

Characteristics and Incidence of Traumatic Brain Injury in Older Adults Using Home Care in Ontario from 2003–2013



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ABSTRACT

Objectives

Describe the characteristics and determine the annual cumulative incidence of traumatic brain injury (TBI) in older adults receiving home care in Ontario from 2003 to 2013.

Methods

A retrospective cohort study of longitudinal data from the Ontario Association of Community Care Access Centers (N = 554,313). TBI, demographic variables, depression, neurological conditions, and recent falls were measured from the Resident Assessment Instrument–Home Care. Comparisons were made between service users with and without TBI using odds ratios. Standardized incidence rates were calculated and the 10-year trend of annual cumulative incidence rates was examined.

Results

Characteristics associated with TBI: male sex (OR: 1.54), aboriginal origin (OR: 1.98), increasing age (low of OR: 1.22, in 70–74 years; high of OR: 2.31, in 90 years and older; comparison 65–69 years), being widowed (OR: 1.59), having one or more falls (OR: 2.31), the use of antidepressants (OR: 1.49) and the presence of depression (OR: 1.57), dementia (OR: 1.65), hemiplegia (OR: 4.34), multiple sclerosis (OR: 3.19) or parkinsonism (OR: 1.22). TBI incidence was significantly higher than rates previously reported in the literature. There was no change in the overall annual cumulative incidence over the 10-year period ($p = .13$).

Conclusions

Certain demographic characteristics, neurological diseases, antidepressant use, and a recent fall are associated with TBI.

Incidence of TBI is higher than previous estimates and the overall incidence is not changing over time. These results can be used to improve care of the elderly and to generate hypotheses for future research regarding TBI in the home care setting.

Key words: cohort, TBI, aged

INTRODUCTION

Traumatic brain injury (TBI) is a significant cause of disability and death in the adolescent and older adult population. (1,2) Sustaining a TBI is not limited to a certain age group, however youth below the age of 21 and older adults aged 65 and above have the highest incidence of TBI hospitalizations. (3) Symptoms of TBI include a variety of physical, cognitive, emotional, and behavioural consequences. TBI can also increase the risk of other adverse conditions such as epilepsy, depression and potentially Alzheimer's disease. (4-7) Because of the risk of disability and adverse health events, TBI is considered one of the most serious injuries among older adults. The yearly costs of TBI in Canada, both direct and indirect, have been estimated at over \$20 billion. (8) An estimated 70% of this cost is due to older adults aged 65 years and above. (8,9)

Older adults are at the highest risk for TBI (3) and the characteristics of older adults who sustain a TBI have been examined in hospital-based studies. Such studies have shown that demographic risk factors for sustaining a TBI in the older adult population include non-white race, male sex, conditions such as depression and Alzheimer's disease, (4,7) and the use of antidepressants. (4) These studies have mostly taken place using hospitalization-based cases; it appears no studies have examined potential risk factors in the general home care population, which may have varied rates and characteristics of TBI.

It is estimated that over 10 million TBIs occur annually across the globe and that over 57 million people have been hospitalized with a TBI during their lifetime.⁽²⁾ For comparison, the annual cumulative incidence of TBI is greater than that of spinal cord injury, multiple sclerosis, HIV/AIDS, and breast cancer combined.⁽¹⁰⁾ Because only hospitalized cases are commonly captured when determining TBI incidence in older adults, the true annual cumulative incidence rate of TBI is likely much higher than the reported figures.⁽¹⁰⁾ In the United States, the crude overall hospitalization rate for TBI in the general population is 85.6 per 100,000 population.^(8,11) However, for older adults aged 65 and above this rate increases to 155.9 per 100,000 population.^(8,11) Although longitudinal trends of TBI have been largely understudied in the general population, U.S. studies have shown a small overall decrease in the annual incidence of TBI leading to hospitalization.⁽¹²⁾ Comparisons between the years 1980–1981 and 1994–1995 show that the annual incidence of TBI leading to hospitalizations decreased 9% in older adults aged 65 years and older.⁽¹²⁾ Older adults have the highest rates of TBI hospitalization and death; yet, the incidence of TBI and associated risk factors in the general older adult population are largely understudied and have typically been studied using hospitalization-based studies completed in the U.S.

