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Traumatic brain injury, driver aggression and motor vehicle collisions in Canadian adults

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ABSTRACT

Objective: This study examines the associations between lifetime traumatic brain injury (TBI), driver aggression, and motor vehicle collisions among a population sample of adults who reside in the province of Ontario, Canada.
Method: A cross-sectional sample of 3993 Ontario adults, aged 18–97 were surveyed by telephone in 2011 and 2012 as part of Center for Addiction and Mental Health's ongoing representative survey of adult mental health and substance use in Canada. TBI was defined as trauma to the head that resulted in loss of consciousness for at least five minutes or overnight hospitalization.
Results: An estimated 91% (95% CI: 90.0, 91.9) of individuals in this sample held a valid Ontario driver's license at the time of testing. Among those, 16.7% reported a history of lifetime TBI and 83.3% reported no TBI. The prevalence of TBI was higher among men than women. Relative to licensed adults without TBI, adults with a history of TBI had significantly higher odds of engaging in serious driver aggression in the past 12 months, such as making threats to hurt another driver, passenger or their vehicle (AOR = 4.39). These individuals also reported significantly higher odds (AOR = 1.74) of being involved in a motor vehicle collision that resulted in hurting themselves, their passenger(s) or their vehicle.
Conclusion: This is the first population-based study to demonstrate a relationship between a history of TBI and higher rates of serious driver aggression and collision involvement. Given the large proportion of adult drivers with a history of TBI, these individuals may account for a disproportion burden of all traffic safety problems. Whether the increased road safety risk of adults with a history of TBI is reflective of neurocognitive deficits or is merely evidence of a cluster of unsafe activities produced by a higher risk lifestyles requires further research attention.

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1. Introduction

Driver aggression has been linked to collisions, injuries and deaths across the world (Hemenway et al., 2006; Joint, 1995; Mann et al., 2007a,b; Sagar et al., 2013; Smart and Mann, 2002; Wells-Parker et al., 2002). Collisions are a leading cause of fatalities (Peden et al., 2004). Drivers can be victims, perpetrators of driver aggression, or both (Smart et al., 2003). Understanding the factors associated with both driver aggression and collisions, and the pathways between them, would contribute significantly to prevention of both.

Being a perpetrator of driver aggression is more common among drivers who are victims of driver aggression themselves (Asbridge et al., 2003). Drivers who have been victims and perpetrators of driver aggression are more likely to report being involved in a collision in the past 12 months (Mann et al., 2007a,b). Driver anger has been reported to be associated with many risky behaviors ranging from loss of control of the vehicle, dangerous and reckless driving, causing traffic collisions, vengeful and retaliatory aggression, lapses in concentration while driving, and close calls that could have led to serious motor vehicle collisions (Deffenbacher et al., 2003; Deffenbacher et al., 2001; Hennessy and Wiesenthal, 2004). While driver aggression is observed in all age

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groups, younger drivers are more likely to be perpetrators (Wickens et al., 2011), while males and females show similar rates of driver aggression after controlling for demographic factors (Hennessy and Wiesenthal, 2004; Wickens et al., 2012, 2013). Driver aggression is more commonly experienced in urban centers with higher population density (Smart et al., 2003). Individuals who report driving more kilometers and those who drive high performance vehicles also report more driver aggression (Smart et al., 2004).

Driver aggression and collision risk are affected by psychiatric factors. Individuals who experience psychological distress are more likely to report perpetration of both mild and more serious forms of driver aggression (Fong et al., 2001; Smart et al., 2003). Specific psychiatric disorders have been linked to serious driver aggression, including intermittent explosive disorder and borderline personality disorder (Galovski and Blanchard, 2002; Sansone et al., 2010). Depression and other psychiatric disorders have been linked to increased collision risk (Mann et al., 2010a; Wickens et al., 2013). Individuals who are heavy or problem users of alcohol, or who use illicit drugs, are also more likely to report driver aggression (Butters et al., 2005, 2006; Fierro et al., 2011; Mann et al., 2004; Yu et al., 2004). The link between alcohol and collision risk is well established in the literature (Borkenstein et al., 1964). Many other psychoactive substances also have been demonstrated to increase collision risk (Asbridge et al., 2014; Callaghan et al., 2013; Li et al., 2012; Mann et al., 2007b, 2010b).

