Protocol: Mild Traumatic Brain Injury in the Workplace: Prevalence, Correlates and Comorbidities, and Outcomes

CHRISTINE M. WICKENS[1,2,3,*], VINCY CHAN[4], ANGELA COLANTONIO[2,4,5,6,7], GINA STODUTO[1], DANIELLE TOCCALINO[8], ROBERT E. MANN[1,2,3]

1. Institute for Mental Health Policy Research
Centre for Addiction and Mental Health,
33 Russell St,
Toronto, M5S 2S1
Canada

2. Dalla Lana School of Public Health
University of Toronto,
155 College St,
Toronto, M5T 3M7
Canada

3. Campbell Family Mental Health Research Institute
Centre for Addiction and Mental Health

4. Kite-Toronto Rehabilitation Institute
University Health Network,
550 University Ave,
Toronto, M5G 2A2
Canada

5. Rehabilitation Sciences Institute
University of Toronto,
500 University Ave,
Toronto, M5G 1V7
Canada

6. Department of Occupational Science and Occupational Therapy
University of Toronto,
500 University Ave,
Toronto, M5G 1V7
Canada

7. ICES
2075 Bayview Ave,
Toronto, M4N 3M5
Canada

8. Institute for Health Policy, Management and Evaluation
University of Toronto,
155 College St,
Toronto, M5T 3M7
Canada

Email: christine.wickens@camh.ca

Abstract

Introduction. Traumatic brain injuries (TBI) are common and frequently comorbid with, or may precede or result from, mental health and substance use problems. Population-based data on mild traumatic brain injury and subsequent return to work (RTW) are limited, particularly by sex. This research will pursue four primary aims: (1) to provide a population-level estimate of the prevalence of work-related mild TBI in Ontario; (2) to identify and compare correlates (e.g., demographic and occupation characteristics, injury characteristics) and comorbidities (e.g., mental and physical health, substance use) of work-related versus not-work-related mild TBI; (3) to identify factors (e.g., demographic and occupation characteristics, injury characteristics, psychosocial and work environment factors) predictive of the RTW experience (e.g., length of time before RTW, level of productivity, length of time workplace accommodations are in place, length of time employed in that position post-injury); and (4) to examine publicly-funded health services used following work-related mild TBI in Ontario. **Methods and Analysis.** New work-related TBI items will be included in the Centre for Addiction and Mental Health (CAMH) Monitor survey of the Ontario adult population that will provide a population-based estimate of the prevalence of work-related TBI, stratified by injury severity. Follow-up interviews with those reporting a work-related TBI will include questions related to the circumstances specific to work-related TBIs (e.g., industry, job type) and the RTW experience. Interview data will be linked to healthcare usage data from ICES (formerly Institute for Clinical Evaluative Sciences). **Ethics and Dissemination.** All participants will be asked to provide informed consent to participate, and approval will be obtained from the REBs at CAMH, York University, and the University of Toronto. Using a multi-faceted knowledge transfer and exchange plan, study findings will be used to leverage support for prevention and intervention initiatives from government, research, and regulatory authorities, and to guide improvements to workplace TBI policies and programs.

Submitted: Feb. 24, 2020 Revised: Mar. 3, 2020 Accepted: Mar. 11, 2020

Literature Review

Traumatic Brain Injury: Prevalence and Impact. Injuries produce greater population harm than most chronic health conditions (World Health Organization, 2004). A leading source of these injuries is traumatic brain injury (TBI). Globally, TBI had an estimated prevalence of 55 million in 2016 (James et al., 2019), and in the United States an estimated 3.17 million individuals are living with sequelae of TBI (Maas et al., 2017). Prevalence of a lifetime TBI has been estimated at 1 in 5 in adolescents and 1 in 6 among adults in North America (Faul et al., 2010; Ilie et al., 2019; Ilie, Wickens, et al., 2017; Veliz et al., 2017). TBIs have been identified as a leading cause of disability and death among adults and children (Ilie et al., 2013; Lu et al., 2005; Tagliaferri et al., 2006). TBI can cause a wide range of functional changes, including cognition, sensation, language, and emotions, and may affect many aspects of an individual's life (Dillahunt-Aspillaga et al., 2015); however, there is wide variation between individuals in the outcomes of TBI, based on severity (Gamboa et al., 2006). Of note is that mental health and substance use problems are also comorbid with TBI. People who have experienced TBI are significantly more likely to experience mental health problems including anxiety and depression, and substance use problems and

disorders including those related to alcohol and cannabis (Ilie, Ialomiteanu, et al., 2015; Ilie, Vingilis, et al., 2015).

Even mild TBIs can have substantial and lingering effects. The symptoms of a mild TBI usually disappear quickly, with most patients recovering within 3 to 6 months (Belanger et al., 2005; Cancelliere et al., 2014; Eme, 2017); however, approximately 15% of patients continue to experience symptoms for much longer (Eme, 2017). Some deficits associated with TBI may not emerge immediately, and may only be noticeable when patients attempt to return to their original home and work life (Ilie, Ialomiteanu, et al., 2015; Ilie, Mann, et al., 2017; Ilie, Vingilis, et al., 2015; Shames et al., 2007). Mild TBI has been associated with cognitive outcomes (e.g., decreased speed of information processing, attention problems, confusion), behavioural outcomes (e.g., irritability, emotional lability, hyperactivity), and somatic outcomes (e.g., headache, dizziness, nausea) that can significantly impact family, social, and work life (Eme, 2017). It is believed that 70 to 90% of all brain injuries are considered mild (Cassidy et al., 2004). The incidence of hospital-treated mild TBI is estimated to range from 100 to 300 per 100,000 globally, but because many mild TBIs are not treated at hospitals (Kristman et al., 2014) and because mild cases are often missed or misdiagnosed by primary care physicians, the true incidence is suspected to exceed 600 per 100,000 (Cassidy et al., 2004; Faul & Coronado, 2015; Ryu et al., 2009).

Workplace Traumatic Brain Injury. Individuals who have been injured in the workplace represent a distinct subgroup of individuals with TBI, having suffered their injuries from high-energy processes and special hazards (Paci et al., 2017), but relatively few studies have focused exclusively on work-related TBI (Chang, Guerriero, & Colantonio, 2015). Based on data from the Workplace Safety and Insurance Board (WSIB) in Ontario, Xiong et al. (2016) reported an increase in the percentage of injuries coded as "concussion" from 0.6% in 2002 to 3.3% in 2013, and an increase in the proportion of injuries affecting the cranial region from 1.9% in 2002 to 4.2% in 2012 across all industrial sectors. Increases in the incidence of TBI generally have also been reported in the United States (Faul & Coronado, 2015). This elevation in rates of reported TBI may be the result of changes in the population's demographic profile, in related health conditions or chronic diseases, or may be the result of increasing awareness of TBI symptoms and the need to seek immediate treatment. Length of stay in hospital resulting from any type of work-related TBI ranges significantly, but an estimated mean of 13 to 15 days in hospital has been commonly reported, with a median of 7 days (Kim et al., 2006; Paci et al., 2017). Kristman et al. (2008, 2010) reported that approximately 6 out of every 1000 insurance claims for lost wages due to injury in Ontario involve a mild TBI, and 87% of Ontario workers with a mild TBI file a claim for wage replacement that results in a median duration of 11 days. Five percent of these claims persist more than two years beyond the original injury. Healthcare utilization by Ontario workers affected by a mild TBI has been shown to peak in the first 4 weeks following initiation of a claim to the WSIB, and remained 182% higher relative to pre-injury levels up to the 12th week after initiating the claim (Kristman et al., 2014). Healthcare utilization was still elevated by 9.5% relative to pre-injury levels 2 years after initiation of a claim. Relative to the general unemployed population, workers who have experienced a mild TBI are more than three times as likely to remain unemployed 12 months later (Doctor et al., 2005).

