Peer Reviewed Papers

Data and graphing errors in the Voukelatos and Rissel paper

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I am writing to you regarding a peer-reviewed paper titled 'The effects of bicycle helmet legislation on cycling-related injury: The ratio of head to arm injuries over time' by Alex Voukelatos and Chris Rissel, which appeared on pages 50-55 of the August 2010 issue of the *Journal of the Australasian College of Road Safety.*

The paper as published contains serious arithmetic and data plotting errors. These are:

a) The all-ages total counts of hospital admissions for head and arm injuries in cyclists by financial year in Table 2 do not equal the sum of the age-group-specific counts in the rest of the table. Some of the totals in the table are higher than the sum of the age-specific counts, and some are lower – thus this discrepancy cannot be explained by inclusion of records with missing age-group in the totals (the source hospital admissions data contains a very small percentage of missing ages, in any case). It may be that either the totals are correct and the age-group-specific counts in the table are wrong, or the age-group-specific counts are correct and the totals are wrong – it is impossible to determine which from examination of the published paper, although the latter seems more likely.

What is certain is that the data presented in the paper are arithmetically incorrect. As a result of these errors, at least some of the corresponding head-to-arm injury admission ratios in Table 3 of the paper must also be incorrect – probably those for all ages – because they have been calculated from the hospital admissions counts as they appear in Table 2. Most importantly, as a result of these unequivocal data errors, the time-series of all-ages head-to-arm injury admission ratios plotted in Figure 2, upon which the conclusions of the paper appear to be principally based, is also almost certainly incorrect.

b) The data points for the proportions of adult and child cyclists observed to be wearing helmets in NSW Roads and Traffic Authority (RTA) surveys are incorrectly plotted some 15 months too late in Figure 2. The RTA surveys were conducted in September 1990 and in April of 1991, 1992 and 1993 [1-4].The hospital admissions ratio data plotted in Figure 2 are based on financial year counts, and thus each data point in the time-series should properly be plotted on the x-axis at 1 January of the second of the calendar years in each financial year.

For example, the third data point from the left in the Figure 2 head-to-arm admission ratio time-series represents the ratio for the 1990/91 financial year, and thus the horizontal position of the plotted point corresponds to 1 January 1991. The first of the RTA survey points (September 1990) should therefore be 3 months to the left of this third head-to-arm ratio data point, not 12 months to its right as it appears in the published paper. The other RTA survey data points are similarly misplaced. In addition, the caption for Figure 2 labels the helmet law compliance data as 'self-reported helmet use'. This is incorrect: the data were collected by observation of cyclists by trained observers, as clearly described in the report by Smith and Milthorpe [4], which the authors cite as the source of these data.

c) The authors have also made a pre-press version of their paper which states that it was '...accepted for publication in the *Journal of the Australasian College of Road Safety*, August 2010', available at several locations on the Internet. This pre-press version contains an additional data plotting error. As noted above, the data points for the head-to-arm-injury ratio in Figure 2 are the mid-points of financial years, that is, 1 Jan of each calendar year. Therefore, the shaded bar representing the 6-month period in which the adult and then child cycling helmet laws were introduced in NSW should be positioned immediately to the right of the third data point, not immediately to the left of the fourth data point as shown in the pre-press version of the paper.

The concern is not just that the tabulated data and the key graph in the paper contain significant arithmetic and data plotting errors, but that the combined effects of these errors have led the authors to draw erroneous conclusions from the data on which they have based their study. Assuming, as seems most likely, that the age-group-specific admission counts in Table 2 are correct, and that it is the all-ages totals that are wrong, then Figure 2 should appear as shown in Figure 1 below (which I reproduced from the data in Table 2 after recalculating the all-ages totals).

Please note that at the time of writing, I have not yet been able to verify the accuracy of the age-specific hospital admission counts presented in the paper by Voukelatos and Rissel, and there may be other errors in their data. Thus Figure 1 should be viewed with this possibility in mind.

On the basis of these results, the authors' conclusions do not appear to be supported by the data, when it is correctly plotted. For example, they state:

'The main conclusion of this examination of the ratio of head to arm injuries over time is that there was a marked decline in head injuries among pedal cyclists before the introduction of mandatory helmet legislation and behavioural compliance, most likely a result of a range of other improvements to road safety.'

