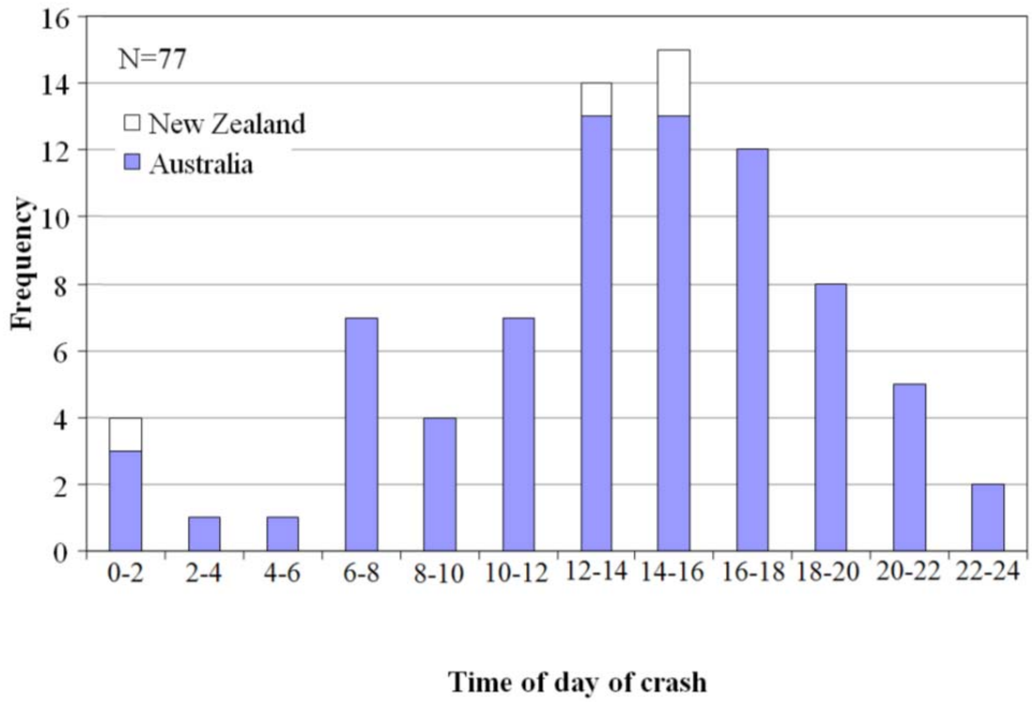

Figure 9: Time of Crash of motorcyclist fatalities involving impact into a roadside safety barrier in Australia and New Zealand (2001 to 2006)