In a review of the Ontario Trauma Registry for the years 1993 through 2001, Kim et al. (2006) compared the predictors of workplace TBIs with non-workplace TBIs that were considered serious. Injuries occurring in the workplace affected slightly older individuals who were more likely to be male. Generally, individuals with a work-related TBI were less likely to demonstrate psychiatric comorbidity. Although certain occupational categories demonstrated a higher proportion of individuals with a psychiatric history, overall results suggested that this factor should not play an important role in future prevention initiatives. In a more recent study, Paci et al. (2017) reviewed medical records of patients admitted to the Montreal General Hospital following a work-related TBI. Consistent with the results of Kim et al. (2006), patients were predominantly middle-aged men with a high school level of education who were working in heavy industries, such as construction. Paci et al. (2017) suggested that although older workers generally have a better understanding of and commitment to workplace safety (Siu et al., 2003; Gyekye & Salminen, 2009), their lessened musculoskeletal coordination and strength may be contributing to increased workplace injuries in construction-related industries. The low prevalence of mental health problems in the sample was consistent with the findings of Kim et al. (2006).

Although not the only measure of a successful recovery from TBI, return-to-work (RTW) (i.e., paid employment) is typically viewed by individuals with a TBI, their families, professional clinicians, researchers, and disability insurers as the most valued possible outcome of post-injury rehabilitation (Levack et al., 2004). The loss of a meaningful occupation by individuals with a TBI can threaten their autonomy, sense of self and identity, and their self-worth (Sveen et al., 2016). For TBI survivors and their families, returning to paid employment provides increased control over one's life and a sense of

productivity, purpose, and personal value. RTW is also associated with reduced risk for anxiety, depression, substance abuse, and other negative sequelae known to affect TBI survivors, and reduces usage of health services post-injury (Cancelliere et al., 2014; Wehman et al., 2005; Xiong et al., 2016). Being able to predict vocational outcome is valuable for rehabilitation planning, specialized vocational support services, role adjustment for patients and their families, and medico-legal proceedings tasked with determining potential impairment moving forward (Ownsworth & McKenna, 2004). Identifying factors that predict delayed or failure to RTW may help to identify individuals with TBI who might benefit from rehabilitation and to improve RTW outcomes (Cancelliere et al., 2014). Inconsistencies regarding the most relevant predictors have been recognized, but likely result from methodological differences between studies (Ownsworth & McKenna, 2004; Wehman et al., 2005).

A broad range of potential predictor variables relevant to vocational outcome, including demographic and employment characteristics, have been empirically assessed. Type of occupation at the time of injury has been identified as a predictor of RTW, with more frequent success observed among professional/managerial occupations, followed by skilled work, and then manual labour (Crépeau & Scherzer, 1993; Ownsworth & McKenna, 2004; Walker et al., 2006; Xiong et al., 2016). Individuals without higher qualifications, and thus less stable employment pre-injury, likely face greater difficulty reintegrating into the workplace than individuals with these pre-existing assets (Ownsorth & McKenna, 2004). The relationship between age at the time of TBI and employment outcome has been associated with mixed findings. Some studies have suggested that individuals over the age of 40 at the time of injury are less likely to return to paid employment at 1 to 5 years post-injury (Keyser-Marcus et al., 2002; Ponsford et al., 1995). However, Kristman et al. (2010) reviewed WSIB claims and suggested a "U" shaped relationship between age and RTW after mild TBI. Specifically, more susceptible workers experience injury earlier in their careers and exit the profession, while "healthier" workers who persist in the profession experience a lower rate of injury mid-career but a rising rate of injury later in the profession due to the physical effects of age. In terms of sex and gender differences, an early meta-analysis by Crépeau and Scherzer (1993) concluded that males were more likely than females to RTW following less serious TBIs. However, other researchers have suggested that the small proportion of female patients with TBI challenges assessment of sex as a predictor of RTW following TBI. More recent studies, including more recent meta-analyses, have failed to identify sex as a significant predictor of RTW (Cancelliere et al., 2014; Ownsworth & McKenna, 2004; Vikane et al., 2016).

The association between injury severity and RTW has received extensive empirical attention, often suggesting that a shorter duration of coma, posttraumatic amnesia, length of stay in rehabilitation, and lower scores on acute measures such as the Glasgow Coma Scale may be positive indicators of subsequent RTW (Keyser-Marcus et al., 2002; Wehman et al., 2005). However, a critical review by Ownsworth and McKenna (2004) concluded that the predictive value of severity indices for vocational outcome were inconclusive and perhaps more valuable when predicting survival or specific aspects of neuropsychological functioning. Recent research has begun to examine the predictive value of acute cognitive and neuropsychological impairment and functional status. Scores on the Glasgow Outcome Scale six to eight weeks post-injury have been found to predict RTW one year post-injury (Vikane et al., 2016), and scores on the Functional Independence Measure at time of discharge have been found to predict employment status at a 5-year follow-up of patients with TBI (Keyser-Marcus et al., 2002). Cognitive and neuropsychological disturbance have also been recognized as indicators of RTW outcomes (Dawson et al., 2007; O'Connell, 2000; Ownsworth & McKenna, 2004; Xiong et al., 2016). Drake et al. (2000) reported that verbal memory, verbal fluency, and a speed test for planning and strategy predicted employment status up to 15 months after mild TBI.