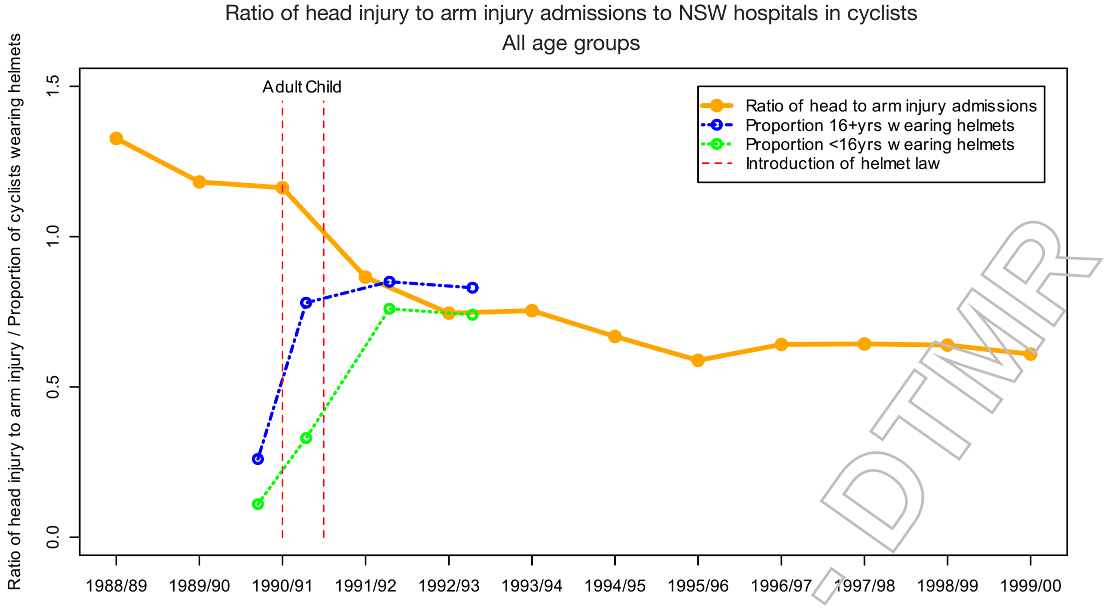

Figure 1. Ratio of head injury to arm injury admission to NSW hospitals in cyclists

The authors also discuss both age-group-specific and total counts and the ratios derived from them in their results section: at least some of that discussion must be also be incorrect. In addition to these unequivocal errors, there may also be a problem with comparability of the very first data point in the head-to-arm-injury time-series. The authors state in the Methods section of their paper:

'The data were categorised according to principal diagnosis using ICD10 codes. Only codes representing head injuries and arm/hand injuries were used in the study (see Table 1). Cases that had both head and arm injuries were counted in each group.'

It should be noted that the first and third sentences are logically incompatible, because there can only be one principal diagnosis code for each record, representing only one type of injury. However, the third sentence suggests that the authors checked multiple diagnosis code variables on each admission record for codes indicating head or arm injuries, rather than just the single principal diagnosis variable.

Ordinarily, checking multiple diagnosis code variables on each record is good practice. The potential comparability problem arises because for the 1988/89 financial year data, and only for that year, there is just one diagnosis code variable available on each record – in all later years of the hospital admissions data collection, there are up to five or more diagnosis code variables on each record. In cases in which both head and upper limbs have been injured, the head injury is more likely to be recorded as the singular principal diagnosis, which may lead to an artefactual increase in the head-to-arm injury ratio for 1988/89. This possibility can be easily investigated by the authors tabulating or plotting the head-to-arm injury ratio by month or quarter rather than by year – a sudden drop in the ratio time-series at July 1989 would indicate a comparability problem.

There are several more methodological points that require consideration by any readers of the paper.

The first relates to the ICD-9-CM codes used by the authors to select hospital admission records prior to 1999/2000. The actual codes used are not reported in the paper, and the authors state that they used an ICD-10-AM to ICD-9-CM back-mapping provided by the National Centre for Classification in Health. This back-mapping is an excellent starting point, but it is always wise to manually check for additional relevant ICD-9-CM codes, and the paper would be strengthened by stating exactly which ICD-9-CM codes were used to select hospital admission records.

A minor point is that the NSW hospital admissions data are coded using ICD-9-CM (Australian version) and ICD-10-AM, not 'ICD9' and 'ICD10' as stated in the paper. ICD-9 and ICD-10 are code sets published by the World Health Organisation, which in Australia are primarily used for coding mortality data – they are not the same as the ICD-9-CM and ICD-10-AM code sets.

It is not clear if the available weighting factor was used to adjust for the temporal sampling used for the data collected from smaller public hospitals and some private hospitals prior to 1994. Failure to adjust for the sampling is unlikely to have affected the head-to-arm injury ratio substantially, but nevertheless it should be done.

Finally, it is not clear if the authors excluded inter-hospital transfers from the data, to avoid double-counting. This is relevant because the NSW Trauma Plan was introduced in 1993, which had the effect of reducing inter-hospital transfers for more severe trauma cases. It is theoretically possible that this may have introduced a minor systematic shift in the time-series data, albeit well after the cycling helmet laws were introduced.

References

1. Walker MB. Law compliance and helmet use among cyclists in New South Wales. Consultant Report 6/90. Rosebery, NSW: Road Safety Bureau, NSW Roads and Traffic Authority, 1990.
2. Walker MB. Law compliance and helmet use among cyclists in New South Wales, April 1991. Consultant Report 1/91. Rosebery, NSW: Road Safety Bureau, NSW Roads and Traffic Authority, 1991.
3. Walker MB. Law compliance among cyclists in New South Wales, April 1992: A third survey. Rosebery, NSW: NSW Roads and Traffic Authority, 1992.
4. Smith NC and Milthorpe FW. An observational survey of law compliance and helmet wearing by bicyclists in New South Wales - 1993. Rosebery, NSW: NSW Roads and Traffic Authority, 1993.

Note from Professor Raphael Grzebieta, Peer Review Editor

On the receipt of Tim Churches' letter, a copy was sent to the authors Dr Alexander Voukelatos and A/Prof. Chris Rissel on 7 October 2010 seeking their response. A reply letter was subsequently received from the authors on 20 October 2010. Both Tim Churches' letter and Dr Voukelatos and A/Prof. Rissel's reply letter were sent to four independent reviewers along with the original paper. Three of the reviewers are Australian and one is German. The reviewers' qualifications range across the professions of psychology, engineering, medicine and science, while their extensive expertise ranges across the areas of epidemiology, bio-statistics, cycling safety, transport engineering, hospital and crash databases, and crash investigations.

