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.'

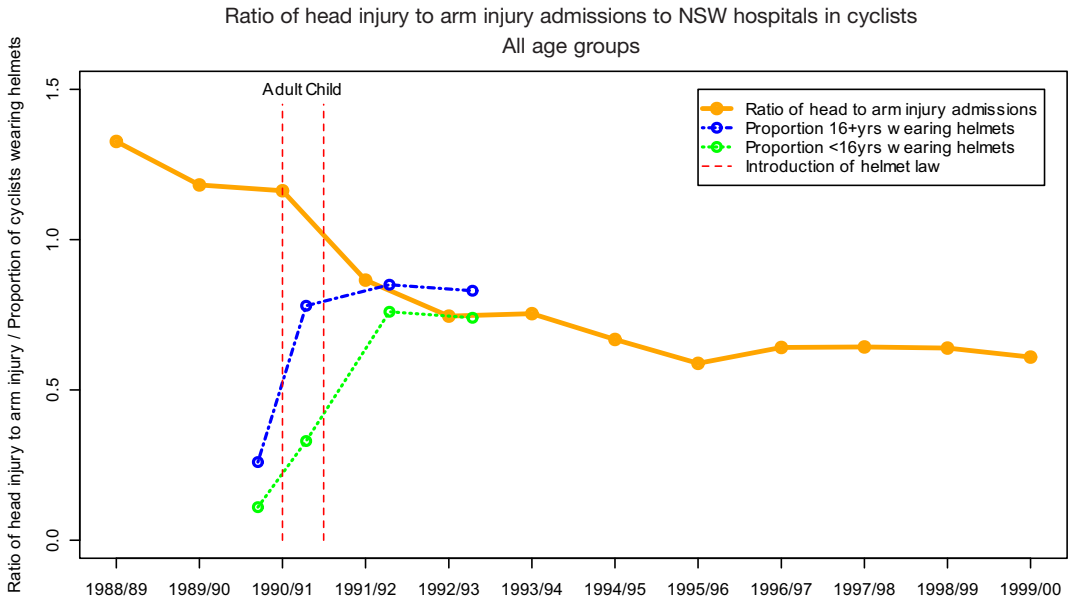

Figure 1. Ratio of head injury to arm injury admission to NSW hospitals in cyclists

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.