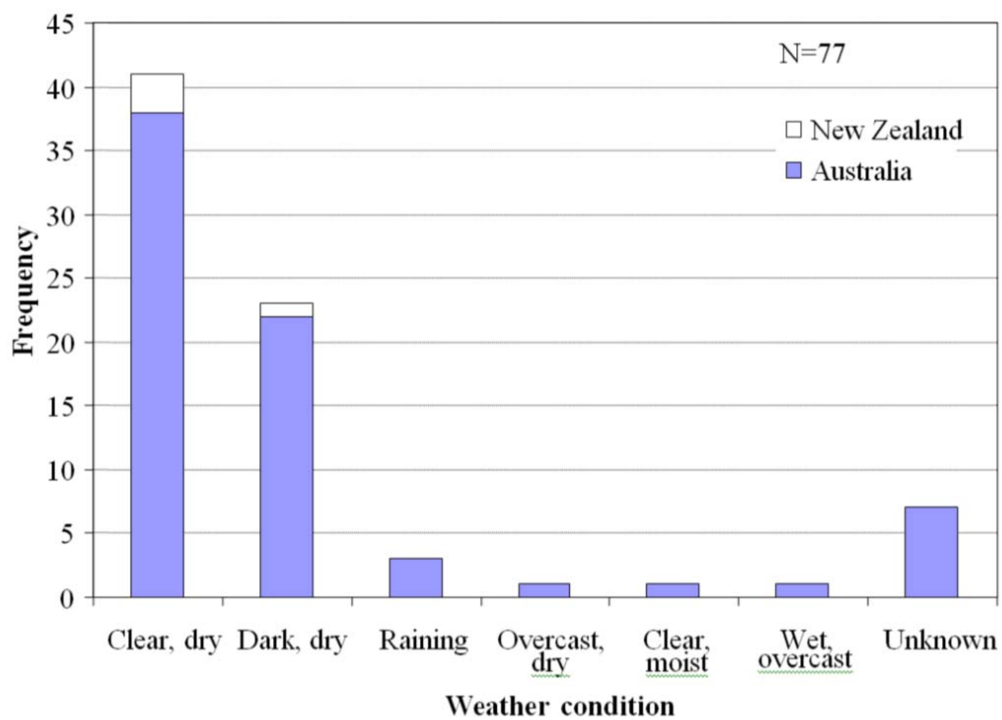

Figure 10: Weather condition at the time of a crash involving a motorcyclist fatality and a roadside safety barrier in Australia and New Zealand (2001 to 2006)

In regards to the issue of wire-rope installations, some recent work concerning the effectiveness of wire-rope barriers has also been carried out in Sweden[5]. Around 1,800 km of wire-rope safety barrier systems have been installed in Sweden. A study by the Swedish National Road and Transport Research Institute (VTI) to evaluate the in-service performance of this road safety barrier type was published in January 2009. It showed that this barrier system significantly reduces road trauma. The evaluation covered 470 km of what the Swedish researchers called “collision-free” expressways of which 336 km have a speed limit of 110 km/h. These are also sometimes referred to as 2+1 roads.

Sweden’s 2+1 roads are a category of three-lane road, consisting of two lanes in one direction and one lane in the other, alternating every few kilometres, and separated with a steel wire-rope barrier. Traditional roads of at least 13 metres width can be converted to 2+1 roads.

The evaluation also examined data from 1,275 km of 2+2 roads of which 400 km had a posted speed limit of 100 km/h. A 2+2 road is a specific type of dual-carriageway built in Sweden, consisting of two lanes in each direction separated by a steel wire rope barrier. These roads do not have hard shoulders.

The Swedish report[5] found that compared to normal 13 metre wide roads and expressways, 2+1 and 2+2 roads with a speed limit set at 110 km/h showed an overall reduction in fatalities and serious injuries of about 57% and 39% respectively. For the roads with a posted speed limit of 90 km/h, the fatalities and serious injuries were reduced by 62% and 63% on the 2+1 and 2+2 road types, respectively.

The Swedish study also looked into the road safety outcome of the 2+1 roads for motorcyclists. This was in response to complaints registered by motorcyclists concerning the safety of 2+1 roads. Fatal and seriously injured (FSI) motorcyclists were found to constitute 7.8% of the total FSI’s for this road type being slightly lower than the Swedish nationwide proportion of 9.3%. When compared to standard 13 metre wide roads (without a wire-rope median barrier) and accounting for the mileage covered by motorcyclists, the 2+1 road type showed a reduced number of killed or seriously injured motorcyclists (65-70%). Carlson points out that even when the mileage travelled by motorcyclists was reduced significantly, the 2+1 road type showed a reduction of 32% to 35% in the number of killed or serious injured motorcyclists.

A recent similar effective installation of wire-rope barriers was noted in New Zealand[6] on the Centennial Highway. Prior to installation of the barriers there were 12 fatalities and 4 serious injuries over a 10 year period (1996 – 2004). After installing median wire-rope barrier and reducing the speed limit from 100 km/h to 80 km/h there have been no fatalities or serious injuries over the past five years (2005 – 2009). Other examples demonstrating the safety benefits of installing wire-rope barriers are contained in Grzebieta et al (2009)[3]

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[5] Carlson, A., Evaluation of 2+1 roads with cable barriers. 2009, Swedish National Road and Transportation Research Institute (VTI): Linkoping, Sweden.