The outcome of the review to date is that all reviewers unanimously indicated that Tim Churches' letter should be published in the journal and all supported that his criticisms, his graph and comments appear valid.

Concerning Dr Voukelatos and A/Prof. Rissel's response, all reviewers agreed it was deficient and required further elaboration and re-review to address adequately Tim Churches' concerns. The reviewers were particularly critical in regard to the scientific evidence Dr Voukelatos and A/Prof. Rissel presented in their reply as support of their main conclusion that *'mandatory bicycle helmet legislation appears not to be the main factor for the observed reduction in head injuries among pedal cyclists at a population level over time'*. The editors have decided to further communicate with the authors and seek another written reply that addresses all reviewers' concerns. This reply will be further assessed by the reviewers.

It should be noted that at this point in time Dr Voukelatos and A/Prof. Rissel have stated in their response: *'Mr Churches is quite correct in writing that the paper titled 'The effects of bicycle helmet legislation on cycling related injury: The ratio of head to arm injuries over time' has serious arithmetic and data plotting errors. We sincerely apologise for these unintentional errors and any confusion that this may generate.'*

Unfortunately, at the time this issue of the journal went to publication, there was insufficient time to further relay the reviewers' assessment to Dr Voukelatos and A/Prof. Rissel for them to reply adequately to the reviewers' concerns. It is hoped that a consensus position will be reached by the authors and the reviewers, which can subsequently be published in the February 2011 issue of the journal.

A prospective study on pedestrian injuries in an urban Australian population

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Abstract

Pedestrian injuries are associated with substantial morbidity, mortality and cost, with very little published work on this topic in Australasia over recent years. The objective of this study was to examine the demographics, injury profile, relationship with alcohol and intoxication, motor vehicle, and environmental factors of pedestrian versus motor vehicle collisions (MVC) in a central city hospital in Sydney. The method comprised a descriptive study with structured questionnaire of 35 pedestrians involved in a MVC admitted to a tertiary hospital in inner-city Sydney over a five-month period, during which 97 pedestrians involved in injuries were treated.

The mean age was 48.5±19.7 years, and 65.7% were females. Mean emergency length of stay (LOS) was 8.9±6.5 hours, with a trend towards longer LOS for older patients (11.0 vs. 6.71 hours, p=0.056). Peak injuries occurred between 1500-1800 on weekdays, and 1800-0300 on weekends, with 53% occurring at sites other than a crossing. Twenty per cent of those injured had pre-existing disabilities involving gait abnormality. Dark-coloured clothing worn above the waist was associated with MVCs at night-time. Alcohol consumption was associated with a higher cost of radiological investigations and length of stay, resulting in an estimated additional $7755 per hospital admission.

This study demonstrates that readily defined and clinically relevant characteristics are associated with pedestrian injuries in an urban Australian population. Pedestrian intoxication is associated with increased utilisation of hospital resources contributing to the burden on health systems. This information may be used to help design effective public health strategies to educate the community on the cost of care.

Keywords

Pedestrians, Road traffic injuries, Motor vehicle collisions, Descriptive study, Prevention

Introduction

Collisions between pedestrians and road vehicles present a major challenge for public health, trauma medicine and traffic safety professionals. More than a third of the 1.2 million people killed and the 10 million injured annually in road traffic crashes worldwide are pedestrians [1]. In New South Wales, the number of pedestrian injuries occurring in 2007 was 2119, with an annual average fatality of 75.7 in 2006 to 2008 [2]. The total direct cost for trauma patients admitted to a large metropolitan Australian trauma centre over a three-month period was estimated at around $3 million [3]. In particular, direct medical costs for admitting a pedestrian trauma patient has been estimated to be $16,320 per admission, and for patients who died, to be $28,831 [4].

There have been very few papers published on pedestrian injury in Australasia over recent years. Of existing studies, most have focused on paediatric and older pedestrian trauma [5-7] in a retrospective manner [4]. There has been no Australasian review of adult pedestrian trauma in inner city urban environments conducted prospectively with an a priori protocol.

The primary aim of this descriptive study was to examine the demographics, injury profile, morbidity and causative factors of adult pedestrian trauma in a central city hospital in Sydney, with the secondary aim of examining the effect of blood alcohol concentrations (BAC) on severity of injury and cost of treatment.

Method

The study was carried out at St Vincent's Hospital, Sydney, which is located on the edge of the Sydney central business district. The study was a review of all adult pedestrians injured by motor vehicles and admitted to the emergency department (ED) during a five-month period from June to October 2009. A review of patient records and a structured questionnaire was conducted on consented pedestrians (previous accident history, alcohol consumption, colour of clothing during time of accident, usage of electronic device, warning of oncoming vehicle), including information on environmental factors at the time of accident (whether a crossing was used, proximity to a pub). See Table 1. Exclusion criteria included patients who were unable to speak English, medically unstable, or cognitively and/or speech impaired. Ethics approval was obtained from the ethics review board of St Vincent's and Mater Health.

