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Title	Traumatic brain injury and incarceration in men and women: a population-based cohort study
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Reviewer 1	Ms. Allison J. Bethune
Institution	Division of Neurosurgery, Sunnybrook Health Sciences Centre, Toronto, Ont.
General comments (author response in bold)	This work describes a retrospective cohort investigation of incarceration and association with previous TBI. It has important potential impact for improving follow-up care to a large portion of young adults who experience TBI in the community. The strengths of the manuscript: - A very large sample size - Long follow-up duration / large volume of person/years - A very important topic facing health care and society - Appears to be limited current Canadian literature describing the problem - Statistical methods appear appropriate and robust. Suggestions for improvement: 1. TBI severity is an important factor that is not mentioned. If it is possible, using the ICD codes break down by mild/moderate/severe TBI would provide more useful insights, for researchers/clinicians to quickly gauge the proportion of each severity. **We agree that severity is interesting and we intended to do those analyses. However, we were unable to assign severity scores to 35% of the TBI-population: the Abbreviated Injury Scale (AIS) assigns severity scores from ICD codes but were are not available for all of the diagnosis codes in the database (Unspecified head injury). We now include this as a limitation (Page 9, lines 194-196).** **Per reviewer 3's suggestion, we did perform a sensitivity analysis, examining if TBI and risk of incarceration differed among men and women who were admitted to the hospital with a TBI vs. discharged from the ER with a TBI. Being admitted to the hospital was more strongly associated with risk of incarceration and, assuming men and women who were admitted to the hospital have more severe TBI, this research supports the hypothesis that more severe TBI is associated with greater risk of incarceration. (Table 4; Page 9, lines 196-199)** 2. It is important to clarify whether you have included concussions (or mild TBI) in your definition of TBI. This could be clarified in the methodology section where ICD codes are described, using a sentence with a brief clinical descriptions (Lines 66-73). **We list the ICD-9 and ICD-10 codes that were used to define TBI, including concussions (ICD-9: 850; ICD-10; S06. Using ER and hospital discharge data, we are limited to TBI seen in these medical settings. We do note this as a limitation (Page 9, line 191-194). We also found, in our sensitivity analyses, that the association between TBI and incarceration risk was upheld when physician visits were included (Page 9, lines 193-194; Table 4)** **We encourage interested readers to look to other websites for a more full description of these diagnoses codes (e.g. http://www.who.int/classifications/icd/en/).** 3. As you point out, many community based concussion patients will not present to ED, while severe TBI can lead to long inpatient stays. These patient groups will have different impact on rehabilitation access and recovery times. **Yes, we agree.** 4. Mechanism of Injury data, if available would be of interest- in particular to guide future research. Behavioural differences after TBI have been linked to injury mechanism. Was there a predominant mechanism of injury (pedestrians hit by car vs drivers, sports-related, assault)? **The quality of mechanism of injury data that is held the Institute for Clinical Evaluative Sciences is poor. We now indicate that more work is needed on mechanisms of injury in TBI and incarceration research. (Page 10, Lines 213-215).** 5. The implications of this work are important for point of care medical professionals, if referral to appropriate interventions for behavioral/social counseling are realistic. It