[6] Marsh F and Pilgrim M., (Evaluation of narrow median wire rope barrier installation on Centennial Highway, New Zealand, Journal of the Australasian College of Road Safety, November, Vol. 21 No. 2, pp. 34 – 41.

A Note on Additional Issues:

Motorcycle rider safety has received patchy research attention. Although some issues, such as risk taking and rider education and training, have received more attention than others, the knowledge base around rider safety is insufficient to underpin a comprehensive road safety strategy. Some areas are particularly under-researched, including:

1. Rider fatigue

Despite anecdotal evidence that fatigue is an issue for motorcyclists, there has been almost no scientific research conducted on this issue to inform effective road safety policy.

- Haworth and Rowden (2006)[7] concluded that the crash data sets currently available across Australia do not permit the calculation of reliable estimates of fatigue involvement in motorcycle crashes. In the data sets they examined, the estimated involvement of fatigue varied widely from 2% to 16% of crashes but none of the data sets could isolate fatigue crashes well from crashes involving other factors (e.g., speeding, alcohol, drug use, etc). Some of the data suggested that fatigue may be involved in a smaller proportion of motorcycle crashes than car crashes but other data suggested the reverse.

- Forty percent (40%) of the recreational riders participating in a small pilot study (n=20; Ma, Williamson and Friswell, 2003)[8] reported experiencing fatigue on at least half of their longer trips. In the previous 4 months, 22% reported nodding off while riding, 56% had a fatigue-related near miss and more than 50% had crossed lane lines, over- or under-steered, and/or braked late while riding fatigued. These results suggest that rider fatigue is common and contributes to potentially dangerous on-road behaviour. Confirmation in a larger, more representative group of riders is clearly called for.

- It is not known whether the development of fatigue in riders is similar to that in drivers, but there are good reasons to suspect that it may be different. Although riders and drivers share basic human vulnerabilities to circadian, sleep, and task-related contributors to fatigue, motorcycle riders are subject to unique stressors that may exacerbate or attenuate fatigue effects. These include the greater physical demands of riding compared to driving and, potentially, greater mental demands in terms of ongoing attention and vigilance. Both might increase riders' vulnerability to fatigue and performance impairment after a period of riding. On the other hand, riders might be protected from fatigue effects early in a ride by an 'adrenalin rush' that temporarily heightens their alertness. We do not know the typical time course for the development of rider fatigue. However, a pilot study of rider fatigue conducted by the NSW IRMRC (Ma et al., 2003)[8] found that self-reported fatigue started to increase towards the end of a trip with 3 hours 40 minutes of riding (interspersed with 1:10 of breaks). Reaction speed and sustained attention performance did not decline over this length of ride, but the effects of a longer ride are not known.

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[7] Haworth, N.L., & Rowden, P. (2006). Investigation of fatigue related motorcycle crashes – literature review (RSD-0261). Brisbane: Centre for Accident Research and Road Safety, Queensland University of Technology.

[8] Ma, T., Williamson, A., & Friswell, R. (2003). *A pilot study of fatigue on motorcycle day trips.* Sydney: NSW Injury Risk Management Research Centre, University of New South Wales.

In summary, there is preliminary evidence suggesting that fatigue is common, impairs riding performance and may contribute to a significant proportion of crashes. However, strategic investment in good quality research is required to properly understand the extent and nature of the problem so that targeted, evidence-driven policy responses can be developed.