Table 1. Demographics of those consented to questionnaire

	Gave consent	
	N (%)	**Mean ± SD**
Age (years)	35	48.5±19.7
15-29	11 (31.4)	
30-44	5 (14.3)	
45-64	8 (22.9)	
≥65	11(31.4)	
Gender	35	
Male	12 (34.3)	
Female	23 (65.7)	
Marital status	34[a] (97.1)	
Single	13 (38.2)	
Married	12 (35.3)	
De facto	5 (14.7)	
Divorced	4 (11.8)	
Language spoken at home	35	
English	23 (65.7)	
Non-English	12 (34.3)	
Country of birth	35	
Australia	19 (54.3)	
Others	16 (45.7)	
English speaking	3 (18.8)	
Non-English speaking	13 (81.2)	
BAC (%)	14[a] (40.0)	0.0886±0.105
<0.03	9 (64.3)	
≥0.05	5 (35.7)	
GCS on admission	31[a]	14.5±0.4
LOS in ED (hours)	30[a]	8.9±6.5
LOS (if admitted)(days)	13 (37.1)	11.7±10.6
LOS ICU (if admitted) (days)	1	9.42
ISS	35	14.1±3.5

[a]Unaccounted numbers are unknown or missing cases

Patients were identified from the Emergency Department Information Systems (EDIS) database. The subjects were a convenience sample in that (1) those who were in hospital while the researcher was present were approached for consent once medically cleared by the treating team, and the questionnaire was administered prior to discharge; and (2) those who were discharged from hospital were mailed an information sheet, consent form, questionnaire and stamped addressed reply envelope, and subjects with returned questionnaires were included in the study analysis.

Medical records were used to gather relevant demographic data such as age, gender, postal code, marital status, language spoken at home, country of birth, admission Glasgow Coma Scale (GCS), Injury Severity Score ISS [8], LOS in ED, LOS in hospital if admitted, LOS in intensive care unit ICU if admitted, time, date and location of accident, estimated impact speed, and injuries sustained. MediWeb™ [9] was used to determine tests performed and BAC taken by emergency personnel. A BAC less than 0.05% was considered non-intoxicated, and greater than or equal to 0.05% was considered intoxicated, in accordance to current NSW drink-driving laws [10].

ISS [11] was scored from information gathered from ED and Trauma Registry. Types of vehicle were classified into (1) passenger cars including sedans and hatch-backs; (2) light truck vehicles including four-wheel drives, sports utility vehicles, small pick-ups, mini-vans, buses and trucks; and (3) motorcycles, scooters, bicycles and push-bikes. Clothing colours such as black, blue and grey were considered 'dark', whilst green, red, orange, yellow, white, pink and purple were considered 'light'. Blue, if indicated 'light' or 'pale', was recorded as a light colour. The Australian Bureau of Meteorology website was used to determine 'daylight' or 'darkness' on the day of accident [12]. The sample population was compared with the population of Sydney Statistical Division (SD) obtained from the Australian Bureau of Statistics, which is most relevant to an urban population in Sydney [13].

An independent sample t-test or z-test was used to compare means of continuous outcomes of a normal distribution with two categorical factors of the same group. A non-parametric independent sample test (Mann-Whitney U) was used to compare means of continuous variables that were not normally distributed. Crosstabs were used to determine frequencies between two categorical variables. All statistical analyses were carried out using SPSS software [14]. P-values of less than 0.05 were considered statistically significant.

Results

Of a total of 97 pedestrians admitted to ED from 19 May to 30 September 2009, 35 (36.1%) consented to complete the questionnaires. Fifteen patients were approached personally, of which 14 (93.3%) consented. Eighty-two letters with stamped addressed reply envelopes were mailed out, of which 21 (25.6%) recipients responded. Analysis revealed that patients who consented were likely to be older, to be married, to have greater physical injury (higher ISS), and to have a longer ED and total LOS. The ≥65-year age group was 16.1% higher as compared to the Sydney SD population ($z=2.64$, $p<0.05$).

Participant demographic characteristics

Demographic characteristics of the 35 injured pedestrians are indicated in Table 1. Their age ranged from 20 to 84 years, with an average age of 48.5±19.7 years. The highest frequency was in the age range 15-29 years and ≥65 years (31.4% each); females accounted for 65.7% of injuries. The mean GCS on admission was 14.5±0.4. Mean ED LOS was 8.9±6.5 hours (range 2.5-73.75 hours), and mean hospital LOS (37.1% of subjects) was 11.7±10.6 days (range 1.0-45.0 days). One pedestrian was admitted to the ICU with a LOS of 9.42 days.

Those ≥65 years accounted for 30.8% of hospital admissions, with a trend for longer ED LOS compared to 15-29 year olds (11.0 vs 6.71 hours, $p=0.056$), as well as longer hospital LOS (7.63±6.29 vs 3.50±3.54 days), although not statistically significant ($p=0.452$). See Table 2.

Table 2. Time spent in hospital according to age group

Age group (years)	N=30[a]	LOS in ED in hours (mean)	p-value	N=13	LOS (if admitted) (mean ± SD)	p-value
15-29	7	6.71	-	2	3.50±3.54	-
30-44	5	7.90	0.250	3	6.67±4.62	0.478
45-64	8	9.13	0.296	4	23.5±17.4	0.203
≥65	10	11.0	0.056	4	7.63±6.29	0.452

[a]5 unknown or missing cases

Crash circumstances

More pedestrian collisions occurred on Tuesdays, 4.2 times the number on Sundays (Figure 1). Overall injuries were more common during 1500-1759 on weekdays (Figure 2); pedestrians ≥65 years were more likely to be injured during daytime and those 15-29 years between the hours of 1500-1759 and 0000-0259 (Figure 3). The early morning hours had the least number of injuries, which were rare from 0300-0559.

