

The Burden of Work Disability Associated with Mild Traumatic Brain Injury in Ontario Compensated Workers: A Prospective Cohort Study

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Abstract: Objectives: To estimate the incidence of compensated claims involving mild traumatic brain injury among Ontario workers covered by the Workplace Safety & Insurance Board (WSIB) and to describe the number and duration of days off work related to incident claims using workers compensation administrative data.

Methods: We used a population-based, historical cohort of 111,800 injured workers aged 20 or older with a claim to the Ontario Workers' Safety and Insurance Board in 1998. We estimated the incidence as the rate of new mild traumatic brain injury in the Ontario working population eligible for compensation by the WSIB. We described the number and duration of disability days using an episodic and cumulative analysis of time on benefits over a two-year period (1997-98) determined from administrative data.

Results: The annual incidence was 1.5 (95% CI: 1.3, 1.7) per 10,000 full-time equivalents. Eighty-seven percent of claimants had a single episode of benefits with median duration of 11 days (95% CI: 10, 12). Fifty percent were off benefits after 17 days and 75% by 72 days.

Conclusions: Mild traumatic brain injury is disabling in the working population. Most work disability is short-term, but a small proportion of claimants become chronically disabled and unable to work.

Keywords: Brain injuries, accidents, occupational, epidemiology, workers' compensation, incidence.

INTRODUCTION

The incidence of hospital-treated mild traumatic brain injury (MTBI) is high, with reported rates from 100-300 per 100 000 globally [1]. A hospital-based cohort study in Glasgow, UK, found 47% (95% CI: 42%, 52%) of MTBI patients had moderate to severe disability one year after injury [2]. Moderately disabled individuals had restrictions in their lifestyle or work capacity, while severely disabled persons were unable to support themselves for 24 hours in society. Data on MTBI from the Glasgow study suggest that more than 100 per 100 000 individuals are still disabled one year after their mild injury [2].

MTBI most commonly occurs in people who are of working age [1]. A recent systematic review examined return to work after Acquired Brain Injury [3], but surprisingly,

little is published on the return to work of mild brain injury. The prevalence of MTBI among workers' compensation claims varies from 39 to 58 per 10 000 claimants depending on the codes used to classify MTBI [4]. However, we are not aware of any study reporting population-based estimates of the incidence of MTBI in workers.

A study using hospital admissions found that, on average, workers sustaining a mild to moderate brain injury return to work within three months of injury and about 73% have

returned to their previous job one year after injury [5]. A study of volunteers at an outpatient rehabilitation clinic found that on average those in litigation at three months after their injury took significantly more days to return to work (mean = 161.6 days) than did those not seeking compensation (mean = 50.4 days) [6]. However, there is little evidence describing return to work from a large population of mild traumatic brain injured workers covered by workers' compensation.

The objective of this study was to report on the incidence of compensation claims related to MTBI among Ontario

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workers covered by the Workplace Safety & Insurance Board (WSIB) and to describe the number and duration of days off work related to MTBI in workers' compensation lost-time claims.

MATERIALS AND METHODOLOGY

Ontario Workplace Safety & Insurance Board (WSIB)

The Ontario WSIB is a public insurance system legislated to provide no-fault insurance for workplace injuries and diseases to Ontario workers and workplaces. In 1998, approximately 65% of Ontario workers were covered by the WSIB (2,819,437).

Two main types of coverage exist within the WSIB: "Schedule 1" and "Schedule 2". Under "Schedule 1" coverage, employers are not individually liable to pay benefits directly to workers or their survivors. These employers are required to submit a claim to the WSIB within three days of a worker's injury if the injury resulted in lost time from work, wage loss or the worker receiving health care. Employers covered under "Schedule 2" are companies that do not pay premiums to the WSIB but are compulsorily covered through a system of individual liability. These companies include: telephone and telegraph companies, navigation companies, international bridges, provincial government (including boards, commissions and Crown agencies), airlines with a regularly scheduled international passenger service, municipalities (including municipal boards and commissions, except hospital boards), public library boards and school boards. "Schedule 2" employers are required to report all workplace injuries to the WSIB and they are responsible to pay the total costs of benefits for their injured employees.