2) Crash data

Research into the causes of motorcycle crash injuries is hindered by the current separation of crash information and injury information into separate data sets that are maintained by different NSW government departments. The crash data is routinely gathered by the NSW RTA in their Traffic Accident Database System (TADS) and is based upon police crash reports. Injury data is available in the NSW Health data collections (e.g., Emergency Department and Hospital Admissions data sets). An ongoing, collaborative agreement between these departments to routinely link their datasets would permit:

- better estimations of the incidence of motorcycle crashes. Not all injury crashes are reported to the police and not all crash injuries are treated in hospital. Together, the two data sets will provide a more complete profile of motorcycle crashes;

- timely analyses of the relationships between injury outcomes and crash characteristics. This will allow prevention efforts to be targeted at those crashes producing more severe injuries;

- biomechanical analyses of motorcycle crashes. Currently the IRMRC is examining fatal motorcycle crash cases in the National Coronial Information System in order to link types of injuries and types of roadside fixtures. This research will identify opportunities for improved infrastructure engineering and design to improve safety for motorcyclists. Linked RTA-Health data would allow this type of research to be extended to non-fatal injury crashes.

- similar analyses of all other types of crashes.

3) Rider behaviour

Like all crashes, motorcycle crashes often involve behavioural contributors (e.g., speed, alcohol and drug impairment etc; e.g. Grzebieta et al, 2009[3]) which may occur on the part of the rider or other road users. As a result, strategies for encouraging safer behaviour will be a necessary part of any efforts to improve the safety of motorcyclists. Of course, it is possible to legislate around some behaviours (e.g., helmet wearing, blood alcohol, speeding) and to enforce the laws with some level of success. However, the legislate-enforce model cannot realistically be expected to address all behaviours all of the time. Other strategies that target behaviour, such as education, training, and media campaigns, will also be necessary.

These strategies must be devised and targeted with a clear understanding of the rider population if they are to be effective. The motorcycling population covers the full age spectrum and contains diverse subgroups of people whose riding patterns and motivations vary (e.g., commuters versus recreational riders). Research to identify the important dimensions of this diversity must inform any strategy to improve rider safety, but particularly when the strategy targets rider behaviour. For example, recent research conducted by the

IRMRC to evaluate the RTA's 2007 direct mail campaign about safe cornering (Friswell & Williamson, 2008)[9] provided evidence of a modest (10%) increase in reported safe cornering behaviour among riders. Of interest to future interventions, however, was the finding that younger riders (17-24years) were over-represented among those who knew but did not practice the safest cornering style. In contrast, the oldest group of riders (50+ years) were over-represented among those who neither knew nor practiced the safest cornering style. Understanding this diversity leads to different recommendations about appropriate interventions for different subgroups of riders. In this example, information-based strategies are unlikely to impact younger riders who already know the appropriate behaviour but such strategies may be effective for older riders who do not. Whether an information-based strategy for older riders would be more effectively delivered via a media campaign or via a system of mandatory refresher training, however, requires investigation. Evaluation research that quantifies the impact of strategies targeting behaviour is critical to ensure that the best interventions are pursued and less effective interventions are not.

A Note on Additional Resources

Prof. Raphael Grzebieta is Chair of Road Safety at the IRMRC and is also the Chief Peer-Review Editor of the Journal of the Australasian College of Road Safety. A special issue was published last year in which Ms Liz de Rome from The George Institute for International Health was Guest Editor compiling various contributed and peer-reviewed articles concerning motorcycle and scooter safety, see: http://www.acrs.org.au/srcfiles/ACRS-Journal-20No4Web.pdf. A special issue of Accident Analysis and Prevention on Powered two-wheelers inside the traffic system will be published later this year. Prof Grzebieta and Dr Bambach have submitted a paper on the Australian study focusing on the biomechanics and survivability of motorcycle impact.[10]

9 Friswell, R., & Williamson, A. (2008). Evaluation of the direct mail component of the2007 RTA motorcycle cornering campaign. Sydney: NSW Injury Risk Management Research Centre, University of New South Wales.