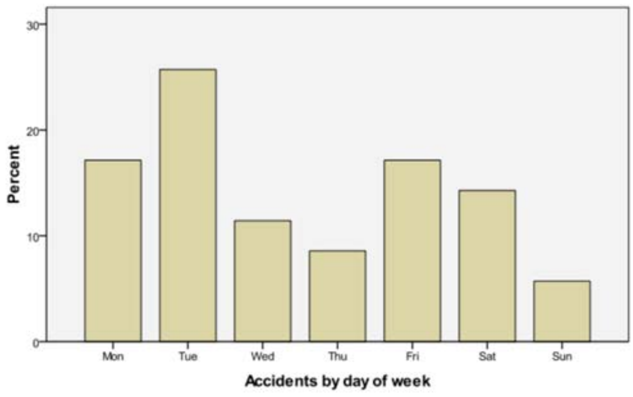

Figure 1. Distribution of pedestrian injuries by day

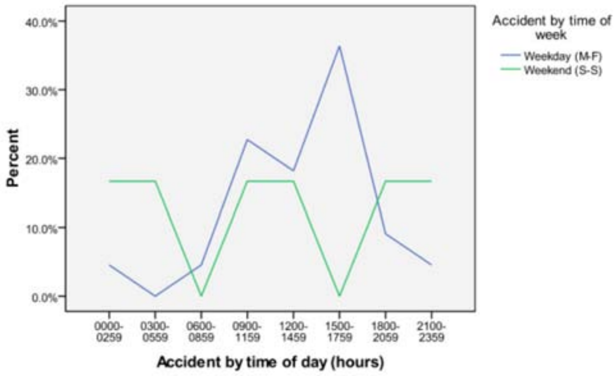

Figure 2. Comparison of proportions of injuries by time of day according to time of week

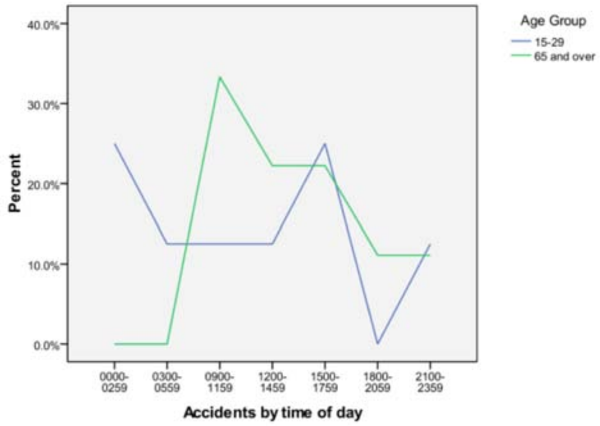

Figure 3. Pedestrian injuries by time of day according to age group.

Sixteen respondents (53.3%) were not using any pedestrian crossings at the time of accident (Figure 4). Thirty respondents (85.7%) reported that 'it wasn't raining at the time' of the collision, and two (5.7%) said the rain just stopped. Of the four accident locations recorded in those found intoxicated, all were located within 100 metres of a pub, and one location had three or more pubs within a 50-metre radius.

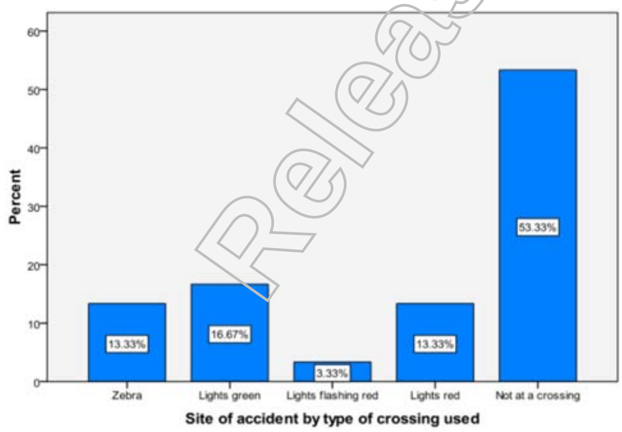

Figure 4. Distribution of type of crossing used at time of injury

A history of prior motor vehicle injuries was reported in 11.4% of respondents, and 28.6% had pre-existing disabilities of which 70% reported to have an abnormal gait. Dark-coloured clothing worn above the waist was reported in 70.8% of pedestrians injured, and dark-coloured clothing worn below the waist was reported in 78.6% cases. Dark-coloured clothing worn above the waist was associated with injuries at night-time, although not statistically significant (83.3% vs 58.3%, p=0.185) (Table 3).

Table 3. Colour of clothing by time of injury

	N (%)	Daylight N (%)	Darkness N (%)	p-value
Colour of clothing above waist	24[a] (80.0)	12 (50.0)	12 (50.0)	0.185
Dark		7 (58.3)	10 (83.3)	
Light		5 (41.7)	2 (16.7)	
Colour of clothing below waist	28[a] (82.4)	15 (53.6)	13 (46.4)	0.600
Dark		12 (80.0)	10 (76.9)	
Light		3 (20.0)	3 (23.1)	

[a]Unaccounted numbers are unknown or missing

Fifteen respondents (51.7%) reported not noticing the oncoming vehicle, and 20.0% of those reported not 'looking at all'. Only one of the five intoxicated pedestrians reported having seen the vehicle. Patients ≥65 years made up the largest proportion (33.3%) of those who did not notice the vehicle. The majority (85.7%) who saw the vehicle said that it was 'too late to have evaded the accident'. Four of 32 respondents (12.5%) were using an electronic device during the accident. Three used an MP3 player, and one was having a conversation on a mobile phone. All four were aged 30 or less.

