Associations between a History of Traumatic Brain Injuries and Current Cigarette Smoking, Substance Use, and Elevated Psychological Distress in a Population Sample of Canadian Adults

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ABSTRACT

BACKGROUND: This study describes the prevalence of lifetime traumatic brain injury (TBI) and its association with reports of current substance use, cigarettes smoking and psychological distress among Canadian adults in a population sample.

METHODS: A cross-sectional sample of 1,999 Ontario adults aged 18 to 93 were surveyed by telephone in 2011 as part of Centre for Addiction and Mental Health’s ongoing representative survey of adult mental health and substance use in Canada. Loss of consciousness for at least five minutes or at least one overnight hospitalization due to symptoms associated with the head injury represented minimum criteria for TBI.

RESULTS: An estimated 16.8% (95% CI: 14.8, 19.0) of adults reported a TBI in their lifetime. Men had higher prevalence of TBI than women. Adults with lifetime TBI had higher odds of past year daily smoking (AOR=2.15), using cannabis (AOR=2.80) and nonmedical opioids (AOR=2.90), as well as reporting elevated psychological distress (AOR=1.97) in the past few weeks, than adults without TBI.

CONCLUSION: The co-occurrence of lifetime TBI with reports of elevated psychological distress and substance use warrants vigilance among medical practitioners to assess the possibility of past TBI during reviews of the history leading to the occurrence of these conditions.

KEYWORDS: Traumatic brain injury, adults, substance use, psychological distress
Traumatic brain injury (TBI) is a major cause of permanent disability world-wide contributing to a third of all unintentional injury-related deaths (Faul, Xu, & Coronado, 2010). The prevalence and persistent disabilities associated with TBI render this injury particularly costly. Combined yearly direct and indirect costs (e.g., lost productivity) associated with TBI were estimated at $77 billion in US, and over 100 billion euros in Europe (Gustavsson et al., 2011). Residual deficits post TBI include decreases in speed of information processing, executive functions and memory, but also psychiatric and mental health issues, all of which affect personal relationships, health, social, and vocational success (Dean & Sterr, 2013; Yasuda, Wehman, Targett, Cifu, & West, 2001). Over the past 15 years the incidence of TBI has increased rapidly in the industrialized world, especially among youth (Ilie, Boak, Adlaf, Hamilton, Asbridge, & Cusimano, 2013; Ilie et al., 2014; Institute of Medicine of the National Academies, 2013; Sosin, Sniezek, & Thurman, 1996). In 1991 it was estimated that 1.7 million people experienced TBI (Faul et al., 2010; Sosin et al., 1996). The Centre for Disease Control and Prevention stated that TBI had become a “silent epidemic” and a public health issue, reporting an estimation of 2.5 million TBI in the US (Faul et al., 2010; National Center for Injury Prevention and Control, 2003. The number of TBI among adolescents has raised significantly in recent years, with increases as high as 57% among youth sports injuries in the US between 2001 and 2009, rendering surveillance of TBI in population a top health priority in North America (Gilchrist, 2011; Ilie et al., 2013; 2014; Institute of Medicine of the National Academies, 2013).

Consequences of TBI range from cognitive deficits, mental health sequelae, substance misuse, aggression and misconduct to challenging social relations (Cassidy et al., 2004; Ilie
Mental health and substance misuse play a significant risk factor for homelessness and violence among homeless populations (Topolovec-Vranic et al., 2014). Assessing the relationship between TBI and related harms is important given growing evidence that people who have had one or more TBIs are at greater risk of future TBIs, and evidence that multiple brain injuries can result in lasting cognitive impairment, substance use, mental health and physical health harms (Dean et al., 2013; Yasuda et al., 2001). One area of particular concern that requires monitoring, is the association of substance use, psychiatric symptoms and TBI. Little population-based data on this association exists, and studies on the relationship between psychiatric related issues (e.g., elevated psychological distress), substance misuse and TBI have been either contradictory or disproportionately based on very small clinical samples (Anstey, Butterworth, Jorm, Roders, & Windsor, 2004; Tait, Anstey, & Butterworth, 2010). Population based data, based on more than hospitalized data is scarce. Data from an Australian survey 10 years ago found that 5.6% of the total sample (of approximately 7,500 Australian people aged 20-64) reported a brain injury that resulted in loss of consciousness for at least 15 minutes. In this sample the history of TBI was related to substance use and psychiatric problems post injury (Anstey et al., 2004). Two recent population based studies based on a province wide survey of adolescents grades 7 through 12 found that 1 in 5 youth reported a TBI in their lifetime and that history of a lifetime TBI was significantly related to past year drug and substance use, mental health issues, as well as poorer current grades in school (Ilie et al., 2013; 2014).