10 http://www.elsevierscitech.com/pdfs/Call_for_Papers_AAP_PTW_issue.pdf

PART 2: NSW IRMRC SUBMISSION ON BICYLE SAFETY

Background

Cycling has many benefits to the individual and to the community. It is a healthy activity - one that reduces all-cause mortality and cardiovascular risk and is an important tool in the fight against the obesity epidemic. It is environmentally friendly as well: as a major alternative means of commuting, cycling can reduce carbon dioxide emissions and other pollutants, as well as reducing traffic congestion. Cycling also has economic benefits and enhances social cohesion and urban liveability.

It is gratifying to see the benefits of cycling recognised by strategies to encourage cycling that exist at all levels of government. Moreover many of these strategies explicitly recognise that if cycling is to be encouraged it is imperative to maximise cycling safety - not only as a duty of care, but also because people are more likely to cycle if they perceive it to be safe. Interestingly, some evidence suggests that as cycling rates increase cycling becomes safer – perhaps because of associated improvements in cycling infrastructure and greater awareness and acceptance of cycling.

As cyclist numbers increase, it is critical to provide a safe cycling environment in order to avoid increases in numbers of cycling casualties.

Response to Terms of Reference

a) *Patterns of usage*

Bicycle usage appears to be increasing, particularly amongst adults. However, existing data about levels and patterns of use is inadequate. The IRMRC is currently involved in a large cohort study of NSW cyclists to provide much needed data to inform policy and planning for safer cycling. Researchers hope to enrol at least two thousand cyclists to measure cycling patterns, and crash, near miss, and injury rates, over a one year period. These rates will be examined in the light of exposure (distance and duration of travel), and infrastructure utilisation. The research is being funded by an ARC Linkage Grant, with RTA, Bicycle New South Wales, Sydney South West Area Health Promotion Service and Willoughby City Council as research partners.
See also Garrard, Greaves, and Ellison (2010), Cycling injuries in Australia: Road safety's blind spot?, at http://www.acrs.org.au/srcfiles/ACRSVol21-3-WebLR.pdf .

b) *Trends in bicycle injuries and fatalities*

The IRMRC has conducted an analysis of NSW hospitalisation data for this Inquiry [at Attachment A] to provide the most up-to-date information. Results indicate that whilst the hospitalisation injury rate (per population) has increased overall, there has been an increase amongst adults (aged 15-64) and a larger increase amongst older adults (aged 65+) (offset by a reduction amongst children aged (0-14). This is likely to partly reflect patterns of usage, but this is difficult to determine in the absence of adequate usage data (see above). In any case, increase in injury numbers underscores the importance of cycling safety initiatives. See also Garrard, Greaves, and Ellison (2010), Cycling injuries in Australia: Road safety's blind spot?, at http://www.acrs.org.au/srcfiles/ACRSVol21-3-WebLR.pdf

A slightly older analysis was also carried out by the IRMRC in collaboration with other researchers of UNSW exploring death and morbidity data for NSW to examine rates and severity of injury arising from collisions between pedestrians and cyclists, and between cyclists and motor vehicles (MVs). An analysis of the severity of hospitalised injuries was conducted using International Classification of Diseases, Version 10, Australian Modification (ICD-10-AM) diagnosis-based Injury Severity Score (ICISS) and the Disability Adjusted Life Year (DALY) was used to measure burden of injury arising from collisions resulting in death or hospitalisation. The greatest burden of injury in NSW, for the studied collision mechanisms, is for cyclists who are injured in collisions with motor vehicles. Collisions between cyclists and pedestrians also result in significant injuries. For all collision mechanisms, the odds of serious injury on admission are greater for the elderly than for those in other age groups. The significant burden of injury arising from collisions of cyclists and MVs needs to be addressed. However in the absence of appropriate controls, increasing the opportunity for conflict between cyclists and pedestrians (through an increase in shared spaces for these users) may shift the burden of injury from cyclists to pedestrians, in particular, older pedestrians. Figure 11 is a key graph from Chong et al[11] (2010) showing how the highest rate of cyclist injuries results from motor vehicle injuries.