Seventeen respondents (48.6%) identified themselves as alcohol drinkers, and eight (22.9%) reported to have consumed alcohol on the day of the accident. Fourteen BACs were recorded at ED staff request, with a mean of 0.0886±0.105% (median less than 0.03; range, 0.03-0.33%). Six of the eight who consumed alcohol that day had their BACs recorded, where five (83.3%) had levels (BAC≥0.05%) that would have rendered them intoxicated and unsuitable to control a motor vehicle. None was 65 years or older. Two-thirds who identified themselves as non-alcohol drinkers were women.

Effect of a positive BAC on LOS and cost

A total of 41 X-rays and 27 CT scans were performed on the 14 pedestrians who had their BAC recorded. The mean number of X-rays and CT scans was higher, with a trend towards more X-rays amongst those intoxicated (3.6 vs. 2.56, p=0.056) (Table 4). Whilst five (71.4%) CT scans of the head in non-intoxicated cases yielded positive findings, only one (25.0%) of intoxicated cases did.

Table 4. Diagnostic investigations performed according to BAC[a]

	N (%)	BAC<0.03	N (%)	BAC≥0.05	p-value
X-rays (mean±SD)	23 (56.1)	2.56±1.01	18 (43.9)	3.60±0.55	0.056
CT scans (mean±SD)	15 (55.6)	1.78±1.30	12 (44.4)	2.4±1.14	0.390

[a]Reported values from MediWeb™ included BAC values <0.03 and ≥0.05 only

Intoxicated pedestrians had a higher mean hospital LOS, although not statistically significant (17.7±4.23 vs 11.5±12.7 days, p=0.671). The estimated cost of a single intoxicated pedestrian was an extra $7755 (calculated by the extra cost of 6.2 hospital days: $7551.04 using a daily rate of $1217.91 ($16,320 at average length of stay: 13.4 days) [3] and costs of additional radiological investigations of $203.64 (1.04 extra X-rays and 0.6 extra CT scans [15]) compared to their non-intoxicated counterparts per admission.

Motor vehicle factors

Passenger cars were involved in the majority (68.6%) of injuries involving pedestrians. Twenty-nine (82.9%) impact speeds were recorded, of which 18 (62.1%) occurred at ≤25km/h, 8 (27.6%) at 26-39km/h and 3 (10.3%) at ≥40km/h.

Discussion

This five-month descriptive sample from St Vincent's Hospital Sydney provides an overview of the circumstances and major injuries of pedestrians admitted to ED. We found a similar mean age (48.5) to the inner Sydney sample from Small et al. [4] conducted five years before at the same institution. In addition, we found a disproportionately high percentage of younger and older pedestrians injured, location, gender, time of day of week, pedestrian controls, lighting, alcohol, as well as the use of electronic and mobile communication devices as contributors to pedestrian injuries, similar to recent findings from the Staysafe Committee's report on pedestrian safety [16].

There was a higher frequency of pedestrian injuries in those aged between 15-29 years and ≥65 years (31.4% each). Older pedestrians have been reported to be vulnerable to injuries, consistent with other studies [17-19], evidenced by longer ED and hospital LOS, for several reasons. Owing to their reduced mobility and vision (one-third of respondents), usual traffic conditions may not allow sufficient time to cross the roadway safely, which may be contributed to by crosswalk controls themselves being set for a pace of transit crossing speed that many older people may not be able to achieve [20-21]. In addition, older individuals may be less likely to perceive a hazard and may be less likely to escape (one-third of those injured had a disability, of which 70% was related to an abnormal gait). Once injured, older road users are at extremely high risk of severe injury because of their greater susceptibility to injury (frailty) compared to younger people [22].

In this cohort, younger pedestrians who were injured were more likely to be engaged in risk-taking road-crossing behaviour, which may be further compounded in those intoxicated. All of those who reported using an electronic device at the time of the accident were aged 30 or less. Hatfield has shown that the use of electronic devices may be associated with increasing exposure to potential pedestrian injuries [23].

Injuries were more common during 0600-1759, consistent with previous studies showing injuries occurring in daylight hours [4, 24]. In our study, two peak accident periods were observed, consistent with Small [4]. The first was between 1500-1759, which corresponds to peak traffic time. Peak hour injuries can be attributed to high vehicular and pedestrian flow, increasing exposure to risk of injuries [25]. Sunset occurring at those times could also play a role in compromising drivers' vision leading to these pedestrian injuries and explain why this phenomenon is seen less commonly in the morning peak hour. The second was observed between 0000-0259 on weekends, especially for the age group 15-29, which may correspond to a time of high pedestrian flow in entertainment precincts of the city.

Intoxicated pedestrians suffer metabolic changes that could impair judgement, leading to reckless behaviours and inability to take quick evasive actions as compared to their sober counterparts [26]. Males were found to be more likely to consume intoxicating levels of alcohol as compared to their female counterparts, consistent with observations of older non-intoxicated and young and middle-aged intoxicated males as high-risk groups of adult pedestrians for serious injury and mortality [4].

We reported a higher total cost (extra $7755) of treating intoxicated pedestrians, consisting of a longer ED and hospital LOS, as well as higher numbers of investigations yielding a lower positive CT result (25.0% vs 71.4%). This not only shows that intoxicated pedestrians use up more of the hospitals' resources, but also that these resources are not used as efficiently. Longer overall hospital stays can be attributed to requiring more care and more time spent on associated social issues with alcohol [27].