There has been a worldwide shift towards community-based health care, particularly in Canada.⁽¹³⁾ Home care enrolment in Ontario has increased from 45,077 service users in 2003 to 71,303 service users in 2013, which represents a 36.8% increase. As the Canadian population ages, the need for home care will continuously increase and place a larger burden on the health-care system.^(13,14) To properly inform planning and develop support structures for home care use, we need better estimates of the incidence and prevalence of TBI in this older adult population.

The objectives of this study were to 1) describe the characteristics of older adults who used home care in Ontario, Canada and who sustained a TBI, and 2) determine the annual cumulative incidence and assess the 10-year trend of TBI incidence in older adults using home care in Ontario.

It is hypothesized that TBI will be associated with older age, male sex, and non-white race. It is further hypothesized that the annual cumulative incidence of TBI in the older adult home care population will be greater than the reported figure for the age-specific hospitalization rate of 155.9 per 100,000 population. It is also expected that the 10-year trend of TBI incidence in older adults using home care in Ontario will decrease over time, as shown in the U.S.

METHODS

Data Source

Data are from the Ontario Association of Community Care Access Centres (OACCAC) home care database, which includes assessments of all individuals in Ontario, Canada, expected to be in home care service for 60 or more days (i.e.,

long-stay clients).⁽¹⁵⁾ Service users are assessed approximately every six months, after a significant change in status (for example, sustaining a TBI), and at the time of discharge from home care services.⁽¹⁶⁾ The dataset used in this study included assessments over a 10-year period, between 2003 and 2013. This study was exempted from ethical review due to the use of anonymized secondary data.⁽¹⁷⁾

Assessment Instrument

Analyses are based on the Resident Assessment Instrument–Home Care (RAI-HC),⁽¹⁸⁾ which is used as part of regular practice in Ontario’s home care sector. The RAI-HC assessment is completed by trained assessors (e.g., nurses, social workers), who use all sources of information available.⁽¹⁸⁾ The RAI-HC has a variety of items which fall under the domains of identifying information, demographic items, assessment information, cognitive patterns, communication/hearing patterns, mood and behaviour patterns, social functioning, physical functioning, disease diagnosis, medications, and others.⁽¹⁸⁾ The items have been shown to be valid and reliable in numerous national and international studies.^(19–22) The RAI-HC supports evidence-informed clinical decision-making, and can help health professionals in the planning, implementation, and monitoring of care.⁽¹⁸⁾ For example, many items are organized into scales and clinical assessment protocols (e.g., Depression Rating Scale) to help interpret and track status over time.

Study Design

A retrospective cohort study was used to determine the annual cumulative incidence and describe demographic characteristics of older adults (i.e., those aged 65 years or more) sustaining a TBI while using home care in Ontario between 2003 and 2010. The characteristics of older adults who sustained a TBI (cases) during the 10-year observation period were compared to those who did not (controls); these were based on the initial RAI-HC assessment for controls, and on the first RAI-HC assessment identifying the occurrence of TBI for cases.

The annual cumulative incidence of TBI was determined using the yearly number of incident cases as the numerator, and the yearly number of long-stay home care service users as the denominator. The occurrence of a TBI is captured at the time of the injury and on all subsequent RAI-HC assessments (as long as it is an issue affecting health status). As such, only the first occurrence of TBI was counted for the respective year in which it occurred. Age and sex standardized rates were calculated using 2003 as the standard population; these rates were then used to examine incidence over the 10-year period.

Study Measures

Traumatic Brain Injury

TBI was identified in the RAI-HC in two ways. The “head trauma” item in the disease diagnoses section was used.

Head trauma is defined as: “damage to the brain as a result of physical injury to the head”,⁽¹⁵⁾ and is indicated as present if the person’s physician has indicated it affects his/her status, requires treatment, or symptom management; if it is being monitored by a home care professional; or if it led to a hospitalization in the 90 days prior to the assessment (or since last assessment if less than 90 days).⁽¹⁵⁾ If present, the item is coded as 1 (not subject to focused treatment or monitoring by home care professional), or 2 (monitored/treated by home care professional).⁽¹⁵⁾ In this study, TBI was considered present regardless of whether it was monitored/treated or not (i.e., coded as 1 or 2).