Although identification of pre-injury characteristics and acute functional impairments that are predictive of RTW can be valuable (e.g., to assist with rehabilitation planning and medico-legal proceedings), these factors are not subject to alteration or facilitation. On the contrary, psychosocial and work environment factors predictive of RTW outcomes can be positively influenced. A number of studies have demonstrated that anxiety, depression, and psychological distress following a TBI are associated with poor employment outcomes (Dawson et al., 2007; Ownsworth & McKenna, 2004; Vikane et al., 2016; Xiong et al., 2016). Maladaptive coping styles, known to increase risk for mood disorders (Parle et al., 1996; Thompson et al., 2010), have also been found to predict poor employment outcomes following TBI (Dawson et al., 2007; Tomberg et al., 2005). Psychosocial interventions such as cognitive behavioural therapy and coping effectiveness training have been shown to be effective in reducing anxiety and depression and to enhance adaptive coping strategies in traumatically injured populations (Kennedy et al., 2003; Khan-Bourne & Brown, 2003). Tomberg et al. (2005, 2007) identified weaker perceptions of and satisfaction from social support in TBI patients versus controls, and several studies have suggested a

positive impact of social support on RTW outcomes following TBI (Izaute et al., 2008; Tomberg, 2007). Few studies have assessed the association between employer or work environment variables and RTW (Ownsworth & McKenna, 2004). Johnson (1987) found that the opportunity to return to the previous pre-injury position, special accommodations (e.g., modified duties), and a longer period over which special accommodations were maintained were associated with successful RTW. Although rarely studied, attitudes in the workplace including those of the employer and co-workers can also be perceived as environmental barriers that threaten RTW outcomes (Whiteneck et al., 2004). Work support systems that are carefully coordinated and managed may contribute significantly to successful RTW experiences (Gilworth et al., 2008; West, 1995).

Population-Level Surveying of Traumatic Brain Injury. We have initiated an innovative program of research examining the prevalence and correlates of TBI in our ongoing representative surveys of the Ontario adult (aged 18 years and older) and student (grades 7-12) populations (e.g., Boak et al., 2016; Ialomiteanu et al., 2016). These studies provide a valuable perspective on TBI in the population, since estimates of TBI are not limited to those captured by healthcare databases which are believed to miss large numbers of injuries not reported to healthcare practitioners or treated at hospitals (Cassidy et al., 2004; Kristman et al., 2014; Ryu et al., 2009). We have observed that the incidence of past-year TBI in student and adult populations ranges between 3 and 6% (Ilie et al., 2013; Ilie, Vingilis, et al., 2015), with the prevalence of lifetime TBI ranging between 16 and 20% (Ilie et al., 2013; Ilie, Vingilis, et al., 2015). Lifetime experience of these injuries is associated with problems related to substance use (including problem gambling), mental health, and aggression (Ilie, Ialomiteanu, et al., 2015; Ilie, Mann, et al., 2017; Ilie, Vingilis, et al., 2015; Ilie, Wickens, et al., 2017; Turner et al., 2019), which are in turn associated with negative outcomes such as increased suicidality, injury, and chronic health problems including heart and liver disease (e.g., Mann et al., 2003; 2006; Wickens et al., 2016; 2017). Comorbidity of TBI with hazardous or harmful drinking is associated with higher likelihood of aggression, and possible other mental health problems, compared to the presence of either by itself (Ilie et al., 2019; Ilie, Wickens, et al., 2017). These findings point to the value of population surveys for the study of TBI and its consequences.

Research Objectives

To maximize the impact of initiatives designed to prevent TBI and improve outcomes, a strong evidence base is needed. Prevalence, correlates, and outcomes of mild TBIs and their impact on health service needs are most commonly estimated from hospital data. However, many mild TBIs are not treated at hospitals, likely resulting in underestimation of prevalence and limited understanding of correlates and outcomes. Data on factors that predict RTW following mild TBI are often restricted to those cases reported to hospitals and disability insurers. Studies of RTW are also often limited to short follow-up periods, obscuring knowledge of whether individuals who returned to work were able to sustain their employment over longer durations of time. The proposed study focuses on expanding and refining the existing literature/knowledge base.

The CAMH Monitor is a population-based survey of Ontario adults aged 18 years and older which assesses substance use and related harms, mental health, and general well-being. Questions related to past-year and lifetime TBI, status of a TBI as a workplace injury, and the severity of this TBI will be included in the CAMH Monitor for an 18-month period. Individuals who self-identify as having experienced a workplace injury will be invited to participate in a follow-up interview to further explore their workplace TBI and their RTW experience. To further assess the use of health services following work-related mild TBI beyond those reported to the WSIB, deterministic linkage to health administrative databases available through ICES (formerly the Institute for Clinical Evaluative Sciences) will be conducted using the date of birth, sex, forward sortation area (FSA; part of the postal code), and first and last name (if available) of respondents who indicate a lifetime history of work-related mild TBI.

The project will have four primary aims: (1) to provide a population-level estimate of the prevalence of work-related mild TBI in Ontario; (2) to identify and compare correlates (e.g., demographic and occupation characteristics, injury characteristics) and comorbidities (e.g., mental and physical health, substance use) of work-related versus not-work-related mild TBI; (3) to identify factors (e.g., demographic and occupation characteristics, injury characteristics, psychosocial and work environment factors, accommodations requested of and made by the employer, financial stress, involvement in litigation) predictive of the RTW experience (e.g., length of time before RTW, level of productivity, fatigue, workplace stress, impact of RTW on non-workplace activities, length of time workplace accommodations are in place, length of time employed in that position post-injury); and (4) to examine publicly-funded health services used following work-related mild TBI in Ontario.

Expected Outcomes

Available data on work-related mild TBI is limited and likely biased by the decision of some not to seek immediate medical treatment or from misdiagnosis by primary care

physicians (Cassidy et al., 2004; Kristman et al., 2014; Ryu et al., 2009). Study of factors predictive of RTW after mild TBI is similarly biased and often limited to short follow-up of TBI patients. The proposed research is designed to expand and refine the literature/knowledge base regarding work-related mild TBI in an effort to inform prevention and intervention initiatives, which in turn can reduce strain on the workers' compensation system. Inclusion of the proposed TBI items in the CAMH Monitor population survey will help to address the existing underestimation of work-related mild TBI, providing a less biased estimate of prevalence and a means by which to assess correlates and comorbidities of mild TBI generally and in the workplace (aims 1 and 2). By identifying those most at risk for a work-related mild TBI and its most common negative comorbidities, the proposed study will also inform how best to target these initiatives. Follow-up interviews with individuals who have experienced a work-related mild TBI will provide valuable insights regarding time away from work, how injured workers experience RTW (e.g., productivity, perceived support), what impact RTW may have on their home and social life (e.g., increased fatigue from RTW may result in less quality time with family and friends), how long workplace accommodations were needed and provided, and if workers were able to continue in their original position over the long term (aim 3). Identification of perceived barriers to and facilitators of RTW will enable the WSIB to support employers in their efforts to help injured employees transition back to work. Deterministic linkage to health administrative databases will build on previous studies of health data by identifying patients who did not seek treatment for a mild TBI or did not report it to their employer, allowing for identification of the otherwise hidden costs associated with work-related mild TBIs (aim 4). The outcomes associated with each aim will be used to leverage support for prevention and intervention initiatives focused on work-related mild TBI, and will inform the development of evidence-based education and awareness programs for Ontario employers and workers. Through an extensive knowledge translation plan, these outcomes will assist employers in providing workplace accommodations that are perceived as supportive and helpful by injured workers returning to their place of work.