Workers who are self employed or employed by companies that are not required to have WSIB coverage are not required to report injuries to the WSIB. Employers not required to have coverage include banks, insurance companies, and trust companies; barbers and hair salons; membership organizations (such as labour organizations, professional associations, political associations, etc.); motion picture producers; offices of lawyers, dentists, medical doctors and veterinarians; photographers; radio and television broadcasters; and touring and travel agencies. These employers may apply for Schedule 1 coverage if they choose. The WSIB does not extend coverage, under any circumstances, to teams or individuals competing in sports; circuses; persons who perform stunts in films, videos, theatrical, or live performances, including any actor or performers who do their own stunts; and foreign diplomats and members of a diplomatic staff in embassies. The WSIB maintains a comprehensive administrative lost-time claims database for all reported injuries.

Source Population and Study Design

The source population for this prospective study included all Ontario workers covered by the WSIB in 1997 and 1998. The annual incidence was calculated for both 1997 and 1998, but only 1998 estimates are presented as there was no difference between the two years. Workers aged 18-19 were excluded from analyses due to the lack of denominator information for this age group. Incidence rates (i.e., the rate at which *new* lost-time claims related to MTBI occur in the population of workers covered by the WSIB), were determined by forming historical cohorts of injured workers with

new lost-time claims and dividing by the estimated number of workers covered by the WSIB in that year. We followed claims from 1997-1998 for a period of two years following the injury date to describe the number and duration of disability episodes related to MTBI. Incident claims included only claimants with no claim for MTBI in the year prior to the index claim to ensure that the claim was in fact new. The study received ethics approval from the University of Toronto Ethics Review Board.

Definition of MTBI and MTBI-Related Work Disability

The methodology used to identify MTBI was indirectly based on the World Health Organization task force recommendations [7]. We used the World Health Organization definition of MTBI to define MTBI: an acute brain injury resulting from mechanical energy to the head from external forces. But since we did not have access to hospital records, we operationalized this definition to identify cases of MTBI based on the coding system of the WSIB [8]. We used the "part of body" (POB) and "nature of injury" (NOI) codes to classify injured workers with lost-time claims involving MTBI. The NOI code describes the physical characteristics of the injury or disease (e.g., sprains, concussion). The POB code specifies the worker's anatomical location directly affected by the NOI (e.g., brain, head). We hypothesized that using just the "concussion" code (POB = Brain (1100) and NOI = Concussion (6200)) would underestimate the incidence of MTBI. The methodology used to identify coding groups capturing MTBI lost-time claimants is described elsewhere [4], but briefly, we selected a random sample of claims with codes we thought might include MTBI. Then we examined the clinical information related to the claim and deemed the claim to involve a MTBI or not [4]. We identified four groups of codes that captured MTBI; the proportion of MTBI in the groups was 19% for the cranial region, 29% for the head, 32.4% for the brain, and 92% for the concussion code [4]. As expected, most MTBI was captured under the concussion code. However, enough MTBIs were misclassified to warrant including these proportions in our incidence estimates.

We defined MTBI-related work disability as time off work related to MTBI. Operationally, a MTBI work disabled worker was one who received benefits from a WSIB accepted lost-time claim.

Estimation of the Population of Workers Covered by the WSIB

Ideally, knowing the number of WSIB-covered full-time and part-time workers would be the best method to estimate the population under study; however, this information was not available. We estimated the size of the population covered by the WSIB according to the method developed by Smith *et al.* using Statistic Canada's Labour Force Survey [9,10]. The Labour Force Survey estimates the working-age population in Canada using a sample of approximately 54 000 Canadian households each month. For our analysis, the Labour Force Survey was restricted to "non self-employed" labor force participants working in Ontario. Because of data availability, we restricted our analysis to workers at least 20 years of age. We adjusted our estimates to account for differences in mandatory coverage and reporting of work-related injuries to the WSIB among particular industry

groups in Ontario [11]. To account for differences in employment hours between labor force participants (e.g. age and gender groups), we present all denominators as full-time equivalents (FTEs). One FTE corresponds to 2 000 work hours in one year (50 weeks x 40 work hours).

