PEER REVIEW HISTORY

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ARTICLE DETAILS

TITLE (PROVISIONAL)	Severity of urban cycling injuries and the relationship with personal, trip, route and crash characteristics: Analyses using four severity metrics
AUTHORS	Cripton, Peter; Shen, Hui; Brubacher, Jeffrey; Chipman, Mary; Friedman, Steven; Harris, Anne; Winters, Meghan; Reynolds, Conor; Cusimano, Michael; Babul, Shelina; Teschke, Kay

VERSION 1 - REVIEW

REVIEWER	Liz de Rome Neuroscience Research Australia
REVIEW RETURNED	02-Oct-2014

GENERAL COMMENTS	This is a well-written paper in which the innovative injury metric is a potentially useful contribution to research. I have a number of comments and some suggestions for improving the clarity of the paper. Introduction. Page 5, lines 41-55. It would help the reader to understand that the current paper is part of a wider research program, this is mentioned but needs to be stated more plainly. It was only in going back to re-read the introduction that I realised that you have published other analyses of the data. Results: The description of the sample characteristics is difficult to follow and would be greatly assisted by an additional table showing the distribution of routes types (streets, bike lanes etc) by the other crash factors: types (falls/ collisions) and crash partners (motor vehicle, pedestrian, other cyclist etc) and other key factors. Did you consider including all crash partners in the analysis and if not why not? Given the high proportions of crashes that do not involve motor vehicles, there would be value in identifying the other crash partners particularly cycle-cycle crashes and cycle to pedestrian. Discussion page 14 lines 3-8. Your finding about no confounding or interaction between injury severity and route type is surprising and should be fully described in the methods and results.

REVIEWER	John Parkin University of the West of England, United Kingdom
REVIEW RETURNED	06-Oct-2014

GENERAL COMMENTS	This is a clearly written paper that reports important findings and usefully builds on previous work in the area. I have two minor general comments which might help the clarity for a reader. I also note some other minor specific issues.

Treatment urgencies. I assume the four severities on page 7 are not mutually exclusive (continued by bike, transported by ambulance, admitted, CTAS score). It may be useful to the reader to construct a cross-tabulation to show numbers in each common class. (Presumably, for example, there will be few in the 'continued by bike' class that are also in class 1 for CTAS, but it would be interesting to see the pattern in such a cross-tabulation as I think this would assist in interpreting the Table 1 results.)

Causal mechanisms. You draw quite strong conclusions about the need to separate bicycle traffic and motor traffic. I do not dispute this. I do note, however, that there is no information on the precise cause or causes of collisions. In the majority of cases this is likely to involve, as one factor, human error: either that of the driver or the cyclist. I suggest it is beginning to be tendentious to draw conclusions as firm as you have without some greater knowledge of the reasons for individual collisions. You may like to add a caveat concerning this.

Specific issues.
p6 I am not convinced that the word 'eligible' is correct when talking about those who were fatally injured.
p8 Third bullet point. You discuss collision circumstances. This may be a place where you note that you do not have information on the precise factors that caused the collision, or whose 'fault' it was.
p8 Penultimate paragraph, last line. It seems odd to suggest that the basis of your modelling was directed solely at your readers. Surely you were doing it to create the most appropriate model for yourselves to interpret as well?
Table 1 Footnote about CTAS. Would you be able to expand a little on the interpretation of the OR for 1&2 vs 3, 4 & 5 and 1, 2 & 3 vs 4 &5, please?
Table 1 last footnote about speed. Do you mean that only five speed observations were made, or that a comprehensive survey of speed was undertaken at five different times of the day and week? One might usually measure around 100 or more vehicle speeds in order to derive a mean with a reasonably small confidence interval.

REVIEWER	Cara Hamann University of Iowa USA
REVIEW RETURNED	06-Oct-2014

GENERAL COMMENTS	Super interesting study and great follow-up/complement to the previous publications from these data. I think this really contributes some new and useful information to the literature. Abstract -I suggest specifying the metrics, instead of just saying 3 metrics or one metric in the results part of the abstract. Methods -What significance level was used as the cut-point in the unadjusted regression models for inclusion in the adjusted models? Did you also take into account a priori knowledge (beyond just p-values)? -Did the use of bike lights question only apply if it was dark at the time of the crash or was this more of a question of whether or not

	they had bike lights on their bike? Results -It would be helpful to see the breakdown by bicycle-specific infrastructure (at least in descriptives). -pg. 15, first paragraph: Reference #39 should go with the Slaughter et al sentence. Also, the last sentence should be more specific. For example, you could state it like this: Compared to routes with major streets, injuries occurring on routes with bicycle-specific infrastructure did not have increased severity. Figure 1 -It is hard to distinguish the categories since it is all in grayscale. I would suggest changing to color or making some of the categories have patterns so they are more distinguishable.