	wasn't clear if patients hospitalized with TBI vs. those seen in ED and discharged were analyzed all together. It would be expected that closer follow-up occurs with a longer in-patient hospital stay. It would be of interest to know if a hospital in-patient stay (or any rehabilitation) was associated with the incarceration of patients with a TBI. **We have included a sensitivity analyses, parsing out those TBIs requiring hospital admissions and those TBIs that were seen and discharged from the ER. We found the association between TBI and incarceration was stronger for men who were admitted to hospital as opposed to men who were discharged from the ER. Point estimates suggest similar findings for women, although there was no statistically significant difference between TBI and risk of incarceration for those women admitted to the hospital vs. discharged from the ER (Table 4)** 6. Overall the study provides an interesting description of an important problem; more specifics clarifying the TBI population would useful.
Reviewer 2	Dr. Jonathan Silver
Institution	Department of Neurology, New York University School of Medicine, New York, NY
General comments (author response in bold)	This is an interesting paper that explores the relationship between the occurrence of a traumatic brain injury and incarceration in the Canadian federal system. They find that those who sustained a TBI were more likely to be incarcerated, and conclude that TBI is an important risk factor in criminal justice involvement. I have several comments and questions about the methodology, findings, and conclusions. 1. There is no description of the reasons for incarceration. As a United States citizen, I do not know why someone would be in the Canadian federal vs. provincial legal system. Is there a difference in type of crime? If the data is not available, a description would be helpful. **This paper used offenders in the Federal Correctional System (i.e. the Correctional Service of Canada) where by legislation of persons serving a sentence of two years or more are handled. This means that persons entering the federal system are more likely to be chronic offenders or to have committed more serious offences. Details of differences between the two systems can be found at http://www.statcan.gc.ca/pub/85-002-x/2016001/article/14318-eng.htm.** **On page 1, Lines 20-23 we indicate the federal justice system supervises persons sentenced by the courts to two or more years and that these sentences are characteristic of persons committing serious offences or who are in chronic contact with the criminal justice system.** 2. There is no data on severity of the TBI. **We intended to explore how the severity of TBI impacted incarceration risk and tried to assign AIS scores. Unfortunately, we were unable to assign these scores to a large proportion of our data (~35%) because many diagnosis codes for TBI were "unspecified head injury" and there are no severity scores for such codes. We have elaborated on this in the limitations section (Page 9, lines 194-196)** 3. There is no data or discussion of the circumstances of the TBI. Were they from motor vehicle accidents, falls, or assaults? There are known emotional consequences to accidents. This should be taken into consideration, or, if data not available, included in the discussion. **The quality of mechanism of injury data that is held the Institute for Clinical Evaluative Sciences is poor. We now indicate that more work is needed on mechanisms of injury in TBI and incarceration research (Page 10, Lines 213-215).** 4. I had difficulty finding the data on the time of occurrence of the TBI vs. time of incarceration. That would be the only way to know which occurred first. If it is there, please make the description clearer. **The traumatic brain injury occurred prior to federal incarceration. On Page 3, Line 64-65 we indicate that persons sustaining a TBI between July 1, 1997 and September 30, 2010 were classified as sustaining a TBI. On page 2 line 37-38 we indicate the reasons people would "drop out" of our study and federal incarceration is one of these ways. We also restate this on page 5,lines 101-103, i.e persons stopped contributing to analysis on the date of their first federal incarceration. We have added an additional sentence clarifying that TBI occurred prior to incarceration (page 5, lines 103-104)** 5. My biggest concern is the issue of association vs. causation. This was not adequately addressed in the discussion. It is easy to conceptualize common risk factors for TBI and crime: substance use, impulsivity, antisocial personality. In fact one study on mild TBI