Indeed, there is dissociation between the public health message (drink-driving laws) and support for those who 'do the right thing' and the services that support them. Whilst fatalities associated with drinking-driving have decreased, the morbidity has remained the same for drivers [28]. Paradoxically, there may be a hidden cost of the impact of an intoxicated pedestrian who has chosen 'not to drive' by virtue of public health campaigns and education. The total annual estimated costs of healthcare attributed to alcohol was $A1.98 billion dollars. Another consequence often overlooked in injuries involving intoxicated pedestrians may be the undue emotional stress placed on the driver involved.

All intoxicated cases occurred within 100 metres of a drinking outlet, which indicates that intoxicated pedestrians may be vulnerable to injuries in these areas. Lee and Abdel-Aty [29] showed that night-time crashes were more likely to be the pedestrian's fault than the driver's if alcohol was involved. Current NSW regulations restrict vendors from supplying liquor to those already intoxicated. Having three or more drinking outlets within a 100-metre radius also raises the issue of pub-hopping. However, people who may be refused alcohol in one outlet as they appear intoxicated may walk several metres to the next outlet where vendors are unaware of their level of intoxication and recommence drinking.

Further, the majority of injuries in our study occurred not at a proper pedestrian crossing, consistent with Koepsell [30]. Crossing the road at a non-designated area may create a more dangerous situation, as drivers may not expect pedestrians at those sites. As those areas are well defined, they may be suitable sites for protection devices to prevent inappropriate road crossing. Road dividers with elevated fencing or barriers may be of benefit in high-density areas to deter pedestrians from inappropriate crossings [31].

Dark-coloured clothing worn above the waist may be associated with injuries during times of poor visibility such as the evening/night but not during daytime. Our finding is consistent with the observation that poor street-lighting leads to severely compromised visualisation (5%) of pedestrians wearing black clothing and at low beam [32]. Given that 85.7% of our cohort of pedestrians saw the vehicle approaching but was unable to evade the collisions, improving existing street-lighting or enhancing crossings with flashing lights to increase detection and recognition by drivers close to pubs and other traffic black spots may prevent pedestrian injuries [33]. Implementing improved lighting could coincide with peak accident times in a similar manner used in school zones in NSW, particularly those with flashing lights, which have shown to be effective in reducing mean speed of vehicles [34].

Limitations

Several limitations are acknowledged: modest sample size, incomplete BAC records, BAC collected only at ED staff request and observational study conducted at a single site. In addition, most of the pedestrians surveyed were discharged from hospital and those who consented and completed surveys had more severe injuries. The study could be improved with a larger sample size over several sites, as well as retrieving driver factors such as BAC and license validity through linkage with police records.

Conclusion

This is the first prospective study linking pedestrian factors to in-hospital progress and supports results from previous retrospective studies. It identifies the role of intoxication and the proximity of collisions to alcohol outlets, which are potential sites for protective measures such as enhanced lighting and barriers. Larger studies with data linkage of in-patient, environmental and police data are required to co-ordinate safety measures to target preventative strategies.

References

1. Crandall J.R., Bhalla K.S. and Madeley N.J. Designing road vehicles for pedestrian protection, Br Med J, Vol. 324, No.7346, 2002, pp.1145-8.
2. NSW Centre for Road Safety (NCRS). Road traffic crashes in New South Wales. Surry Hills, NSW: Roads and Traffic Authority, 2007.
3. Curtis K., Dickson C., Black D. and Nau T., The cost of trauma in an Australian trauma centre, Aust Health Rev, Vol. 33, No.1, 2009, pp.84-92.
4. Small T.J., Sheedy J.M. & Grabs A.J., Cost, demographics and injury profile of adult pedestrian trauma in inner Sydney, ANZ J Surg, Vol. 276, No.1-2, 2006, pp.43-47.
5. Turner C., McClure R., Nixon J. and Spinks A., Community-based programmes to prevent pedestrian injuries in children 0-14 years: a systematic review. Inj Control Saf Promot., Vol.11, No.4, Dec., 2004, pp.231-7.
6. Holland A.J., Liang R.W., Singh S.J., Schell D.N., Ross F.I. and Cass D.T. Driveway motor vehicle injuries in children., Med J Aust., Vol.173, No.4, Aug., 2000, pp.192-5.
7. Gorrie C.A., Brown J. and Waite P.M. Crash characteristics of older pedestrian fatalities: dementia pathology may be related to 'at risk' traffic situations., Accid Anal Prev., Vol.40, No.3, May, 2008, pp.912-9.
8. Baker S.P., O'Neill B., Haddon W Jr. and Long W.B., The injury severity score: A method for describing patients with multiple injuries and evaluating emergency care. J Trauma., Vol.14, No.3, 1974, pp.187-96.
9. MediWeb. http://www.agfa.com/en/he/products_services/all_products/mediweb_results.jsp (Accessed 9 November 2009)
10. Roads and Traffic Authority, NSW (RTA), Blood alcohol limits. Retrieved 20 October 2009 from http://www.rta.nsw.gov.au/roadsafety/alcoholdrugs/bac/index.html
11. NSW Institute of Trauma & Injury Management. AIS & ISS Resources. NSW: ITIM; 2009 (Accessed 14 May 2009). Available from: http://www.itim.nsw.gov.au/go.cfm?path=/go/data-and-coding/ais-and-iss-resources
12. Australian Bureau of Meteorology (BOM). Daily weather observations. http://www.bom.gov.au/climate/dwo/IDCJDW2124.latest.shtml (Accessed 20 October 2009)
13. Australian Bureau of Statistics. Regional population growth, Australia, 23 April 2009. http://abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3218.02007-08?OpenDocument (Accessed 20 October 2009)
14. SPSS for Windows, Version 16, Chicago: SPSS Inc.
15. Medicare Benefits Schedule Book, (Accessed 11 November 2009)
16. New South Wales. Parliament. Joint Standing Committee on Road Safety. Report on pedestrian safety: Ministerial reference / Staysafe Committee, Parliament of New South Wales. [Sydney, N.S.W.]: The Committee, 2009.
17. Harruff R., Avery A., Alter-Pandya A. Analysis of circumstances and injuries in 217 pedestrian traffic fatalities. Accid Anal Prev., Vol.30, Issue.1, 1997, pp.11-20.