VERSION 1 – AUTHOR RESPONSE

Reviewer: 1
Reviewer Name Liz de Rome
Institution and Country Neuroscience Research Australia
Please state any competing interests or state 'None declared': None declared

This is a well-written paper in which the innovative injury metric is a potentially useful contribution to research. I have a number of comments and some suggestions for improving the clarity of the paper.

Introduction. Page 5, lines 41-55. It would help the reader to understand that the current paper is part of a wider research program, this is mentioned but needs to be stated more plainly. It was only in going back to re-read the introduction that I realised that you have published other analyses of the data.

- Thanks for letting us know that this is not easy to pick up. The name of the study is now mentioned in the Abstract, and in the Introduction to try to clarify this, pages 3, 5 and 6. Hope this helps.

Results: The description of the sample characteristics is difficult to follow and would be greatly assisted by an additional table showing the distribution of routes types (streets, bike lanes etc) by the other crash factors: types (falls/ collisions) and crash partners (motor vehicle, pedestrian, other cyclist etc) and other key factors.

- We have another paper in review at the moment on exactly this issue: routes types versus crash types (including crash partners), and it includes exactly the table that the reviewer is requesting. It is cited as reference 38.

- We have added a table of descriptives (Table 1) and shortened the text to make it easier to follow the descriptive information at the start of the Results.

Did you consider including all crash partners in the analysis and if not why not? Given the high proportions of crashes that do not involve motor vehicles, there would be value in identifying the other crash partners particularly cycle-cycle crashes and cycle to pedestrian.
Discussion page 14 lines 3-8.

- We did consider this, but because direct collisions with motor vehicles had the strongest relationship to the severity metrics, we did not pursue other categories of collisions. If the collision vs. fall variable had the stronger association with severity, we would have considered further subdividing it into categories of collisions to see which collision type had stronger associations than motor vehicles collisions.

- There were very few cyclist-cyclist and cyclist-pedestrian crashes (now tallied separately on page 9).

- We can see why pedestrian-cyclist collisions were of interest, given the increased injury risk and severity on sidewalks and multi-use paths. We originally used this evidence to suggest that bike facilities "not mix bicyclists with pedestrians". But on review of our analysis of route type and crash circumstances [reference 38], we realized that only a small minority of the crashes on sidewalks and multi-use paths were with pedestrians or their pets. So we have changed the wording to our abstract and conclusions (page 20) to this: "provide bike facilities … that are not designed with pedestrians in mind." We hope this helps.

Your finding about no confounding or interaction between injury severity and route type is surprising and should be fully described in the methods and results.

- Good point, added, top of page 9.

Reviewer: 2
Reviewer Name John Parkin
Institution and Country University of the West of England, United Kingdom
Please state any competing interests or state 'None declared': None declared

This is a clearly written paper that reports important findings and usefully builds on previous work in the area. I have two minor general comments which might help the clarity for a reader. I also note some other minor specific issues.

Treatment urgencies. I assume the four severities on page 7 are not mutually exclusive (continued by bike, transported by ambulance, admitted, CTAS score). It may be useful to the reader to construct a cross-tabulation to show numbers in each common class. (Presumably, for example, there will be few in the 'continued by bike' class that are also in class 1 for CTAS, but it would be interesting to see the pattern in such a cross-tabulation as I think this would assist in interpreting the Table 1 results.)

- We have added cross-tabulations of the most severe categories to Table 2 (now moved to the Results section), alongside the Pearson correlation coefficients. Cross-tabulation of all five CTAS classes vs. the other metrics are shown in Figure 1. We have added text to describe Figure 1 and Table 2 information in more detail, pages 10 and 11. We have also added a sentence to the methods about these elements, page 7. We hope this helps.

Causal mechanisms. You draw quite strong conclusions about the need to separate bicycle traffic and motor traffic. I do not dispute this. I do note, however, that there is no information on the precise cause or causes of collisions. In the majority of cases this is likely to involve, as one factor, human error: either that of the driver or the cyclist. I suggest it is beginning to be tendentious to draw conclusions as firm as you have without some greater knowledge of the reasons for individual collisions. You may like to add a caveat concerning this.