The RAI-HC contains a text entry section for diagnoses (e.g., to input text that describes the diagnoses of interest, or specific diagnoses); this was also used to capture TBI. Any text diagnoses in this section that referred to head trauma, concussion, closed head injury, head injury, or acquired brain injury was used to capture cases of TBI. This method of capturing TBI (i.e., item and text entries) has been previously validated;⁽²³⁾ it had a sensitivity of 0.23, a specificity of 0.99, a positive predictive value of 0.22, and a kappa statistic of 0.22 when compared to linked data from the National Ambulatory Care Reporting System (NACRS) and the Canadian Institute for Health Information (CIHI).⁽²⁴⁾

Demographic Variables

Demographic characteristics from the RAI-HC used in this study include: sex, age, aboriginal origin, marital status, and highest level of education completed.⁽¹⁵⁾

Depression

Depression was assessed using the Depression Rating Scale (DRS), a summary scale ranging between 0 and 14 that is based on seven items from the mood and behaviour patterns section of the RAI-HC.⁽²⁵⁾ Individual items are coded as follows: 0 = not present, 1 = exhibited in one to two of the last three days, or 2 = exhibited on each of the last three days.⁽¹⁵⁾ Scores of 3 or more are considered to be indicative of possible depression. The scale was validated using the Cornell Scale for Depression and the Hamilton Depression Rating Scale.⁽²⁵⁾ Specifically, a cut-point score of 3 or greater on the DRS maximized sensitivity (0.78 for Cornell and 0.94 for Hamilton) with minimum loss of specificity (0.77 for Cornell and 0.72 for Hamilton) when tested against cut-offs for mild to moderate depression.⁽²⁵⁾

Antidepressants

Antidepressant use was captured as a categorical variable, and as present if antidepressants were taken in the last seven days or since last assessment. Antidepressant use was captured on the first assessment in which TBI is indicated for cases and from the assessment date nearest to the index date (time of matched case’s TBI) for controls.

Neurological Diseases

Neurological diseases were reported using the list of disease diagnoses and included: Alzheimer’s disease, dementia other

than Alzheimer’s disease, hemiplegia/hemiparesis, multiple sclerosis, and parkinsonism.⁽¹⁵⁾ Foebel and colleagues⁽²³⁾ found that the validity of items related to diagnoses of Alzheimer’s disease and other dementia (sensitivity of 0.76; specificity of 0.89; PPV of 0.53; kappa statistic of 0.55), parkinsonism (sensitivity of 0.83; specificity of 0.98; PPV of 0.59; kappa statistic of 0.68), and multiple sclerosis (sensitivity of 0.90; specificity of 1.00; PPV of 0.77; kappa statistic of 0.83) was acceptable when compared to linked NACRS and CIHI data.⁽²⁴⁾

Recent Fall

The presence of a recent fall (i.e., in the last 90 days) was based on the ordinal falls frequency item (coded from 0 = none to 9 = 9 or more falls). The presence of any fall in the last 90 days (i.e., falls frequency = 1+) was used to indicate presence of a recent fall.

Data Analysis

Univariate descriptive analyses were conducted on all variables to check for errors and outliers, examine distributions and to examine responses for each of the variables. Counts and proportions were determined for all variables and means and standard deviations were reported for continuous variables.

The characteristics of service users who sustained a TBI were described using univariate statistics. Means and standard deviations were used to examine continuous variables and proportions were used to describe categorical variables. Odds ratios and 95% confidence intervals were calculated for each characteristic to compare home care service users who did and did not sustain a TBI.