Methodology

The CAMH Monitor. The CAMH Monitor is a population-level, computer-assisted telephone interview survey of Ontario adults aged 18 years and older. Designed to be the primary means for monitoring substance use and mental health issues in the Ontario adult population, the CAMH Monitor assesses mental and physical health status, alcohol and other drug consumption, gambling behaviour, debt stress, and driving and collision experiences. The sample is generated through a stratified (by six regional area code aggregates), two-stage (primary sampling unit: telephone number; secondary sampling unit: respondent), list-assisted random-digit-dialing (RDD) rolling probability selection procedure. Quarterly non-overlapping samples of approximately 750 completions each are merged at the end of each calendar year to provide a single annual dataset (Alexander, 2002; Kish, 1999); thus, a total of approximately 3,000 complete responses are collected each year. The survey is administered by the Institute for Social Research at York University.

Increasing rates of cell phone-only households have created sampling challenges for single-frame landline-based telephone samples (see Sean Hu et al., 2011). Therefore, the CAMH Monitor adopts a dual-frame sampling (landline and cell phone numbers) strategy: (1) a province-wide list-assisted RDD sampling frame (80% of the sample); and (2) a province-wide cell phone RDD sampling frame (20% of the sample). To increase the probability of selecting a younger adult (aged 18 to 30 years) as the respondent in a household, thereby increasing sample representativeness, when calling landline numbers interviewers ask, “Including yourself, how many people between 18 and 30 years of age live in your household?” If only one person between the ages of 18 and 30 years lives in the household, this individual is selected as the respondent. If the household includes more than one adult in this age range, one of the younger adults is randomly selected using the next birthday method. In households with no adults under 30 years of age, the next birthday selection method is used; the probabilities of selection remain unchanged by the ages of household members. For the cell phone sample, it is assumed that each cell phone is linked to a single individual. Thus, the adult user of the cell phone is identified as the respondent, regardless of the number of adults living in the household. To improve and balance the precision of estimates within each regional stratum, the sample is equally allocated among six area code strata within the province, resulting in a disproportional-to-population allocation. Based on the most recently available census figures, survey weights are introduced to restore population representation. This weighted sample is considered representative for Ontarians aged 18 years or older. Over the past five years, the response rate of the CAMH Monitor has ranged from 37% to 48%, which is considered good for telephone surveys of this nature (Ialomiteanu et al., 2018; Morton et al., 2012; Pew Research Centre, 2017).

The CAMH Monitor includes items about lifetime and past-year TBI, defined as any head injury that resulted in unconsciousness for at least 5 minutes or that required at least a one-night stay in hospital. By considering loss of consciousness only, this definition may exclude some cases of mild TBI. Nonetheless, we have found that

approximately 18% of respondents report lifetime TBI using this definition (Ilie, Wickens, et al., 2017). As of January 2018, an additional item asks about "any hit or blow to the head or neck that resulted in a headache, dizziness, blurred or double vision, vomiting, feeling confused or 'dazed', problems remembering, neck pain, or knocked out or loss of consciousness". Early estimates suggest that 30% of respondents report a lifetime TBI using this more inclusive definition. The CAMH Monitor also includes an item asking about the causes of any reported TBI (e.g., falls, motor vehicle collisions).

New Items for the CAMH Monitor. The proposed study will include additional questions regarding: (1) the severity of a TBI; and (2) whether any cases of mild TBI were work-related. Although it is the source of some debate, mild TBI is typically defined by normal structural imaging, loss of consciousness for 0-30 minutes, altered mental state duration for less than 24 hours, post-trauma amnesia for less than 1 day, and a Glasgow Coma Scale score ranging from 13 to 15 (Eme, 2017). Epidemiological surveys can accommodate only a few items per construct. Thus, the TBI severity item to be added to the survey will focus on loss of consciousness: "How many times in your life have you had a head or neck injury that resulted in a neck pain, headache, dizziness, blurred or double vision, vomiting, or made you feel confused or "dazed", or resulted in you having problems remembering, or being knocked out or losing consciousness for up to 30 minutes?" Loss of consciousness for no more than 30 minutes is the primary criterion used to define mild TBI, and is most likely to be answered accurately by respondents without a medical education. Cases where participants respond 'yes' to this question will be identified as mild TBIs. Participants reporting a mild TBI will be asked if this type of injury ever occurred while working for income, including self-employment. The inclusion of these new items in the CAMH Monitor will allow for a population-based estimate of the prevalence of work-related mild TBI in Ontario, beyond what is available in hospital and insurance data. When combined with the existing items in the CAMH Monitor, these additional items will allow for the assessment of correlates and comorbidities of work-related versus not-work-related mild TBI.

Follow-up Interviews. We have recently implemented follow-up interviews with individuals who report a lifetime history of TBI in their responses to the CAMH Monitor telephone interview. These follow-up interviews are designed to further explore the circumstances of their injury and subsequent outcomes, including access to healthcare services, unmet healthcare needs, impact of the injury, and mental illness or addiction issues. At present, approximately 55% of those invited to participate in the follow-up interview agree to do so. Recent amendments to that project have created an opportunity to leverage and integrate it with the proposed project. Additional questions will be asked of interviewees who report a work-related mild TBI. These items will request additional details surrounding the injury (e.g., type of employment, industry of employment, whether the injury was reported to the employer, length of any absence from work, level of financial stress associated with time off work, whether the respondent was subsequently involved in litigation) and, for those who took leave from work, details surrounding their RTW experience (e.g., length of time before RTW, whether and for how long accommodations were needed and made by the employer following their TBI, level of workplace stress following their RTW, impact of RTW on non-work activities, how long the worker remained in their position post-injury). Structured interviews will be computer-assisted using REDCap software. Participants are eligible to receive a $20 Tim Hortons gift card.

Deterministic Linkage to Population-Based Health Administrative Data. To further explore the healthcare costs associated with work-related mild TBI, deterministic linkage to health administrative datasets available through ICES will be conducted using the date of birth, sex, FSA, and first and last name (if available) of respondents who indicate a lifetime history of work-related mild TBI. This linkage will facilitate identification of emergency department or acute care use approximately two years after the injury. The following ICES-held datasets will be reviewed: (1) the Ontario Health Insurance Plan Claims Database (OHIP); (2) Ontario Mental Health Reporting System (OMHRS); (3) the Discharge Abstract Database (DAD); and (4) the National Ambulatory Care Reporting System (NACRS). Multiple outcome measures will be considered including: (1) alternate level of care (ALC) days (where a patient is unnecessarily occupying an acute care hospital bed); (2) re-hospitalization within 30 days; (3) repeat non-urgent emergency department visits (defined by a triage level of 4 or 5 on the Canadian Triage and Acuity Scale); and (4) total daily number of healthcare services accessed.