The data reported here in unique in that it expands on previous research by examining province wide data pertaining to adults from the same geographic location with recent
adolescent population based studies that were surveyed the same year (Ilie et al., 2013, 2014). This study describes not only current estimates of adult TBI from a jurisdiction without such prior data, but investigates a range of use of substances, and, unlike many epidemiological studies, examines mental health using a standard screener. Finally, to our knowledge this is the first study to report prevalence estimates of adult TBI that capture hospitalized as well as non-hospitalized incidents of adult TBI. This is an important consideration given that a most TBIs remain unreported to a medical practitioner or hospital.

METHODS

Our data were derived from the 2011 cycle of the Centre for Addiction and Mental Health’s (CAMH) Monitor, a continuously-fielded cross-sectional telephone survey of Ontario adults aged 18 or older, and administered by the Institute for Social Research at York University. Excluded from selection were adults who were phoneless, institutionalized, and unable to speak English. The design employed a stratified, two-stage-probability sample drawn quarterly through random digit dialing of listed and unlisted landline and mobile telephone numbers. Each calendar year, the four quarterly non-overlapping samples are combined to provide a single annual dataset. Although 3,039 adults (response-rate: 51%) completed the survey in 2011, our analysis is based on a random subsample of 1,999 respondents who were asked the TBI question. A complete description of the survey and discussion of potential nonresponse bias is available on the Monitor’s webpage (Ialomiteanu, Adlaf, Hamilton, & Mann, 2011). All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all adults who participated in the
The study was approved by the Research Ethics Committees of CAMH, St. Michael’s Hospital and York University.

**Traumatic Brain Injury**

Head injuries sustained in one’s lifetime were assessed by a single question prefixed as follows: *We are interested in any head injuries that resulted in you being unconscious (knocked out) for at least 5 minutes, or you had to stay in the hospital for at least one night because of it.* Respondents were then asked: *How many times, if ever in your life, have you had this type of head injury?* Responses were recoded to create a binary lifetime TBI measure (yes=1; no=0). Similar questions assessing TBI have been previously validated (Anstey et al., 2004; Gilchrist, 2011; Ilie et al., 2013; 2014; Tait et al, 2010). While respondents were normal adults, able to participate in regular adult activities, we cannot rule out the possibility of cognitive impairments affecting responses of TBI-injured adults. Of relevance here, we found that TBI adult were no more likely than non-TBI adult to assess questionnaire difficulty as “difficult” (10.2%; 95%CI: 6.8%, 15.0% versus 6.7%; 95% CI: 5.4%, 8.2%), Second-order Rao-Scott adjusted chi-square $X^2 (1, 1966) = 5.04, P > 0.05.

**Elevated psychological distress**

The 12-item General Health Questionnaire (GHQ-12) was used to detect current psychological distress. The GHQ-12 assesses depressed mood, anxiety, and social dysfunction. A cut score of 3 or more on the binary-scored GHQ-12 is considered the validated threshold identifying someone experiencing elevated psychological distress during the past few weeks before the survey. Cronbach’s reliability-coefficient ($\alpha$) for these 12 items in this sample is 0.89 (Goldberg et al., 1997).