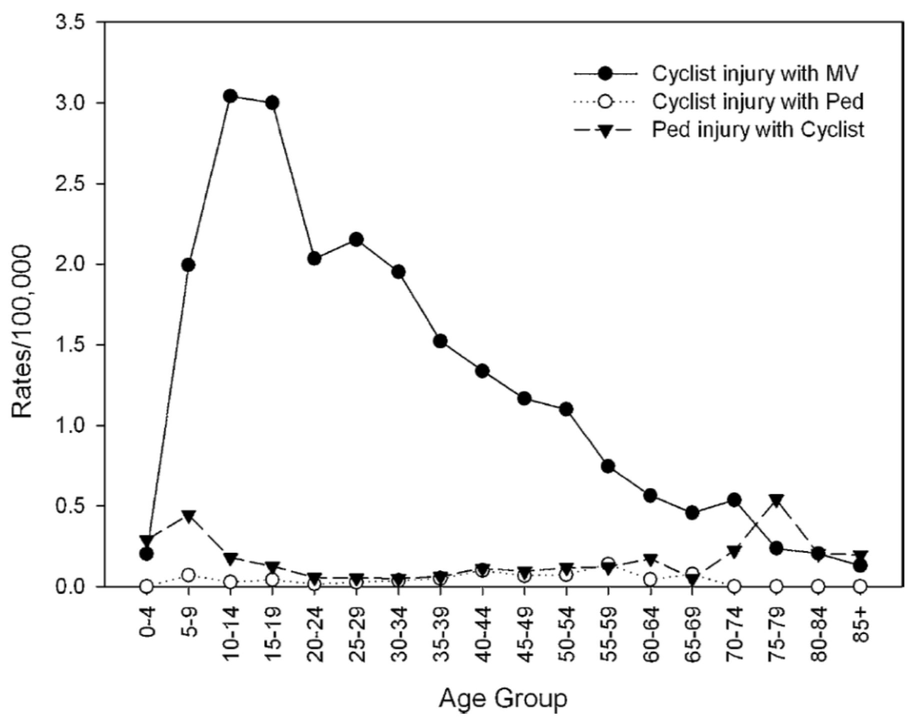

Figure 11: Hospitalisation rate of NSW residents by type of collision and by age group, 1 July 2000 to 30 June 2005. Source: NSW Admitted Patient Data Collection (HOIST), Centre for Epidemiology and Research, NSW Department of Health.

[11] Chong S., Poulos R., Olivier J., Watson WL, Grzebieta R., Relative injury severity among vulnerable non-motorised road users: Comparative analysis of injury arising from bicycle–motor vehicle and bicycle–pedestrian collisions, Accident Analysis and Prevention, Accident Analysis and Prevention 42, pp. 290–296, 2010.

c) *Factors in bicycle injuries and fatalities*

The large cohort study of NSW cyclists in which the IRMRC is involved, will investigate factors involved in bicycle crashes and injuries, through regular questionnaires, and in-depth interviews with cyclists who experience crashes. In addition, a series of detailed engineering safety audits will be conducted on a subsample of crash locations.

d) *Current measures and future strategies to address bicycle safety, including education*

Transport infrastructure which accommodates cyclists must be regarded as a key approach to improving cycling safety, because it:

- Has the potential to benefit large numbers of people
- Requires little active involvement by users
- Requires one-off intervention (though also sufficient maintenance)

We need to know more about the relative merits of different types of infrastructure in terms of user-preference and safety, as previous research has often been limited by the lack of information about where and how much people cycle. On existing evidence, the choice between separated bicycle paths, paths that are shared with pedestrians, and on-road cycle lanes, is not straightforward. However, there is fairly clear evidence that providing well-marked, cycle-specific facilities improves cyclist safety. Designs which involve cyclists travelling in a direction counter to the flow of motorised traffic appear to be dangerous. See Reynolds et al (2009), 'The impact of transportation infrastructure on bicycling injuries and crashes: a review of the literature', at http://www.ehjournal.net/content/8/1/47.