The annual cumulative incidence was determined by dividing the annual number of incident cases of TBI from 2003–2013 by the number who had been assessed with the RAI-HC during that year. A sensitivity analysis was conducted on the overall annual cumulative incidence of TBI using the sensitivity of 0.23 based on previous work⁽²²⁾ to adjust for the misclassification of the TBI measure. The sensitivity of 0.23 indicated that there would be 77% more cases of TBI should a measure with 100% sensitivity be used. Thus, 77% more cases were added to each annual cumulative incidence rate in order to determine the adjusted incidence. Age- and sex-standardized annual cumulative incidence rates were calculated with 95% confidence intervals (standardized to the 2003 base population). Linear regression was used to determine if there was a significant change in standardized annual cumulative incidence rates over the 10-year period. Antidepressant use was measured as a potential confounder and effect modifier using the RAI-HC.⁽²⁴⁾ All data were analyzed using SAS software, version 9.4.⁽²⁵⁾

RESULTS

The sample size for this study was 554,313 home care users, of which 5,215 (0.9%) had sustained a TBI during the observation period (i.e., 2003 to 2013). There were no differences

in demographic variables between TBIs that were captured using the “head trauma” item ($n = 4,188$) and through text diagnoses ($n = 1,027$). Service users with TBI had a more equal sex distribution, a greater prevalence of depression and antidepressant use, dementia, and hemiplegia, and had more service users with a recent fall than those without TBI (Table 1). Males and females with TBI were similar on most characteristics; however, males had greater odds of being married, while females had greater odds of being widowed. Females with TBI also had a higher prevalence of depression and a lower prevalence of hemiplegia compared to males with TBI.

The annual cumulative incidences and sensitivity analysis of TBI from 2003 to 2013 along with associated confidence intervals are shown in Figure 1. Linear regression indicated that there was no significant change in the annual cumulative incidence of TBI over the 10-year period ($p = .13$).

Age- and sex-standardized annual cumulative incidence rates and associated confidence intervals were calculated using the 2003 population as the standard (Figure 2). Female age-standardized incidence rates decreased significantly over the 10-year period ($p = .04$). Male and overall age- and sex-standardized incidence rates decreased in a non-linear fashion.

DISCUSSION

A positive association was found between male sex, aboriginal origin, increasing age, being widowed, having depression, using antidepressants, increasing education level, having had a recent fall, the presence of dementia, hemiplegia, multiple sclerosis and parkinsonism, and the likelihood of sustaining a TBI in the older adult home care population of Ontario. The annual cumulative incidence of TBI was significantly higher than reported figures in the hospital-based literature and there was no change in the annual cumulative incidence over the 10-year period. Male age-standardized and overall sex- and age-standardized incidence rates did not change significantly over the 10-year period; however, female age-standardized rates decreased significantly.

The results indicated that there was a distinctly large sample size for all service users and service users who sustained a TBI during the year 2011, which was an unexpected finding. There are a variety of factors that may have played a part in increasing the number of service users receiving home care during the year 2011. During the fiscal year of 2009/2010, government spending on home care was \$1.9 billion and during the fiscal year 2010/2011 spending increased to \$2.1 billion.⁽¹⁰⁾ This 10.5% increase in spending may have allowed more persons across the province of Ontario to receive home care. Overall, home care across the province of Ontario had received a 56% increase in funding from the fiscal years 2003/2004 to 2010/2011.⁽¹⁰⁾ Another factor that may have led to an increase in service users is the Ontario Aging at Home Strategy, a \$1.1 billion dollar funding package granted to the Community Care Access Centres across Ontario who implement and organize home care.⁽²⁶⁾ This funding package was

spread over four years, from 2008 to 2012; however, a report in 2010 by the Auditor General of Ontario found that funds were used sparingly in the first two years. A greater percentage of the funds were used from 2010–2011 and this may have increased the number of service users in home care.⁽⁹⁾

Demographic characteristics are known to be associated with the recovery time following a TBI,⁽²⁷⁾ however, there is limited research on how certain demographics may be risk factors for TBI. Research in the United States and abroad has shown that males are approximately two times more likely to experience a TBI compared to females.^(2,3) This study found similar results; however, the association was not as strong. This could be due to differences between study populations or other external factors.