Planned Analyses

Data from the CAMH Monitor will provide a population-level estimate of the lifetime and past-year prevalence of mild TBI, and will delineate those injuries that are work-related versus those that are not. Initial exploratory analysis of the sample will be performed, where differences between groups (TBI and no TBI) will be assessed with chi-square tests for categorical variables and one-way ANOVA for continuous variables. Non-parametric tests may be used if the normality assumption is found to be violated. Subsequent unadjusted and adjusted regression analyses will be conducted to identify significant factors associated with experience of a mild

TBI. These analyses will identify risk factors for mild TBI (e.g., demographic characteristics, employment industry, type of job) and possible outcomes (e.g., poor physical and mental health, hazardous substance use, problem gambling behaviour, higher collision risk). Additional analyses will contrast the results for TBIs that were work-related with those that were not. Although previous research has suggested a high over-representation of males versus females among workers affected by a TBI (Kim et al., 2006; Paci et al., 2017), all data collected will be stratified by sex and gender, which will each be included as a covariate in all regression models, followed by separate sex- and gender-specific regression analyses. When examining lifetime TBI, analyses will adjust for year of injury and will assess for changes in relationships over time. Interview data from individuals who have experienced a work-related mild TBI will be subject to initial exploratory analysis for descriptive purposes and comparison to cases that were not work-related. Sex, gender, and year of injury will also be considered. Data from the interviews will provide a more thorough understanding of factors, such as facilitators and barriers to post-injury healthcare, other health-related impacts (e.g., financial stress, work stress), facilitators and barriers to returning to work, and workplace accommodations offered or needed.

The deterministic linkage to ICES datasets will reveal the extent to which publicly-funded health services are used, and will specify the types of services used (e.g., inpatient rehabilitation, homecare, physician services) among individuals with a self-reported mild TBI, which is known to be severely underestimated when using health administrative data. The Andersen Behavioural Model of Health Service Utilization is a commonly used framework used to assess determinants of health service usage, categorizing variables into factors that predispose, enable, or create a need in a population's health service use and outcome (Andersen, 1995, 2008). The model will be used here to categorize exposure factors of interest in this sample of injured workers. Specifically, age and sex will be treated as predisposing factors. Socioeconomic income quintiles, rurality, and Local Health Integration Network (LHIN) concordance (whether care was received in the LHIN of residence) will be assessed as enabling factors. Presence of a TBI diagnosis in the health record (yes vs. no), length of stay in the emergency department/acute care, special care days (use of intensive care units), and comorbidities as measured by the Johns Hopkins Aggregated Diagnosis Groupings will be treated as need factors. Sex-specific unadjusted and adjusted regression analyses will be conducted to identify significant factors associated with each of the outcome measures. Regression analyses will also explore year of injury for possible changes in associations over time.

Application of the Project / Knowledge Exchange and Translation

To maximize effectiveness, policy must be evidence-based. Currently available prevalence estimates of workplace TBI are limited and generally thought to be underestimated due to their reliance on hospital data, which is insufficient, in part, because many individuals who experience a mild TBI do not seek immediate medical attention. Data on the correlates and outcomes of mild TBI and on subsequent RTW may be biased for similar reasons. Studies of RTW and its predictors are also limited to short follow-up periods. The proposed research is designed to expand and refine the existing knowledge base regarding work-related mild TBI, which will inform prevention and intervention initiatives that will reduce strain on the workers' compensation system. Specifically, the proposed research will estimate the prevalence of work-related mild TBI without relying on hospital data and will examine use of public health services post-injury. These outcomes can be used to leverage support for prevention and intervention initiatives and demonstrate a need for backing by government, research, and regulatory authorities. The study will further inform how best to target these initiatives by identifying those most at risk for a work-related mild TBI and its most common negative outcomes. Streamlining education and awareness campaigns on the occupations and demographic groups most impacted will improve the effectiveness of prevention efforts. Likewise, the identification of more common outcomes of work-related TBI can be used in the development of intervention programs accessible to workers immediately following injury. Such intervention programs could minimize negative long-term consequences of mild TBI, thereby reducing costs to the WSIB and to publicly-funded health and social ministries. Identifying long-term predictors of RTW and recognizing perceived facilitators and barriers to RTW will enable the WSIB to assist employers in helping injured employees to transition back to and remain at work. These study outcomes can be packaged as an information guide to employers to assist in their accommodation of returning employees, identifying and tuning recommended strategies to accommodate TBI-related deficits (e.g., physical limitations, visual problems, limited stamina, memory) and thereby reducing the amount of time injured workers receive benefits.

As Canada’s largest addictions and mental health facility, CAMH works provincially and nationally with stakeholders to transfer information and influence education, policy, and practice. The Evidence Exchange Network (EENet), located in the Provincial System Support Program at CAMH, works with stakeholders across the province, including health and social service providers, public health practitioners, researchers, and

policymakers, to assist in moving evidence to action in support of a comprehensive mental health strategy. There is strong empirical support for research exchange networks, demonstrating a significant influence on knowledge exchange and use (Shearer et al., 2014). EENet has agreed to partner with our research team in the dissemination of our findings to WSIB stakeholders, including primary care providers, specialists in rehabilitative medicine, employers in industries at high risk for work-related TBI (e.g., construction), and government and regulatory authorities. Specifically, EENet will assist in the production of tailored knowledge products, such as evidence and policy briefs summarizing our findings, and in the development of infographics designed to summarize information and graphically represent data in a format that is quick and easy to understand. EENet will assist in the development of an online forum focused on mild TBI, where community stakeholders can connect with one another and share knowledge. EENet will assist in organizing and supporting a series of live interactive webinars based on the study's findings, which will then be archived and easily accessible to stakeholders. EENet will also help the team to leverage social media (e.g., Twitter, Facebook) to disseminate key findings. Overall, access to experienced knowledge brokers, resources, tools, and networks through EENet will ensure successful implementation of the knowledge translation plan. In addition, study findings will be published in peer reviewed journals to further communicate the results with the academic community.

Strengths, Limitations, Challenges, and Mitigation Strategies

The proposed study has important strengths and weaknesses that must be acknowledged, as well as challenges that will be faced and mitigation strategies that will be employed. One of the primary strengths of the study design is that it addresses several of the primary limitations of previous studies; specifically, it will estimate the prevalence of work-related mild TBI without reliance on hospital data. Although self-reported data may be subject to recall or social desirability biases, this data source is able to detect cases of mild TBI for which acute or emergency medical care is not sought. It will also better estimate risk factors and outcomes of work-related mild TBI, and costs to the public health system including ALC days and repeat non-urgent emergency department visits following unreported mild TBI. The extensive knowledge translation plan developed in partnership with EENet is another major strength of the project, ensuring maximal dissemination and application of the research findings. The exceptional and internationally respected research team brings substantial experience and expertise to the proposed project, further ensuring its success. The primary challenge of the project will be securing a sufficient response rate for the follow-up interview stage of the study. The response rate for the ongoing project is approximately 55%, which is somewhat less than originally anticipated. To mitigate this challenge, we will introduce participant remuneration ($20 Tim Hortons gift card) to increase the response and retention rates of the follow-up interviews. Another possible challenge may be a recall bias, where interview participants may not be able to accurately recall the year in which the work-related TBI occurred. To facilitate recall, participants will be asked for their age at the time of the injury and will be advised to think of lifetime milestones (e.g., parenthood, career stage) achieved at the time of injury that will aid recall. Uncertainty in respondents' recall of the date in which their TBI occurred will be documented in the experimenter notes. Analyses and estimates based on interview and ICES data will be conducted using both the full dataset and the subset of responses from those participants who expressed no uncertainty about the date the TBI occurred, in order to assess for possible differences.