- We did not query fault in this study, partly because we were only interviewing bicyclists, not other parties who might have been involved in the crash. We also appreciate the Dutch transportation safety principle, that humans (when walking, cycling or driving) make errors, and that the goal of transportation system design is to minimize the consequences of such errors. Offering separated facilities for bicyclists follows this principle: it minimizes the chance of collision when either a driver or a cyclist makes an error. This idea is now elaborated on page 16.

Specific issues.
p6 I am not convinced that the word 'eligible' is correct when talking about those who were fatally injured.

- Good point. Changed, page 6.

p8 Third bullet point. You discuss collision circumstances. This may be a place where you note that you do not have information on the precise factors that caused the collision, or whose 'fault' it was.

- Good idea, added, page 8.

p8 Penultimate paragraph, last line. It seems odd to suggest that the basis of your modelling was directed solely at your readers. Surely you were doing it to create the most appropriate model for yourselves to interpret as well?

- Good point, was meant first to control for confounding then allow us to compare results across metrics. Changed wording, page 8.

Table 1 Footnote about CTAS. Would you be able to expand a little on the interpretation of the OR for 1&2 vs 3, 4 & 5 and 1, 2 & 3 vs 4 &5, please?

- Good idea – explanation included in footnote (now Table 3).

Table 1 last footnote about speed. Do you mean that only five speed observations were made, or that a comprehensive survey of speed was undertaken at five different times of the day and week? One might usually measure around 100 or more vehicle speeds in order to derive a mean with a reasonably small confidence interval.

- Thanks for pointing out the confusion. This is a mean of means: 683 sites, each with 5 speed measurements, averaged. We've tried to explain it better in the footnote (now Table 3).

Reviewer: 3
Reviewer Name Cara Hamann
Institution and Country University of Iowa
USA
Please state any competing interests or state 'None declared': None declared

Super interesting study and great follow-up/complement to the previous publications from these data. I think this really contributes some new and useful information to the literature.

Abstract
I suggest specifying the metrics, instead of just saying 3 metrics or one metric in the results part of the abstract.

- Added, page 3.

Methods
What significance level was used as the cut-point in the unadjusted regression models for inclusion in the adjusted models? Did you also take into account a priori knowledge (beyond just p-values)?

- We used $p < 0.05$.
- We had a priori decided to "force" two variables previously shown to be consistently related to injury severity in the model, however, this criterion was superfluous since age and collision with a motor vehicle entered the model on based on the criteria we used for all variables.
- We have added these elements to the description of the methods, page 8.

Did the use of bike lights question only apply if it was dark at the time of the crash or was this more of a question of whether or not they had bike lights on their bike?

- In our interviews, we asked about the time of day, whether the bike had lights and whether they were on during the trip. The analysis here used the variable indicating whether lights were on, regardless of lighting conditions. This is now clarified in the methods, page 8.
- We did this because a recent randomized trial in Denmark found that running lights reduced collisions with motor vehicles by about 50%. We did not cite that study because lights were not found to be related to severity here.

Results
It would be helpful to see the breakdown by bicycle-specific infrastructure (at least in descriptives).

- More descriptives for route types are now in Table 1.

pg. 15, first paragraph: Reference #39 should go with the Slaughter et al sentence.

- Thank you, changed, page 16.

Also, the last sentence should be more specific. For example, you could state it like this: Compared to routes with major streets, injuries occurring on routes with bicycle-specific infrastructure did not have increased severity.

- Thanks, have reworded this and included more detail, pages 16 and 17.

Figure 1
It is hard to distinguish the categories since it is all in grayscale. I would suggest changing to color or making some of the categories have patterns so they are more distinguishable.
- Good idea. Have added colour to figure 1.

VERSION 2 – REVIEW

REVIEWER	Liz de Rome Neuroscience Research Australia
REVIEW RETURNED	22-Nov-2014

GENERAL COMMENTS	Thank you for the clarification of points raised by myself and other reviewers, however this has raised further questions The multivariate results show little agreement between the proposed injury severity metrics or with the CTAS, indicating their limitations as injury severity metric alternatives to other established metrics such as the Abbreviated Injury Severity scale. As a negative finding, this is a valid outcome and should be the focus of your results. The discussion of why the proposed metrics are of limited value is appropriate and a useful contribution to methodology. While the wider study may have contributed to the understanding of personal, trip and route exposure factors as predictors of crash and injury risk, this current analysis does not and may be redundant to other publications from the wider study. My suggestion would be to focus this analysis on investigating the potential value of the alternative injury severity metrics, but avoid attempting to draw conclusions relating to exposure factors such as infrastructure. The study does not accord with my understanding of a case-control design and is stretching the limitations of the definition, particularly as not all outcome variables were dichotomous. Other comments: The term 'not designed with pedestrians.....etc' does not improve understanding, I suggest that you revert to the more commonly used terms 'sidewalk and multi-use paths'. Increased crash risk in such areas is not just to do with the presence of pedestrians, other research has identified many other factors such as road surface condition and cyclists' underestimation of other potential sources of

crash-risk in vehicle-free environments.