We also need better speed management: developing "cycling corridors" that are speed limited to 30kmph, for example, is gaining sway internationally. Such corridors could allow cyclists to travel more safely and make more direct journeys, while also offering pleasant urban environments. Higher-speed alternatives would remain for motorised traffic.

A shift in attitudes of road users is also important. The notion that "roads are for cars" cannot be maintained in the face of climate change, urban crowding and congestion, and calls for more liveable cities. The "war" between motorists and cyclists and cyclists and pedestrians - often hyped up by a sensation-hungry media - must give way to an attitude of shared respect. Education campaigns informing different road users of each others' rights may have a role to play here.

Finally, we need a whole-of-government approach to improve cycling safety: fragmented responsibilities produce fragmented cycling infrastructure that does not allow for connected and safe cycling trips. The new NSW Bike Plan stresses this need.

See also Garrard, Greaves, and Ellison, Cycling injuries in Australia: Road safety's blind spot?, at http://www.acrs.org.au/srcfiles/ACRSVol21-3-WebLR.pdf .

e) *Integration of bicyclists in the planning and management of the road system in NSW*

Given the benefits of cycling to the individual and the community, and the consequent policies that aim to increase cycling participation, it is crucial that cyclists be integrated in the planning and management of the road system in NSW. Better integration of cyclists will help to increase numbers of cyclists, while also improving their safety.

A Note on Additional Resources

Dr Julie Hatfield, Senior Research Fellow at the IRMRC, has recently guest-edited a special issue of the Journal of the Australasian College of Road Safety (http://www.acrs.org.au/srcfiles/ACRSVol21-3-WebLR.pdf). This special issue includes papers from researchers in Australia and NZ conducting state-of-the-art research on cycling safety.

On September 10th the ACRS Sydney Chapter will host a seminar on the topic *Toward Best-Practice Cycling Infrastructure.* Dr Shane Turner (Beca, NZ), Dr Jan Garrard (Deakin University), Associate Professor Stephen Greaves (University of Sydney), and Ms Marilyn Johnson (Monash University) will present on their cutting-edge research. The seminar will be held from 1:30pm to 5pm at Parliament House in Sydney.

Appendix A: IRMRC analysis of trends in hospitalised injuries among NSW cyclists

Trends in the incidence of pedal cyclist hospitalised injuries in NSW residents, July 1999 to June 2007

Methods

Data sources

We used hospitalisation data from the NSW Admitted Patients Data Collection (APDC) from 1 July 1999 to 30 June 2007. The APDC includes information such as patient demographics, diagnoses and clinical procedures for inpatient separations from NSW public and private hospitals, private day procedures, and public psychiatric hospitals. Information on hospital admissions of NSW residents in other states and territories is included in the APDC, however there is a substantial time lag in receipt of this information and at the time of analysis interstate hospitalisation data was not available for the financial years 2007/08 and 2008/09 and so these years are not included in this report.

Case definition

Pedal cyclist hospitalised injuries were selected employing the following criteria: 1) NSW resident; 2) injury or poisoning was the primary diagnosis (ICD-10-AM range S00-T98) and external cause code in the ICD-10-AM range V10-V19, which represent pedal cyclist injury.

Episodes of care relating to transfers or statistical discharges (e.g., a change from acute to rehabilitation) were excluded in order to minimise for multiple counting that occurs when an individual has more than one episode of care for a single injury event.

Injury severity

Injury severity was categorised using the ICD-10-AM diagnosis-based Injury Severity Score (ICISS), which is an estimate of the survival probability of an injured person at hospital admission, ranging from 0 to 1, with lower scores indicating a lower probability of survival [1, 2]. Patients with an ICISS score $\leq$ 0.941 (i.e. a probability of death of at least 5.9%) were defined as having the most severe injuries [3,4].