Ethics

Each cycle of the CAMH Monitor is reviewed and approved by the CAMH Research Ethics Board and by York University's Ethics Committee. The addition of new items to the CAMH Monitor will necessitate an amendment request to be approved by both research ethics boards. Approval for the addition of new items to be asked during follow-up interviews will be included in the amendment request to the CAMH Research Ethics Board. Ethics approval for the follow-up interviews will additionally be obtained from the University of Toronto.

The study procedures are ethically sound and appropriately address potential ethical issues. Informed verbal consent is sought from CAMH Monitor respondents (see Ialomiteanu et al., 2018) and from follow-up interviewees at the start of each telephone interview. Participants will not be identified by name in analysis of the data or in any presentation or publication resulting from data analysis. Only the research staff directly involved in the study will have access to private, individually identifiable information about human subjects. Any computerized data will be password protected and stored on a secure server at CAMH (and for CAMH Monitor data on a secure server at the Institute for Social Research). Any transportation of electronic files will be via password protected, encrypted storage devices or secure file transfer. All research team members will comply with the duties set out for researchers in the Personal Health Information Protection Act (PHIPA) and with the privacy and confidentiality and consent guidelines outlined in the Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans.

Conclusion.
TBI is increasingly identified as comorbid with mental health and substance use problems. While the nature of these relationships is not always clear, these problems may result from the injury and contribute to difficulty during recovery. This study will assess the prevalence of work-related mild TBI in a general adult sample, identify correlates and comorbidities including mental health and substance use problems, identify factors that affect the RTW experience, and examine the impact of these injuries on publicly-funded healthcare services. This project is important because it will provide the first comprehensive population-based data on these injuries, including those not reported in healthcare databases, and contribute to an enhanced understanding of the impact of mild workplace TBI and factors that may affect recovery and RTW.

References

Alexander, C. H. (2002). Still rolling: Leslie Kish's rolling samples and the American Community Survey. *Survey Methodology 28*(1), 35-41.

Andersen, R. (1995). Revisiting the behavioral model and access to medical care: Does it matter? *Journal of Health and Social Behavior, 36,* 1-10.

Andersen, R. M. (2008). National health surveys and the Behavioral Model of Health Services Use. *Medical Care, 46*, 647-653.

Belanger, H. G., Curtiss, G., Demery, J. A., Lebowitz, B. K., & Vanderploeg, R. D. (2005). Factors moderating neuropsychological outcomes following mild traumatic brain injury: A meta-analysis. *Journal of the International Neuropsychological Society, 11*, 215-227.

Boak, A., Hamilton, H. A., Adlaf, E. M., Beitchman, J. H., Wolfe, D., & Mann, R. E. (2016). *The mental health and well-being of Ontario students 1991-2015: Detailed OSDUHS findings* (CAMH Research Document Series No. 43). Centre for Addiction and Mental Health, Toronto. https://www.camh.ca/-/media/files/pdf---osduhs/the-mental-health-and-well-being-of-ontario-students-1991-2015---detailed-osduhs-findings.pdf?la=en&hash=59BFD5B17408AAEE0E837E01048088ED51E558B2

Brain Injury Association of Canada. (2014). *Eye-opening facts and figures*. http://braininjurycanada.ca/wp-content/uploads/2007/05/BIAC-Fact-Sheet-2014.pdf

Cancelliere, C., Kristman, V. L., Cassidy, J. D., Hincapié, C. A., Côté, P., Boyle, E., Carroll, L. J., Stålnacke, B. M., Nygren-de Boussard, C., & Borg, J. (2014). Systematic review of return to work after mild traumatic brain injury: Results of the international collaboration on mild traumatic brain injury prognosis. *Archives of Physical Medicine and Rehabilitation, 95*(3 Suppl 2), S201-S209.

Cassidy, J. D., Carroll, L. J., Peloso, P. M., Borg, J., von Holst, H. Holm, L., Kraus, J., Coronado, V. G., & WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. (2004). Incidence, risk factors and prevention of mild traumatic brain injury: Results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *Journal of Rehabilitation Medicine, Suppl 43*, 28-60.

Chang, V. C., Guerriero, E. N., & Colantonio, A. (2015). Epidemiology of work-related traumatic brain injury: a systematic review. *American Journal of Industrial Medicine, 58*(4), 353-377. doi:10.1002/ajim.22418

Crépeau, F., & Scherzer, P. (1993). Predictors and indicators of work status after traumatic brain injury: A meta-analysis. *Neuropsychological Rehabilitation, 3*, 5-35.

Dawson, D. R., Schwartz, M. L., Winocur, G., & Stuss, D. T. (2007). Return to productivity following traumatic brain injury: Cognitive, psychological, physical, spiritual, and environmental correlates. *Disability and Rehabilitation, 29*, 301-313.

Dillahunt-Aspillaga, C., Jorgensen Smith, T., Hanson, A., Enlke, S., Stergiou-Kita, M., Dixon, C. G., & Quichocho, D. (2015). Exploring vocational evaluation practices following traumatic brain injury. *Behavioural Neurology*, 924027. doi: http://dx.doi.org/10.1155/2015/924027

Doctor, J. N., Castro, J., Temkin, N. R., Fraser, R. T., Machamer, J. E., & Dikmen, S. S. (2005). Workers' risk of unemployment after traumatic brain injury: A normed comparison. *Journal of the International Neuropsychological Society, 11*, 747-752.

Drake, A., Gray, N., Yoder, S., Pramuka, M., & Llewellyn, M. (2000). Factors predicting return to work following mild traumatic brain injury: A discriminant analysis. *Journal of Head Trauma Rehabilitation, 5*(5),1103 -1112.

Eme, R. (2017). Neurobehavioral outcomes of mild traumatic brain injury: A mini review. *Brain Sciences, 7*, 46.

Faul, M., & Coronado, V. (2015). Epidemiology of traumatic brain injury. *Handbook of Clinical Neurology, 127*, 3-13.

Faul, M., Xu, L., Wald, M. M., & Coronado, V. G. (2010). *Traumatic brain injury in the United States: emergency department visits, hospitalizations, and deaths: 2002-2006*. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. https://stacks.cdc.gov/view/cdc/5571

Gamboa, A. M., Jr., Holland, G. H., Tierney, J. P., & Gibson, D. S. (2006). American Community Survey: Earnings and employment for persons with traumatic brain injury. *NeuroRehabilitation, 21*, 327-333.

Gilworth, G., Eyres, S., Carey, A., Bhakta, B., & Tennant, A. (2008). Working with a brain injury: Personal experiences of returning to work following a mild or moderate brain injury. *Journal of Rehabilitation Medicine, 40*, 334-339.