**Cigarettes smoking**
Smoking (daily or occasionally) was derived from the following questions: (1) *At the present time do you smoke cigarettes daily, occasionally, or not at all?*; (2) *Have you smoked at least 100 cigarettes in your life?*; (3) *How long ago was it that you last smoked?* Cigarette smoking, binary-coded (yes=1), was defined if the participant reported smoking daily or occasionally, having smoked over 100 cigarettes in lifetime as well as having smoked at least one cigarette within the past 30 days.

*Use of substances*

Also appraised was past year use of cannabis and any past year use of opioid pain relievers (e.g., Percocet, Percodan, Tylenol-3, Demerol, OxyContin, codeine) without a prescription or without a doctor’s consent. For both items, responses were binary-coded (yes=1).

*Analysis*

To accommodate the complex survey data, variances were estimated using Taylor Series Linearization available in the Complex Sample module in SPSS V20.0. The final analyses were based on a design with 6 strata (region), and 1,988 adults. Logistic regression assessed the association between lifetime TBI status (acquired vs. not-acquired) and the four outcomes, while holding constant age, sex, family income, education and marital status. To assess gender differences in TBI, a two-way TBI × sex interaction was added to each model separately and assessed with the likelihood test. The mean age was 46.6 years (range: 18-93; SD=17.0) and 47.4% were men.

**RESULTS**

The estimated lifetime prevalence of TBI among Ontario adults was 16.8% (95% CI: 14.8, 19.0). Men had net odds 2.2 times higher (95% CI: 1.63, 2.97) than women of reporting a lifetime TBI. Table 1 shows logistic regression results fitting the four outcomes on TBI
status. Adults who sustained a TBI in their lifetime had higher adjusted-odds of smoking (AOR=2.15), consuming cannabis (AOR=2.80) and using prescribed opioids non-medically (AOR=2.90) than adults with no TBI. Brain injured adults also had increased odds of elevated psychological distress (AOR=1.97). Comparison of the log-likelihood ratios for models with and without the TBI × sex interaction did not show discernible improvement. Thus, the associations presented in Table 1 did not vary between men and women.

DISCUSSION

One-in-six adults surveyed reported sustaining a traumatic brain injury in their lifetime. This estimate is higher than adult TBI estimates based on hospitalized records alone from early 2000 (Dooley, Anderson, Hemphill, & Ohan, 2008; Jorge, Robinson, Moser, Tateno, Crespo-Fracorro, & Arndt, 2004). However, this is expected given the rapid increase in TBI among teens over the past 13 years reported in the literature (Faul et al, 2010; Gilchrist, 2011; Ilie et al., 2013; 2014; Institute of Medicine of the National Academies, 2013). Corroborating the existing literature, TBI was more common among men than women (Faul et al, 2010; Dooley et al, 2008; Jorge et al, 2004). The observed TBI estimate in our sample (16.8%) is higher that the 5.7% lifetime prevalence rate Australian adult TBI reported in 2004, found relatively constant across the 20-24 year old, 40-44 year old and 60-64 year old cohorts (Anstey et al., 2004). However, whereas the Australian survey asked respondents about TBI that consisted of loss consciousness for 15 minutes or longer, our survey assessed milder cases of TBI (or concussions) as defined by DSM-IV, and asked about TBI with loss of consciousness for 5 minutes or longer, or those that resulted in at least one overnight hospitalization due to associated symptoms (Esselman & Uomoto, 1995, Frances, Mack, Ross, & First, 2000). Our estimate is, however, closely related to the
estimate of a large sample of adolescents surveyed the same year (2011), in the same geographic area (20.2%). Taken together these results corroborate the increase in teen TBI reported recently by the Centre for Disease Control in the US (Gilchrist, 2011; Ilie et al., 2013; 2014) and give a rounder picture of this public health issues. The close estimates between the Ontario adult and adolescent samples surveyed in the same year (2011) may render more support to the need for future research and injury prevention efforts against TBI that emanate from smaller scales studies found in the literature currently.