Abstract:
Line 14. Do not name other research in the abstract, any reference should be in the body of the paper. Just provide sufficient information about the study population and how they were recruited (eg 683 adult cyclists recruited in emergency departments etc)
Line 50. I am not convinced that the results of this analysis justify the conclusions.

Introduction:
Page 5. Line 12. 'nearly as safe' is imprecise – use corresponding terms of relative risk as in the previous sentence – ie either relative injury risk or crash risk.
Page 5. Lines 41-55. Risk should be defined as either injury or crash risk.
Page 5, Lines 43 Do not name the study in the text but describe findings and provide the reference. Could say 'our previous study' or some such.
Lines 27 - 32 Again do not name the study in the text but state that this analysis is a part of the wider study previously mentioned and provide the reference.
Method:
P. 6, Line 40. The recruitment methods should be detailed in the Methods section, with 'published elsewhere' and the reference (published or unpublished). Do not assume the general reader will seek out the other paper.
p.8. line 46. Perhaps it would be clearer to explain that the outcome variables were the five injury severity metrics, four of which (did not...etc) were treated as a separate dichotomous variables.

Results and discussion

My review of these two sections are encompassed in my initial discussion on the paper above.

REVIEWER	John Parkin University of the West of England, United Kingdom.
REVIEW RETURNED	29-Oct-2014

GENERAL COMMENTS	Thanks you for addressing the comments I made on the first version of the paper.

REVIEWER	Cara Hamann University of Iowa, USA
REVIEW RETURNED	05-Nov-2014

GENERAL COMMENTS	The changes that have been made in reference to my previous comments look good. The only change I would suggest is the wording in 3 places, where you say "not designed for pedestrians". Specifically, these are located in: 1. conclusions of abstract 2. 2nd bullet under strengths & limitations 3. 2nd to last sentence in conclusions

	Written in that manner could be implied that pedestrians should be ignored. I think it would be better to say something like "designed with separation between bicycles and pedestrians" or further explain that shared facilities were problematic and that is why it would be better to separate bicycles from MVs and peds. Overall, the paper looks good!

VERSION 2 – AUTHOR RESPONSE

Reviewer: 2
Reviewer Name John Parkin
Institution and Country University of the West of England, United Kingdom.
Please state any competing interests or state 'None declared': None declared

Thanks you for addressing the comments I made on the first version of the paper.

RESPONSE: Glad to hear we were complete in our revisions.

Reviewer: 3
Reviewer Name Cara Hamann
Institution and Country University of Iowa, USA
Please state any competing interests or state 'None declared': None declared

The changes that have been made in reference to my previous comments look good.

RESPONSE: Glad to hear our revisions were appropriate.

The only change I would suggest is the wording in 3 places, where you say "not designed for pedestrians". Specifically, these are located in:
1. conclusions of abstract
2. 2nd bullet under strengths & limitations
3. 2nd to last sentence in conclusions

Written in that manner could be implied that pedestrians should be ignored. I think it would be better to say something like "designed with separation between bicycles and pedestrians" or further explain that shared facilities were problematic and that is why it would be better to separate bicycles from MVs and peds.

RESPONSE: Good point – we can see the confusion we've added here. We've changed these to indicate that facilities should be designed with cycling in mind.

Overall, the paper looks good!

Reviewer: 1
Reviewer Name Liz de Rome
Institution and Country Neuroscience Research Australia

Please state any competing interests or state 'None declared': None declared

Thank you for the clarification of points raised by myself and other reviewers, however this has raised further questions

The multivariate results show little agreement between the proposed injury severity metrics or with the CTAS, indicating their limitations as injury severity metric alternatives to other established metrics such as the Abbreviated Injury Severity scale. As a negative finding, this is a valid outcome and should be the focus of your results. The discussion of why the proposed metrics are of limited value is appropriate and a useful contribution to methodology.

RESPONSE: We agree that our four metrics measure different aspects of severity. We highlighted this in Table 2 and the paragraph above it on page 11. We also compare our metrics to Injury Severity Score in the Discussion on pages 19 and 20. We have added a sentence to the Discussion on page 19 showing the strong association found by Rivara et al. between ISS and admission to hospital.