Traumatic brain injury (TBI) occurs when a sudden hit or blow to the head, or when an object piercing the skull and entering brain tissue, causes trauma and damages the brain (Nortje and Menon, 2004). TBI is a form of injury that is on the rise and can have significant neuropsychiatric consequences, and is a leading cause of injury-related disability and death (Centre for Disease Control and Prevention, 2010; Gilchrist, 2011). Concussions are a subset of more mild or moderate forms of TBI. All forms of TBI are associated with important clinical outcomes. Depending on severity and brain impact location a brain injury can reduce reaction time, concentration, visual performance, auditory sensitivity, spatial temporal performance, and hand-eye coordination (Eby and Molnar, 2010). Motor vehicle collisions are among the leading causes of TBI (Centers for Disease Control, 2010). For example, Cassidy et al. (2014) recently observed that 24% of injuries sustained in collisions were TBIs. Since TBI can affect cognitive and psychomotor skills, a serious TBI may permanently affect driver behavior and even preclude driving (D'apolito et al., 2013). Patients with TBI often report developing emotional problems and aggressive tendencies (Baguley et al., 2006; Kim et al., 2007). Population based studies of adolescents have found significant associations between having had a history of TBI and current risk conduct behaviors (e.g., stealing more than $50, carrying a weapon on school property, selling illegal drugs, setting fire), including mental health issues, and bullying (Ilie et al., 2014a,b). A few studies have examined the effects of TBI on driving in small clinical samples. The results are mixed, with some, but not all studies, suggesting a significant association between a history of TBI and driving-related problems and risk behaviors, including increased risk of collisions and driver aggression (c.f., D'apolito et al., 2013; Ilie et al., 2014a,b; Pietrapiana et al., 2005; Schultheis et al., 2002).

Recent research suggests that a relatively large proportion of individuals in the population report a history of TBI in their lifetime, and that many TBIs go unreported to a medical professional, especially milder forms of the injury (Cassidy et al., 2004). For example, Ilie et al. (2013, 2014a) found that 14.6% of a large representative population sample of Ontario students in grades 7–12 reported a history of head injuries that resulted in at least 5 min of unconsciousness, or at least one overnight in the hospital, in their lifetime (but not in the past 12 months) and 5.6% had experienced an injury like this in the past year. Rates of head injuries among adolescents in Western countries appear to have been increasing in recent years (Centers for Disease Control, 2010; Halstead, 2011; McKinlay et al., 2008; Rusnak, 2013), and having experienced a TBI is strongly predictive of experiencing a TBI in the future (Belanger et al., 2010). Individuals who had experienced these injuries were also more likely to report substance use, suicidality, and increased aggression, such as bullying and other violent and delinquent behaviors (Ilie et al., 2013, 2014a,b, 2015). Associations between a history of TBI and current substance use, and a variety of risk behaviors, have also been reported among Australian adults (Anstey et al., 2004).

While clinical studies have shown that more serious cases of brain injury affect driving behavior and further risk of collisions, no studies have yet examined the association between a history of TBI, driver aggression and collision risk in population samples. In this work we examine the association between self-reported history of TBI, driver aggression and collision risk in a large representative sample of the driving licensed adults living in Ontario, Canada.

2. Methods

Our data were derived from the 2011 and 2012 cycles of the Center for Addiction and Mental Health's (CAMH) *Monitor*, a cross-sectional telephone survey of Ontario adults aged 18 years 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 3039 adults (response-rate: 51%) completed the survey in 2011 and 3030 adults (response-rate: 51%) completed the survey in 2012, only 3993 (1999 and 1994 respondents, from 2011 and 2012, respectively) were asked the TBI question and of those only 3626 adults also held a valid Ontario driving license. Our analysis is based on this later figure. Two versions of the survey were administered in this period. The version of the survey that administered the TBI question (Panel B) included 150 questions in total and averaged 23 min to complete. Interviews were distributed across a six-day week (Fridays excluded) and time of day. A complete description of the survey, its items, methods of administration and discussion of potential non-response bias is available on the *Monitor*'s webpage (Ialomiteanu et al., 2011; Ialomiteanu and Adlaf, 2013). The study was approved by the Research Ethics Committees of CAMH and York University.

2.1. Measures

2.1.1. 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 min, 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; Ilie et al., 2013, 2014a,b; 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

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