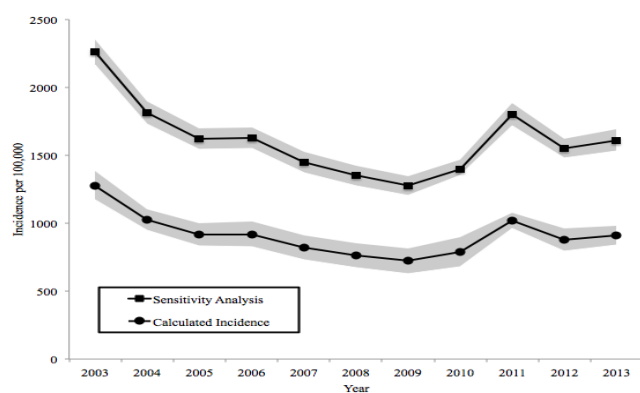
Research in the U.S. has shown that aboriginals are no more likely to sustain a TBI ($p = .002$) than Caucasians.⁽²⁸⁾ However, a Canadian study examining older adults found that persons of aboriginal origin are more likely to sustain a TBI,⁽²⁹⁾ a finding corroborated by our study. Numerous studies have found that increasing age among the older adult population is a risk factor for sustaining a TBI^(2,3,8,10,11,12) and the present study confirms these findings. The association between education level and TBI has not been thoroughly investigated; however, a U.S. study found that persons with some college education had a slightly lower incidence of TBI hospitalization.⁽³⁰⁾ Persons with a higher level of education are also less likely to sustain injuries and develop health conditions in general.^(31–33) The present study found that a higher education level is negatively associated with sustaining a TBI. Studies have examined the effects of TBI on marital status following injury and found that sustaining a TBI increases the risk of divorce or separation.^(34,35) However, the present study is the first to investigate the association between marital status and sustaining a TBI. The finding that being widowed is associated with a higher risk of TBI is worth investigating in future studies. The association between falling and sustaining a TBI has been studied extensively, and falling is regarded as a major risk factor for TBI.^(2,3,10,11,36) The present study corroborates existing evidence suggesting that falling is associated with TBI.⁽³⁶⁾ Interestingly, we found that neurological conditions, such as hemiplegia, multiple sclerosis, and dementia, were associated with an increased risk of sustaining a TBI. Research has not investigated these neurological conditions as potential risk factors for TBI and future studies should incorporate their measurement and other common comorbidities into their study designs.

Depression following brain injury has been studied,⁽³⁷⁾ however no studies have examined depression as a potential risk factor for TBI in older adults. The present study is the first to formally examine the association between depression, antidepressant use, and sustaining a TBI. The present study found a substantial association, which may be due to antidepressant use, possibly leading to an increased risk of falling and consequently sustaining a TBI.^(38–41) The results should be interpreted carefully, as the present study did not control for all potential confounding factors.

TABLE 1.

Univariate descriptive characteristics of all service users, service users without TBI, service users with TBI, and odds ratios comparing service users sustaining and not sustaining a TBI in the older adult home care population of Ontario from 2003 to 2013