The results reported here complement hospitalized data and account for the gap between reports of hospitalized cases alone and reports of adult TBIs that go unreported to a medical professional or a hospital. Adults with TBI in this sample displayed higher odds of elevated psychological distress and corroborate recent evidence that people who report lifetime TBI also report increased symptoms of anxiety, negative affect, suicidal ideation (Anstey et al., 2004; Tait et al., 2010). These results are also consistent with recent results that examined these associations among teens, age 10 to 20 years old, and found that lifetime TBI was associated with substance misuse, elevated psychological distress, suicide attempts (even when elevated psychological distress was statistically controlled), suicide ideation, and poor school performance (Ilie et al., 2013; 2014).

Although our data do not allow us to comment on temporal ordering of substance use and TBI, the current cigarettes smoking, cannabis and nonmedical prescribed opioids reported here could represent a coping mechanism for the effects of lifetime TBI (Anstey, et al, 2004). It is therefore important that medical practitioners assess the possibility of a link between reported substance misuse and psychiatric related conditions and past TBI. At the same time, it is possible that the current reports of substance use may have had a longer history, one that predated the TBI. Assessment of TBI related links would still be important
as a preventive initiative given that research suggests a higher risk of repeated injury among individuals with TBI (Dooley et al., 2008; Jorge et al., 2004). While it is unclear what precipitates this association it is nevertheless the case that individuals sustaining a TBI are more likely to engage in substance use behaviors that could substantially exacerbate any problems they may be experiencing as a result of the TBI and further complicate any treatment regimen (Tait et al., 2010).

Given that these conditions take some time to develop, it is not uncommon for individuals to forget the TBI that preceded their occurrence and not link the two during medical appointments and reviews of the history leading to the emergence of these conditions. Hence medical vigilance on this matter is warranted and recommended.

These results are subject to important limitations. First of all, our results are based on self-report and thus subject to the sources of bias that may affect our prevalence estimates. Also, our response rate (51%), while considered good, represents potential nonresponse-bias, although our post-survey assessment of substance use and mental health indicators did not show evidence of appreciable bias (Ialomiteanu et al., 2011). Another limitation of our study is the lack of information with regards to the temporal relationship between the report of lifetime TBI and the co-occurring psychiatric related issues reported here. Based on our data we cannot establish whether these adverse correlates of TBI represent a coping mechanism to deal with the effects of TBI, or predisposing factors of adult TBI. Although most clinical literature has been devoted to examining the relationship between TBI and psychiatric related symptoms, post TBI, substance misuse and psychiatric related problems may also be viewed as risk-taking behaviours that may lead to TBI. Additional research to identify causal pathways for these relationships is needed.

Despite these limitations the results reported here are important and provide
confirmation of the high prevalence of lifetime TBI in the adult population and point to negative health synergies between TBI, substance misuse and psychiatric consequences. The results reported here corroborate evidence from teens population based studies and adult studies from Australia, and US that a common and preventable injury may underlie a substantial portion of substance misuse and psychiatric related problems in the adult population (Horner et al., 2005; Tait et al, 2010). The magnitude of the prevalence estimates and associated risks identified within this representative sample warrant the improvement of the understanding, prevention, and response to TBI among adults.
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AUTHOR DISCLOSURE STATEMENT

Authors’ contributions: GI contributed to study design, analysis and interpretation of data, drafted and edited the manuscript, and approved the final version for publication (with RM). EA, AI, HH and JR contributed to study conception and design, acquisition of data, analysis and interpretation of data, manuscript writing and editing. RM contributed to study conception and design, acquisition of data, analysis and interpretation of data, manuscript writing and editing, and approved the final version for publication (with GI). MA and MC contributed to study conception and design, interpretation of data, manuscript writing and editing.

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Ethics Approval: The study was approved by the Research Ethics Committees of Centre for Addiction and Mental Health and St. Michael’s Hospital.
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