Gyekye, S. A., & Salminen, S. (2009). Age and workers' perceptions of workplace safety: A comparative study. *International Journal of Aging and Human Development, 68*, 171-184.

Ialomiteanu, A., Hamilton, H. A., Adlaf, E. M., & Mann, R. E. (2016). *CAMH Monitor eReport 2015: Substance use, mental health and well being among Ontario adults, 1977-2013* (CAMH Research Document Series No. 45). Centre for Addiction and Mental Health, Toronto.

Ialomiteanu, A. R., Adlaf, E. M., & Mann R. E. (2018). *CAMH Monitor 2017: Metadata User's eGuide*. Centre for Addiction and Mental Health, Toronto.

Ilie, G., Boak, A., Adlaf, E. M., Asbridge, M., & Cusimano, M. D. (2013). Prevalence and correlates of traumatic brain injury among adolescents. *Journal of American Medical Association, 309*, 1-2.

Ilie, G., Ialomiteanu, A., Adlaf, E. M., Mann, R. E., Hamilton, H., Asbridge, M., Jürgen, R., & Cusimano, D. M. (2015). Associations between a history of traumatic brain injuries and current cigarette smoking, cannabis use, nonmedical opioid use, and elevated psychological distress in a population sample of Canadian adults. *Journal of Neurotrauma, 32*, 1130-1134.

Ilie, G., Mann, R. E., Boak, A., Hamilton, H., Rehm, J., & Cusimano, M. D. (2017). Possession of weapon and school violence among adolescents and their associations with history of traumatic brain injury, substance use and mental health. *Injury, 48*, 285-92.

Ilie, G., Vingilis, E. R., Mann, R. E., Hamilton, H., Toplak, M., Adlaf, E. M., Kolla, N., Ialomiteanu, A., van der Mass, M., Asbridge, M., Vingilis-Jaremko, L., Rehm, J., & Cusimano, M. D. (2015). The association between traumatic brain injury and ADHD in a Canadian adult sample. *Journal of Psychiatric Research, 69*, 174-179.

Ilie, G., Wickens, C. M., Ialomiteanu, A., Adlaf, E. M., Asbridge, M., Hamilton, H., Mann, R. E., Rehm, J., Rutledge, R., & Cusimano, M. (2019). Traumatic brain injury and hazardous drinking: Concurrent and single associations with poor mental health. *Psychiatry Research, 272*, 458-466.

Ilie, G., Wickens, C. M., Vingilis, E., Mann, R. E., Hamilton, H., Toplak, M., Erickson, P., Adlaf, E. M., Kolla, N., Ialomiteanu, A. R., van der Maas, M., Asbridge, M., Rehm, J., & Cusimano, M. D. (2017). Associations between a history of traumatic brain injuries and conduct disorder during youth in a population sample of Canadian adults. *Psychiatry Research, 258,* 184-188.

Izaute, M., Durozard, C., Aldigier, E., Teissedre, F., Perreve A., & Gerbaud L. (2008). Perceived social support and locus of control after a traumatic brain injury (TBI). *Brain Injury, 22*, 758-764.

James, S. L., Theadom, A., Ellenbogen, R. G., Bannick, M. S., Montjoy-Venning, W., Lucchesi, L. R., . . . Murray, C. J. L. (2019). Global, regional, and national burden of traumatic brain injury and spinal cord injury, 1990 - 2016: A systematic analysis for the Global Burden of Disease Study 2016. *The Lancet Neurology, 18*(1), 56-87. doi:10.1016/S1474-4422(18)30415-0

Johnson, R. (1987). Return to work after severe head injury. *International Disability Studies, 9*, 49-54.

Kennedy, P., Duff, J., Evans, M., & Beedie, A. (2003). Coping effectiveness training reduces depression and anxiety following traumatic spinal cord injuries. *British Journal of Clinical Psychology, 42*, 41-52.

Keyser-Marcus, L. A., Bricout, J. C., Wehman, P., Campbell, L. R., Cifu, D. X., Englander, J., High, W., Zafonte, R. D. (2002). Acute predictors of return to employment after traumatic brain injury: A longitudinal follow-up. *Archives of Physical Medicine and Rehabilitation, 83*, 635-641.

Khan-Bourne, N., & Brown, R. G. (2003). Cognitive-behaviour therapy for the treatment of depression in individuals with traumatic brain injury. *Neuropsychological Rehabilitation, 13*, 89-107.

Kim, H., Colantonio, A., & Chipman, M. (2006). Traumatic brain injury occurring at work. *NeuroRehabilitation, 21*, 269-278.

Kish, L. (1999). Combining/cumulating population surveys. *Survey Methodology, 25*(2), 129-138.

Kristman, V. L., Côté, P., Hogg-Johnson, S., Cassidy, J. D., Van Eerd, D., Vidmar, M., Rezai, M., & Wennberg, R. A. (2010). The burden of work disability associated with mild traumatic brain injury in Ontario compensated workers: A prospective cohort study. *The Open Occupational Health and Safety Journal, 2*, 1-8.

Kristman, V. L., Côté, P. Van Eerd, D., Vidmar, M., Rezai, M., Hogg-Johnson, S., … Cassidy, J. D. (2008). Prevalence of lost-time claims for mild traumatic brain injury in the working population: Improving estimates using workers compensation databases. *Brain Injury, 22*, 51-59.

Kristman, V. L., Côté, P., Yang, X., Hogg-Johnson, S., Vidmar, M., & Rezei, M. (2014). Health care utilization of workers' compensation claimants associated with mild traumatic brain injury: A historical population-based cohort study of workers injured in 1997-1998. *Archives of Physical Medicine and Rehabilitation, 95*(3 Suppl 2), S295-S302.

Levack, W., McPherson, K., & McNaughton, H. (2004). Success in the workplace following traumatic brain injury: Are we evaluating what is most important? *Disability and Rehabilitation, 26*, 290-298.

Lu, J., Marmarou, A., Choi, S., Maas, A., Murray, G., & Steyerberg, E. W. (2005). Mortality from traumatic brain injury. *Acta Neurochirurgica Supplement, 95*, 281-285.

Maas, A. I. R., Menon, D. K., Adelson, P. D., Andelic, N., Bell, M. J., Belli, A., . . . Zumbo, F. (2017). Traumatic brain injury: Integrated approaches to improve prevention, clinical care, and research. *The Lancet Neurology, 16*(12), 987-1048. doi:10.1016/s1474-4422(17)30371-x

Mann, R. E., Flam Zalcman, R., Smart, R. G., Rush, B. R., & Suurvali, H. (2006). Alcohol consumption, Alcoholics Anonymous membership and suicide mortality rates, Ontario 1968-1991. *Journal of Studies on Alcohol, 67*, 445-453.

Mann, R. E., Smart, R. G., & Govoni, R. (2003). The epidemiology of alcoholic liver disease. *Alcohol Research and Health, 27*, 209-219.