<i>Variable</i>	<i>All Service Users</i>	<i>Service Users Without TBI</i>	<i>Service Users With TBI</i>	<i>Odds Ratio (95% CI)</i>
N	554,313	549,098	5215	
TBI				
Yes	5215 (0.9)			
No	549,098 (99.1)			
Sex				
Male	202,536 (36.5)	200,094 (36.4)	2442 (46.8)	1.54 (1.45, 1.62)
Female	351,745 (63.5)	348,972 (63.6)	2773 (53.2)	1.0
Aboriginal Origin				
Yes	3973 (0.7)	3900 (0.7)	73 (1.4)	1.98 (1.57, 2.50)
No	550,308 (99.3)	545,167 (99.3)	5141 (98.6)	1.0
Missing	32	31	1	
Age				
65–69	44,531 (8.0)	43,896 (8.0)	635 (12.2)	1.0
70–74	65,964 (11.9)	65,189 (11.9)	775 (14.9)	1.22 (1.09, 1.35)
75–79	102,669 (18.5)	101,609 (18.5)	1060 (20.3)	1.47 (1.33, 1.63)
80–84	139,201 (25.1)	137,949 (25.1)	1252 (24.0)	1.88 (1.71, 2.08)
85–89	122,555 (22.1)	121,557 (22.1)	998 (19.1)	1.40 (1.28, 1.55)
>90	79,393 (14.3)	78,898 (14.4)	495 (9.5)	2.31 (2.05, 2.59)
Mean (SD)	81.9 (7.6)	81.9 (7.6)	80.2 (7.7)	
Education Level				
8 th grade or less	133,701 (24.1)	132,442 (24.1)	1259 (24.1)	1.0
9 th –12 th grade	176,938 (31.4)	175,281 (31.9)	1657 (31.8)	1.01 (0.93, 1.08)
Post-secondary	106,736 (19.3)	105,488 (19.2)	1248 (23.9)	0.80 (0.74, 0.87)
Graduate degree	12,107 (2.2)	11,945 (2.2)	162 (3.1)	0.70 (0.59, 0.83)
Unknown	124,786 (22.5)	123,895 (22.6)	888 (17.1)	1.33 (1.22, 1.45)
Missing	48	47	1	
Marital status				
Never married	24,268 (4.4)	23,978 (4.4)	290 (5.6)	1.0
Married	221,704 (40.0)	219,317 (40.0)	2387 (45.8)	1.11 (0.98, 1.26)
Widowed	269,817 (48.7)	267,786 (48.7)	2031 (39.0)	1.59 (1.41, 1.80)
Separated	33,806 (6.1)	33,335 (6.1)	471 (9.0)	0.86 (0.74, 0.99)
Other	4687 (0.8)	4651 (0.8)	36 (0.6)	1.56 (1.10, 2.21)
Missing	31	31		
Depression				
Yes	39,048 (7.0)	38,497 (7.0)	551 (10.6)	1.57 (1.43, 1.71)
No	515,265 (93.0)	510,601 (93.0)	4664 (89.4)	1.0
Antidepressant use				
Yes	112,836 (20.4)	111,401 (20.3)	1435 (27.5)	1.49 (1.40, 1.59)
No	441,447 (79.6)	437,697 (79.7)	3780 (72.5)	1.0
Alzheimer's				
Yes	45,840 (8.3)	45,401 (8.3)	439 (8.4)	1.02 (0.92, 1.13)
No	508,473 (91.7)	503,697 (91.7)	4776 (91.6)	1.0
Dementia				
Yes	83,431 (15.1)	82,257 (15.0)	1174 (22.5)	1.65 (1.54, 1.76)
No	470,882 (84.9)	466,841 (85.0)	4041 (77.5)	1.0
Hemiplegia				
Yes	9168 (1.7)	8827 (1.6)	341 (6.5)	4.34 (3.88, 4.85)
No	545,145 (98.3)	546,931 (99.6)	4874 (93.5)	1.0
Multiple Sclerosis				
Yes	2232 (0.4)	2167 (0.4)	65 (1.3)	3.19 (2.49, 4.08)
No	552,081 (99.6)	546,931 (99.6)	5150 (98.7)	1.0
Parkinsonism				
Yes	22,456 (4.1)	22,202 (4.0)	254 (4.9)	1.22 (1.07, 1.38)
No	531,857 (95.9)	526,896 (96.0)	4961 (95.1)	1.0
Falls Frequency				
No falls	159,194 (64.8)	356,871 (65.0)	2323 (44.5)	1.0
One or more falls	195,075 (35.2)	192,183 (35.0)	2892 (55.5)	2.31 (2.19, 2.44)
Missing	44	44		
Mean (SD)	0.72 (1.44)	0.71 (1.43)	1.34 (1.97)	

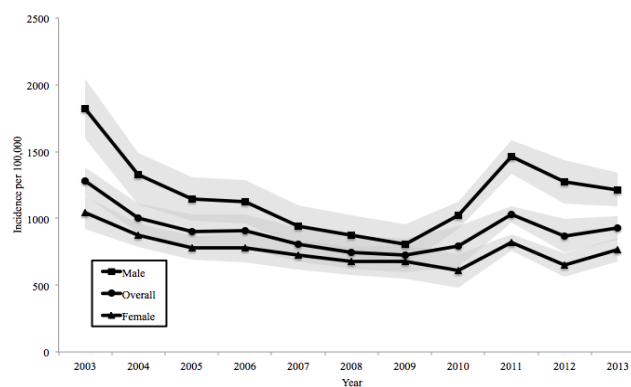


Note: Gray shading indicates 95% confidence intervals.