	and suicide attempts concluded that there was one underlying predisposition to both, and it was not that TBI increased the risk for attempts (http://www.ncbi.nlm.nih.gov/pubmed/15167407). **We agree the relationship between TBI and incarceration is complex and could be influenced by other factors. We have included more details in the discussion (Page 10, lines 210-215).**
Reviewer 3	Dr. Christiaan H.B. van Niftrik
Institution	Department of Neurosurgery, University Hospital Zurich, University of Zurich, Clinical Neuroscience Center, Zurich, Switzerland
General comments (author response in bold)	In this manuscript the authors identified a large cohort of young adults and obtained health records related to traumatic brain injury (TBI), as well as incarceration history. They state that TBI is an important risk factor for incarceration for serious and chronic offending in both men and women The results show a higher incidence of TBI in the incarcerated population as opposed to the general population. The increased incidence was found both men and women. The opinion of this reviewer is that the manuscript in the current form requires major revisions. 1. The manuscript is relatively well-written und very structured and although I read this paper with great interest and the findings based on a large population based cohort are very interesting to me, I at this time fail to see the added benefit of the general hypothesis in this study to the current literature already published. In other studies like the once referenced in this paper, it has been shown that sustaining a TBI has been correlated with risk of incarceration. **We feel there is an additional need for this research: as indicated in the discussion, this is the largest study, with 16% more events than the next largest, it includes estimates for women, it focuses on a different outcome (chronic and serious offending), and is the first in Canada. (page 8, lines 163-173)** Moreover the authors do not sufficiently explain the rational and the added hypothesis of choosing specifically incarceration for serious and chronic offending as a defining endpoint. In the objective and in the interpretation the objective is in the form of a statement (Page 8, sec. paragraph Further…) without a more extensive explanation of the hypothesis and rational. 2. The second issue I have with the paper in the current from is the primary interpretation of the data. TBI as a risk factor has been presented as an indirect causality to the increase rather than a correlation. Especially in this group of subjects, with some chronically in contact with the justice system, it's hard to believe that incarceration is an independent result of the psychological/psychiatric/physical sequelae of brain injury. For instance the papers cited in the introduction (Ref 9 by Slaughter et al) report on higher anger and aggression scores and relate TBI's cognitive, behavioral and psychiatric sequelae to an increase risk of incarceration out of data gained from one single time point. However, it is my strong opinion that it would be a mistake to make any statement without having sufficient data on the included subjects prior to a TBI occurrence. The same goes for the current study discussed. Without any data on a large number of independent variables increasing the risk on incarceration no firm statement can be made about causality and the authors should be careful with that. **We agree the relationship between TBI and incarceration is complex and could be influenced by other factors. We have included more details in the discussion (Page 10, lines 210-215).** Furthermore I have several smaller comments and questions: Abstract: 3. Please state the total amount of subjects included instead of the person years of follow up. **We have indicated the number of subjects in the methods of the abstract (1.418 million) and we feel it is important to include person-years in the results. This is a closed cohort with a long follow-up period (13 years): we would expect many people would leave the study early because of death, moving to another province, or incarceration. Providing the number of subjects in the results is not as meaningful in terms of understanding the rate of events. Reporting rates in person time is also recommended in the STROBE statement (Explanation and Elaboration document).** 4. Please refrain from subjective words as much in the results section. **We have deleted the word "much".**

5. In the interpretation, the authors discuss an intervention strategy for high risk individuals with TBI. Which of the subjects within the TBI group can be seen as a high risk individual or are all high risk?
We have modified this sentence to be clearer, emphasizing primary, secondary and tertiary prevention.

Introduction:
6. As I mentioned before, please state the rational why chronic and serious offences are only taken into consideration and why this particular group of subjects adds anything new to the previous published data. Was it just an accessibility problem as mentioned in the discussion?
Yes; we only have data from the Correctional Service of Canada, the organization responsible for the supervision of men and women sentenced to at least two years. We are sharing data across different government agencies (and different levels of government, i.e. provincial and federal) and legal agreements need to be struck to ensure privacy and confidentiality. Such agreements take considerable time and resources and we were not able to secure provincial data for this project.

7. Moreover, although it might be obvious, I would like to know why the authors have chosen to analysis man and women separately.
The Government of Canada recommends gender-based analyses, as such a strategy will facilitate the achievement of their obligations and commitments to gender equality. Many medical journals also recommend sex-specific analyses (e.g.Lancet). Finally, the Canadian Institutes of Health Research, (the primary funder for health research in Canada) "expects that all research ... will integrate gender and sex into their research designs when appropriate. Doing so has the potential to make health research more ethically sound, more rigorous and more useful. Accounting for sex and gender where relevant thus supports the highest standards of research excellence."
Research suggests that traumatic brain injury can affect men and women differently and incorporating a gender-based lens is important if we wish to create policies, programs, and procedures that are gender-appropriate. Moreover, men and women have different risks of incarceration. See for example: https://www.cdc.gov/traumaticbraininjury/pdf/prisoner_tbi_prof-a.pdf

Methods:
8. Is there any reason or background information to include previous TBI with that timeframe (within 4 years prior of the starting inclusion date)?
There are concerns with the quality of some of the administrative datasets in Ontario prior to 1993. We have added in further clarification (Page 4, lines 84-85)