Statistical Analysis

Statistical analyses were performed using SAS version 9.1.3 [5]. To allow for changes in the age group and sex structure of the population over time, age-adjusted hospitalised injury rates were calculated using direct age-standardisation employing the estimated Australian residential population as of 30 June 2001 as the standard population [6]. Annual change in age-adjusted rates and associated 95% Confidence Interval (CI) were estimated using the per cent change annualised estimator (PCAE), which is robust regardless of whether or not the annual change in rate is linear [7]. A PCAE-associated p-value < 0.05 was considered statistically significant [7].

Results

Table 3 shows that there were a total of 19,821 pedal cyclists hospitalised with injuries between July 1999 and June 2007. The majority of those injured were males (81.3%), and just more than half were aged between 15 and 64 (51%). About 10.9% of hospitalisations were for injuries with an ICISS score $\leq$ 0.941.

The overall age-standardised rate among NSW residents of hospitalisations due to injury to pedal cyclists increased over the 8 year period by 2.1 % (95%CI: 1.3% to 2.9%). The rate of hospitalisation among males increased significantly by 2.5% (95%CI: 1.6% to 3.4%) per annum, whereas that among females remained stable. The rate of hospitalisation for injuries to pedal cyclists trended upwards over time for adults (15-64 years of age) and older adults (65 years and older) by 6.0% (95%CI: 4.8% to 7.2%) and 8.1% (95%CI: 2.2% to 14.4%) respectively, but decreased significantly for young people (aged 0-14 years) by 2.2% (95%CI: -2.5% to -1.9%) per annum.

The rate of hospitalisation for both the most severe injuries to pedal cyclists (i.e. injuries with a risk of death greater than 5.9%) and other injury severity to pedal cyclists increased over the 8 year period, by 3.3 (95%CI: 0.8% to 5.9%)and 2.0 (95%CI: 1.1% to 2.8%) respectively.

Table 3: Age standardised rates per 100 000 person-years for hospitalisations due to injuries to pedal cyclists resident in New South Wales, and trends in rates by sex and age.

	N	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Annualised% change in rate (95% CI)	p-value
All	19,821	36.50	33.92	35.43	36.88	37.02	38.79	41.47	42.20	2.09 (1.29, 2.90)	0.00
Sex*											
Male	16,116	57.62	54.21	57.65	59.06	59.32	62.82	66.52	68.31	2.46 (1.56, 3.37)	0.00
Female	3,704	14.79	13.20	12.66	14.11	14.21	14.28	15.92	15.62	0.78 (-1.04, 2.64)	0.41
Age group*											
Young (Aged 0-14)	9,209	96.68	81.06	81.66	87.81	83.97	92.07	84.90	82.71	-2.20 (-2.51, -1.90)	0.00
Adult (Aged 15-64)	10,146	23.94	24.60	27.11	27.15	28.59	27.99	34.47	36.07	6.03 (4.84, 7.23)	0.00
Old (Aged 65+)	455	4.98	6.46	4.16	5.37	5.13	9.23	7.72	8.57	8.06 (2.22, 14.43)	0.01
Severity of injury (threat to life)**											
Most severe[1]	2,156	3.70	4.02	3.53	3.76	3.75	4.26	4.78	4.63	3.26 (0.76, 5.85)	0.01
Others[2]	17,665	32.80	29.89	31.89	33.11	33.27	34.53	36.69	37.56	1.95 (1.11, 2.81)	0.00

*Note that numbers do not total 19,821 due to missing values

** Estimated via application of the *ICD based injury severity score* (ICISS)

[1] Probability of survival less than or equal to 94.1%

[2] Probability of survival greater than 94.1%

Appendix A References

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4. Cryer C, Langley JD, Stephenson S. Developing valid injury outcome indicators. A report for the New Zealand Injury Prevention Strategy. Dunedin: Injury Prevention Research Unit. Department of Prevention and Social Medicine. University of Otago.

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