FIGURE 1. Annual cumulative incidence and sensitivity analysis of annual cumulative incidence of TBI in the older adult home care population of Ontario from 2003 to 2013

Incidence rates of TBI in older adults vary significantly in the literature, depending on the case definition and population under study.⁽⁴²⁾ However, there have been no studies formally examining TBI incidence in the older adult population of Canada. United States figures for the older adult population aged 65 years or older indicate that the age-specific incidence rate for hospitalized TBIs is 155.9 per 100,000 population.^(8,11) This study found significantly higher rates during the 10-year period in Canada. This is most likely explained by our focus on a home care population, a closely monitored group, while the U.S. study used hospitalized cases of TBI, which are known to be susceptible to under-reporting.⁽⁸⁾ The sensitivity of the TBI item on the RAI-HC is also low, and the sensitivity analysis of the incidence rates indicates that the unadjusted results in this study are most likely an under-estimation of the true incidence. A best evidence synthesis completed by the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury (MTBI) found that the incidence of MTBI in hospital-treated older adults is between 100–300 per 100,000 population.⁽⁴²⁾ The study also indicated that the true population based incidence is most likely higher than 600 persons per 100,000 population.⁽⁴²⁾ Although the present study found that the incidence rates were significantly higher than 600 per 100,000 population, the results corroborate existing literature as the present study included all severities of TBI in the case definition, which could help to explain the higher incidence rates.

Trends of TBI incidence have been examined in a variety of populations across the world and results have been largely mixed. A major U.S. study found that overall hospitalizations for TBI declined 51% from 1980 through 1995 for all ages.⁽⁴³⁾ However, the decline in incidence was least among those aged 65 years or older with a decrease of 9%.⁽⁴³⁾ The literature suggests that a decrease in the incidence of TBI could be due to a number of factors including a change in hospital admission policies, improved safety and preventative programs, and increased survivability after TBI.⁽⁴⁴⁾ A study of TBI incidence



Note: Gray shading indicates 95% confidence intervals.

FIGURE 2. Age- and sex-standardized annual cumulative incidence rates of TBI in the older adult home care population of Ontario from 2003 to 2013

rates in Sweden from 1987 to 2000 found an increase in TBI rates for both males and females.⁽⁴⁵⁾ A study of the general population in Ontario, Canada, found that TBI hospitalization rates were unchanged from the year 1992 to 2001 among those aged 66 years or older.⁽¹⁰⁾ The results of this study concur with the most pertinent study in Ontario,⁽¹¹⁾ which found incidence rates of TBI remained largely unchanged between the years 2003 and 2013. This study also found that male age-standardized rates were significantly higher than female rates, which is similar to numerous recent studies in the United States.^(3,11)

The main strengths of our current study include the use of repeated cross-sectional samples over a long period of time using recently collected data, the large sample size, the population-based nature of the data, the use of a validated instrument, and the ability to assess a number of variables and their associations with TBI. A major limitation of this study is the inability to determine incidence rates for various TBI severities. The RAI-HC amalgamates all severities of TBI under one diagnosis even though the incidence of each severity of TBI varies.⁽¹⁻³⁾ This heterogeneous outcome measure may distort associations between the varying severities of TBI and the service user characteristics. A further limitation of this study is the low sensitivity of TBI measurement using the RAI-HC assessment.⁽¹¹⁾ Based on the sensitivity analysis of the annual cumulative incidence of TBI, the unadjusted incidence rates are likely underestimates of the true incidence and should be interpreted cautiously. The case definition of TBI has not been firmly established, which makes it difficult to accurately measure TBI status. A universal case definition for the various severities of TBI needs to be developed to establish population-based incidence measures for the home-care setting. An additional limitation is that we were not able to control for cause of TBI and history of TBI as potential confounders.

TBI is an important injury due to its short and long-term impact on individuals and its significant burden on individual health and health-care spending. This descriptive study has

identified new associations between a variety of intrinsic characteristics and TBI; future studies should examine these characteristics in more detail. This study has also provided valuable estimates regarding the incidence and impact of TBI on the general Canadian home care population, where previous estimates did not exist. Future research should examine the incidence of TBI in other institutions, such as long-term care and mental health facilities, and in aboriginal and military populations, so that more preventative measures can be identified and implemented.

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CONFLICT OF INTEREST DISCLOSURES

C. McGuire, V. Kristman, L. Martin, and M. Bedard declare they have no conflicts of interest.

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