Morton, S. M. B., Bandara, D. K., Robinson, E. M., & Carr, P. E. A. (2012). In the 21st Century, what is an acceptable response rate? *Australian and New Zealand Journal of Public Health, 36*, 106-108.

O'Connell, M. J. (2000). Prediction of return to work following traumatic brain injury: Intellectual, memory, and demographic variables. *Rehabilitation Psychology, 45*, 212-217.

Ownsworth, T., & McKenna, K. (2004). Investigation of factors related to employment outcome following traumatic brain injury: a critical review and conceptual model. *Disability and Rehabilitation, 26*, 765-783.

Paci, M., Infante-Rivard, C., & Marcous, J. (2017). Traumatic brain injury in the workplace. *Canadian Journal of Neurological Sciences, 44*, 518-524.

Parle, M., Jones, B., & Maguire, P. (1996). Maladaptive coping and affective disorders among cancer patients. *Psychological Medicine, 26*, 735-744.

Pew Research Centre. (2017). *What low response rates mean for telephone surveys*. Washington, DC: Pew Research Centre. https://www.pewresearch.org/methods/2017/05/15/what-low-response-rates-mean-for-telephone-surveys/

Ponsford, J. L., Olver, J. H., Curran, C., & Ng, K. (1995). Prediction of employment status 2 years after traumatic brain injury. *Brain Injury, 9*, 11-20.

Ryu, W. H. A., Feinstein, A., Colantonio, A., Streiner, D. L., & Dawson, D. R. (2009). Early identification and incidence of mild TBI in Ontario. *Canadian Journal of Neurological Sciences, 36*, 429-435.

Sean Hu, S., Balluz, L., Battaglia, M. P., & Frankel, M. R. (2011). Improving public health surveillance using a dual-frame survey of landline and cell phone numbers. *American Journal of Epidemiology, 173*(6), 703-711. doi: https://doi.org/10.1093/aje/kwq442

Shames, J., Treger, I., Ring, H., & Giaquinto, S. (2007). Return to work following traumatic brain injury: Trends and challenges. *Disability and Rehabilitation, 29*, 1387-1395.

Shearer, J.C., Dion, M., & Lavis, J. N. (2014). Exchanging and using research evidence in health policy networks: A statistical network analysis. *Implementation Science, 9*, 126.

Siu, O. L., Phillips, D. R., & Leung, T. W. (2003). Age differences in safety attitudes and safety performance in Hong Kong construction workers. *Journal of Safety Research, 34*, 199-205.

Sveen, U., Lundgaard Søberg, H., & Østensjø, S. (2016). Biographical disruption, adjustment and reconstruction of everyday occupations and work participation after mild traumatic brain injury. A focus group study. *Disability and Rehabilitation, 38,* 2296-2304.

Tagliaferri, F., Compagnone, C., Korsic, M., Servadei, F., & Kraus, J. (2006). A systematic review of brain injury epidemiology in Europe. *Acta Neurochirurgica, 148,* 255–268.

Thompson, R. J., Mata, J., Jaeggi, S. M., Buschkuehl, M., Jonides, J., & Gotlib, I. H. (2010). Maladaptive coping, adaptive coping, and depressive symptoms: Variations across age and depressive state. *Behaviour Research and Therapy, 48*, 459-466.

Tomberg, T., Toomela, A., Ennok, M., & Tikk, A. (2007). Changes in coping strategies, social support, optimism and health-related quality of life following traumatic brain injury: A longitudinal study. *Brain Injury, 21*, 479-488.

Tomberg, T., Toomela, A., Pulver, A., & Tikk, A. (2005). Coping strategies, social support, life orientation and health-related quality of life following traumatic brain injury. *Brain Injury, 19*, 1181-1190.

Turner, N. E., McDonald, A. J., Ialomiteanu, A. R., Mann, R. E., McCready, J., Millstone, D., Hamilton, H., Elton-Marshall, T., Rehm, J., Kurdyak, P., Ilie, G., Wickens, C. M., Le, T. L., van der Maas, M., Faregh, N., Cook, S., Bondy, S., Sanchez, S., & Cusimano, M. (2019). Moderate to severe gambling problems and traumatic brain injury: A population-based study. *Psychiatry Research, 272*, 692-697.

Veliz, P., McCabe, S. E., Eckner, J.T., & Schulenberg, J. E. (2017). Prevalence of concussion among US adolescents and correlated factors. *Journal of American Medical Association, 318*, 1180-1182.

Vikane, E., Hellstrøm, T., Røe, C., Bautz-Holter, E., Aßmus, J., & Sture Skouen, J. (2016). Predictors for return to work in subjects with mild traumatic brain injury. *Behavioural Neurology, 8026414*. http://dx.doi.org/10.1155/2016/8026414

Walker, W. C., Marwitz, J. H., Kreutzer, J. S., Hart, T., & Novack, T. A. (2006). Occupational categories and return to work after traumatic brain injury: A multicenter study. *Archives of Physical Medicine and Rehabilitation, 87*, 1576-1582.

Wehman, P., Targett, P., West, M., & Kreel, J. (2005). Productive work and employment for persons with traumatic brain injury: What have we learned after 20 years? *Journal of Head Trauma Rehabilitation, 20*, 115-127.

West, M. D. (1995). Aspects of the workplace and return to work for persons with brain injury in supported employment. *Brain Injury, 9*, 301-313.

Whiteneck, G. G., Gerhart, K. A., & Cusich, C. P. (2004). Identifying environmental factors that influence the outcomes of people with traumatic brain injury. *Journal of Head Trauma Rehabilitation, 19*, 191-204.

Wickens, C. M., Mann, R. E., Ialomiteanu, A., Rehm, J., Fischer, B., Stoduto, G., Callaghan, R. C., Sayer, G., & Brands, B. (2017). The impact of medical and non-medical prescription opioid use on motor vehicle collision risk. *Transportation Research Part F: Traffic Psychology and Behaviour, 47*, 155-162.

Wickens, C. M., Mann, R. E., Ialomiteanu, A. R., & Stoduto, G. (2016). Do driver anger and aggression contribute to the odds of a crash?: A population-level analysis. *Transportation Research Part F: Traffic Psychology and Behaviour, 42,* 389-399.

World Health Organization. (2004). *Global burden of disease*. www.who.int/violence_injury_prevention/key_facts/VIP_key_fact_1.pdf?ua=1

Xiong, C., Martin, T., Sravanapudi, A., Colantonio, A., & Mollayeva, T. (2016). Factors associated with return to work in men and women with work-related traumatic brain injury. *Disability and Health Journal, 9,* 439-448.

Grant Support: This Project was funded by a research grant provided by the Workplace Safety and Insurance Board (Ontario). The provision of grant support by WSIB does not in any way infer or imply endorsement of the research findings by the WSIB. Additional funding support was received from the 2017/18 Health System Research Fund Program Awards of the Ministry of Health and Long-Term Care (Ministry Grant #267). The

views expressed in the publication are the vies of the authors and do not necessary reflect those of the Ministry of Health and Long-Term Care.