9. How were variables selected for inclusion in the model?
Variables were selected a priori based on their associations with TBI and /or incarceration from previous literature as well as their availability in the administrative data. (Page 4, lines 79-80)

Results:
10. The finding of the dose response relationship is interesting. Why not elaborate on that more?
We have added a sentence to indicate that we are one of the first to explore a dose response relationship between TBI and risk of incarceration. (Page 8, Lines 171-173)

11. Wasn't it possible to make a differentiation between mild, moderate and severe TBI? Would it in your opinion have made a difference?
We agree that looking at severity would make an important contribution to the literature and we were unable to assign Abbreviated Injury Scale (AIS) scores (severity codes) to 35% of the sample because of the diagnosis codes used (e.g. head injury, unspecified). We have listed this as a limitation (Page 9, lines 194-196).
We can only hypothesize if there would be a difference or not with respect to TBI and risk of incarceration. While injury severity may be important, we think there are many factors that may impact incarceration risk, including number of past TBI and anatomical location of injury.
We did perform a sensitivity analysis, examining if TBI and risk of incarceration differed among men and women who were admitted to the hospital with a TBI vs. discharged from the ER with a TBI. Being admitted to the hospital was more strongly associated with risk of incarceration and, assuming men and women who were admitted to the hospital have more severe TBI, this research suggests more severe TBI is associated with greater risk of incarceration. (Table 4)

	Discussion: 12. The sensitivity analysis did not uphold in all sensitivity analyses. Please change that sentence. **The magnitude of the relative association, as indicated by the point estimate, was upheld and we agree the association was not always significant in women. We have added further clarification (page 7, line 158-160).** 13. I really like the use of TBI in a Cox proportional hazard model with time-varying covariates. I would like to read more about the rational for choosing those variables as regressors. **Variables were selected a priori based on their associations with TBI and /or incarceration (in previous literature) as well as their availability in the administrative data. (Page 4, line 79-80)** 14. Please discuss the 2015 paper from Schofield PW et al 2015 contradicting the results in women **We place our gender-based findings in the context of the Schofield research in the discussion (Page 8, line 167-170). We state that both studies found the relative effect of TBI on incarceration risk to be approximately equal in men and women: Schofield, the risk for men and women was around 1.6 and in our study, around 2.5. We discuss reasons for potential discrepancies in the magnitude of the relative effect in the following paragraph (Page 8/9, lines 175-189), i.e. differences in outcomes; research methods; context.** 15. Of about 50.000 subjects got incarcerate, only 206 sustained a TBI. Should intervention be focused of the whole group or merely a future determined subgroup with increased risk of getting incarcerated? **There were 3531 persons who were incarcerated (see Table 2, Table 3 (3321+210=3531): the incarceration rate was 2.3 per 100,000 person-years for women and 35.9 per 100,000 person-years for men. Teasing this apart further, the rate of incarceration was much higher for men and women with as opposed to without a TBI (men: 102.6 vs 33.5; women: 9.3 vs 2.2). This translates to about 70 excess cases of incarceration per 100,000 person years for men with TBI (i.e. 102.6-33.5 ~ 70) and 7 excess cases of incarceration per 100,000 person-years for women with TBI (i.e. 9.3-2.2~7). We agree that it would be important to identify high risk populations; however, as argued by Geoffrey Rose in his seminal article Sick individuals and Sick population (Int J Epid 1985; 14-32-38), targeting the general population is also important. Accordingly, we feel that any interventions would target high risk populations and the general population.** 16. The statement for future research of improve the outcome of persons with TBI who are incarcerated is outside the scope of this paper and should be excluded. **We note that TBI seems to be an important risk factor for incarceration. From a public health perspective, primary, secondary, and tertiary prevention are key. In primary prevention, interventions would seek to reduce the incidence of TBI. In secondary prevention, interventions would focus on rehabilitating persons who sustained a TBI with the intention of reducing and modifying behaviours that could affect ones propensity for incarceration (e.g. behavioural problems). In tertiary prevention, interventions would look at mitigating any effects of TBI among people who are incarcerated. We have added a sentence to address this issue. (Page 10, lines 221-223).**