The reviewer indicates that "the multivariate results show little agreement between the proposed injury severity metrics". This was true for a few of the risk factors studied, but most of the risk factors studied had the same direction of effect across all four metrics: age; motor vehicle collision; cycling experience; local streets, multi-use paths, and sidewalks; downhill grade; and motor vehicle speed. Not all were statistically significant. In addition to the within-study concordance between metrics, our results for many of these risk factors largely concur with results of studies that used fatalities vs. injury or ISS as their severity metrics. Some of the risk factors for which we did not find concordance between metrics (sex, intersections) have also not had consistent results in other studies.

We wondered whether the revised version of the abstract overemphasized some of the results that were not consistent from metric to metric and this gave the wrong overall impression. We have excluded the risk factors with less consistent results from the abstract and added mention of consistency for the remaining ones.

While the wider study may have contributed to the understanding of personal, trip and route exposure factors as predictors of crash and injury risk, this current analysis does not and may be redundant to other publications from the wider study. My suggestion would be to focus this analysis on investigating the potential value of the alternative injury severity metrics, but avoid attempting to draw conclusions relating to exposure factors such as infrastructure.

RESPONSE: We should clarify that we are not proposing these 4 severity metrics as new metrics for the general research population to adopt. We conducted the severity analyses because we were frequently asked by engineers, planners, and cycling advocates whether injury severities differed between route types studied in the original case-crossover study of injury risk.

We did not have AIS or ISS data, but the emergency physicians (JRB and SMF) and neurosurgeon (MDC) on our study team felt that the 4 metrics available were indicators of various aspects of injury severity. They recommended that we proceed with this analysis and provided commentary on the metrics in the paper.

We would like to offer the following example of why our severity results are important. The engineers, planners, and cycling advocates who requested these analyses were disappointed that multiuse paths did not have lower relative risks of injury in the original study analyses. They wondered if injury severity might be lower on such paths, so injuries there would be of less concern. Our severity results showed that this was not the case.

The study does not accord with my understanding of a case-control design and is stretching the limitations of the definition, particularly as not all outcome variables were dichotomous.

RESPONSE: We included "case-control" in the revised title to comply with the editor's request to indicate the study design. Because it was not designed as a case-control study, we used the wording "case-control analysis". The analysis is a case-control analysis (the same form as those of case-control studies of head injuries and helmet use, for example, references 22 and 41). However, we can see that this naming causes confusion, so we checked how other authors described their study designs in article titles in this journal and found many authors were less specific than we were trying to be. We have changed to more general wording in the title by removing the words "case-control".

Other comments:
The term 'not designed with pedestrians.....etc' does not improve understanding, I suggest that you revert to the more commonly used terms 'sidewalk and multi-use paths'. Increased crash risk in such areas is not just to do with the presence of pedestrians, other research has identified many other factors such as road surface condition and cyclists' underestimation of other potential sources of crash-risk in vehicle-free environments.

RESPONSE: Good point. Have revised this, as described in the response to reviewer 3.

Abstract:
Line 14. Do not name other research in the abstract, any reference should be in the body of the paper. Just provide sufficient information about the study population and how they were recruited (eg 683 adult cyclists recruited in emergency departments etc)

RESPONSE: Removed, as requested.

Line 50. I am not convinced that the results of this analysis justify the conclusions.

Introduction:
Page 5. Line 12. 'nearly as safe' is imprecise – use corresponding terms of relative risk as in the previous sentence – ie either relative injury risk or crash risk.

RESPONSE: Good point. Clarified.

Page 5. Lines 41-55. Risk should be defined as either injury or crash risk.

RESPONSE: Good point. Have ensured this is specified throughout.

Page 5, Lines 43 Do not name the study in the text but describe findings and provide the reference. Could say 'our previous study' or some such.

RESPONSE: Removed, as requested.

Lines 27 - 32 Again do not name the study in the text but state that this analysis is a part of the wider study previously mentioned and provide the reference.

RESPONSE: Removed, as requested.

Method:
P. 6, Line 40. The recruitment methods should be detailed in the Methods section, with 'published elsewhere' and the reference (published or unpublished). Do not assume the general reader will seek out the other paper.

RESPONSE: More detail added.

p.8. line 46. Perhaps it would be clearer to explain that the outcome variables were the five injury severity metrics, four of which (did not...etc) were treated as a separate dichotomous variables.

RESPONSE: Revised to remove mention of case or control status, and to make the comparisons for the dichotomous outcomes clearer and simpler.

Results and discussion

My review of these two sections are encompassed in my initial discussion on the paper above.