18. Henary B., Ivarsson J., Crandall J. The influence of age on the morbidity and mortality of pedestrian victims, Traffic Injury Prevention 2006;7:182-190.

19. Falster M., Olivier J., Chong S, Grzebieta R.H., Watson W.L. Trends of severe pedestrian injuries in older people in NSW, Road Safety Research, Policing and Education Conference, Sydney, 2009.

20. Hoxie R.E., Rubenstein, L.Z. Are older pedestrians allowed enough time to cross intersections safely? J Am Ger Soc Vol.42, 1994, pp.241-244.

21. Job R.F.S., Hatfield J. Observational study of older pedestrian behaviour at various pedestrian facilities, Report to the Roads and Traffic Authority of NSW, 2002.

22. OECD. Ageing and transport: Mobility needs and safety issues, Paris, 2001.

23. Hatfield J., Murphy S. The effects of mobile phone use on pedestrian crossing behaviour at signalised and unsignalised intersections, Accid Anal Prev., Vol.39, 2007, pp.197-205.

24. Vestrup J.A., Reid J.D.S. A profile of urban adult pedestrian trauma, J. Trauma, Vol.29, 1989, 741–5.

25. Sze N., Wong S. Diagnostic analysis of the logistic model for pedestrian injury severity in traffic crashes, Accid Anal Prev., Vol.39, 2007, pp.1267-1278.

26. Eluru N., Bhat C., Hensher D. A mixed generalized ordered response model for examining pedestrian and bicyclist injury severity level in traffic crashes, Accid Anal Prev., Vol.40, 2008, 1033-1054.

27. Plurad D., Demetriades D., Gruzinski G., Preston C., Chan L., Gaspard D., Margulies. D., Cryer H. Pedestrian injuries: The association of alcohol consumption with the type and severity of injuries and outcomes, Journal of American College of Surgeons, Vol.202, No.6, 2006, pp.919-927.

28. Collins D.J., Lapsley H.M. The costs of tobacco, alcohol and illicit drug abuse to Australian society in 2004/05, Commonwealth of Australia, 2008.

29. Lee C., Abdel-Aty M. Comprehensive analysis of vehicle-pedestrian crashes at intersections in Florida, Accid Anal Prev., Vol.37, 2005, pp.775-786.

30. Koepsell T., McCloskey L., Wolf M., Moudon A., Buchner D., Karus J., Patterson M. Crosswalk markings and the risk of pedestrian-motor vehicle collisions in older pedestrians, Journal of American Medical Association, Vol.288, 2002, pp.2135-2143.

31. Roads and Traffic Authority, NSW (RTA). Sharing the main street. A practitioner's guide to managing the road environment and traffic routes through commercial centres. 2000.

32. Wood J., Tyrrell R., Carberry T., Limitations of drivers' ability to recognize pedestrians at night, Journal of the Human Factors and Ergonomics Society, Vol.47, No.3, 2005, pp. 644-653.

33. Kwan I., Mapstone J. Interventions for increasing pedestrian and cyclist visibility for the prevention of death and injuries (Review), Cochrane Database of Systematic Reviews, Issue 4, 2006.

34. Roper P., Thoresen T., Tziotis M., Imberger K. Evaluation of flashing lights in 40 km/h school speed zones with comparison of different sign types, ARRB Group Ltd, 2006.

Pedestrian injury in Victoria

Reviewed by Nancy Lane, Managing Editor, JACRS

The Winter 2010 issue of *Hazard* (no. 71) consists of the paper entitled 'Traffic-related pedestrian injury in Victoria (1). Hospital-treated injury' by Cassell, Clapperton, Alavi and Jones. The authors analysed nearly 3500 hospital-treated pedestrian traffic-related injury cases in Victoria from 2006 to 2008, with respect to variables including gender, age, language and driving conventions in country of birth, alcohol involvement, seasonal variation, type of vehicle involved, injury type and site, injury severity and hospital costs (for admissions only). *Hazard* is published by the Victorian Injury Surveillance Unit at the Monash University Accident Research Centre, email visu.enquire@monash.edu, phone (03) 9905 1805.

The cost of road crashes

Reviewed by Nancy Lane, Managing Editor, JACRS

The global consultant firm LECG and the Australasian Railway Association released the study *The cost of road crashes: A review of key issues* by Dr Richard Tooth in August 2010. Its objective is to review important issues relating to road crash costs and the extent to which they are incorporated into people's decisions. It is available for free download at http://www.ara.net.au/UserFiles/file/Publications/TheCostofRoadCrashesReport.pdf.

The study provides background on the costs associated with road crashes and how they are used to formulate policy. In particular, it addresses the debate on costs associated with loss of life, including the methodologies used for this calculation in other countries. It also examines the extent to which these costs are internalised, that is, borne by the users who contribute to them. One of the main findings is that the costs of road crashes in Australia have been consistently underestimated. The additional costs identified relate to costs of loss of life and quality of life, much of which is not borne by the road users responsible.