Incidence Analysis

We computed the annual cumulative, gender-specific, age-specific and age- and gender-specific incidence of MTBI in Ontario workers. We restricted this analysis to workers

who made a new lost-time claim related to MTBI between January 1, 1998 and December 31, 1998. The incidence rate was calculated using the total number of individuals employed by firms with mandatory WSIB coverage as the denominator [10].

Number and Duration of Disability Days Analysis

We conducted two analyses to describe the number and duration of disability days: an episodic and a cumulative analysis. Only cases of MTBI classified under the “concus-

Table 1. Characteristics of Study Population in 1998*

	Lost-time claimants (n, %)	Population covered by WSIB (n, %)
Population size, N	114 836	2 819 437
<i>Age (years)</i>		N/A
18-19	3 036 (2.6%)	
20-29	25 123 (21.9%)	706 216 (25.0%)
30-39	36 684 (31.9%)	875 553 (31.1%)
40-49	29 773 (25.9%)	743 186 (26.4%)
50-59	16 767 (14.6%)	403 240 (14.3%)
60-69	3 337 (2.9%)	85 964 (3.0%)
70+	115 (0.1%)	5 278 (0.2%)
Missing	1	
<i>Gender</i>		
Female	36 341 (31.6%)	1 140 350 (40.4%)
Male	78 479 (68.3%)	1 679 087 (59.6%)
Missing	16	
<i>Industrial sector</i>		N/A
Agriculture	1897 (1.7%)	
Automotive	8079 (7.0%)	
Construction	7191 (6.3%)	
Education	1289 (1.1%)	
Electrical	539 (0.5%)	
Food	4098 (3.6%)	
Forest	1056 (0.9%)	
Health Care	8286 (7.2%)	
Manufacturing	22 751 (19.8%)	
Mining	758 (0.7%)	
Municipal	1124 (1.0%)	
Pulp & paper	418 (0.4%)	
Processing	2699 (2.4%)	
Schedule 2†	16 262 (14.2%)	
Service	26 053 (22.7%)	
Steel	2027 (1.8%)	
Transportation	8933 (7.8%)	
Missing	1376	

*Percentages may not add to 100 due to rounding errors.

†Two main types of coverage exist with the WSIB: mandatory coverage and non-mandatory (including ‘Schedule 2’) coverage. Firms covered under the mandatory coverage plan are required to submit a claim to the WSIB within 3 days of a worker’s injury if the injury resulted in lost time from work, wage loss or the worker receiving healthcare. Employers covered under the alternative schedule (‘Schedule 2’) are companies that do not pay premiums to the WSIB but are required to report all workplace injuries to the WSIB. Workers who are self-employed or employed by companies that are not required to have WSIB coverage are not required to report injuries to the WSIB. Reported injuries are coded and entered into the WSIB database.

sion code” could be used for these analyses because we could not apply the proportion information to the number and duration of disability days. We could not identify the claims that would not have been classified as a MTBI. The number of episodes of time-on-benefits was determined for each claimant and the median length of each episode of time-on-benefits and gaps between each benefit period were calculated over the two-year follow up. All episodes of time-on-benefits of one day or less were excluded to avoid counting administrative payments (such as parking or transportation costs) as time-on-benefits.

The cumulative days on benefit was calculated by merging the benefit periods for each claimant, excluding one day benefit periods. The cumulative results were analyzed with Kaplan-Meier curves. Both analyses were stratified by age and gender and censored at the two-year point. All analyses were done using SAS Version 8.02 on a UNIX system [12].

Assessment and Correction for Hidden MTBI

The selection of POB and NOI codes used to count cases of MTBI from WSIB claims data may influence the incidence [4]. We used two numerators to describe the impact of this potential bias. First, we used the number of WSIB claimants with injuries coded with the concussion code only. As indicated by our validation study, 92% of claimants coded with concussion have a MTBI [4]. Therefore, we weighted the first numerator by 0.92. Our second numerator was a weighted proportion of lost-time claimants with MTBI sampled from all four groups derived from combinations of POB and NOI codes described earlier [4]. We adjusted the variance of the weighted estimates by using the standard deviation of the weight in the calculation of 95% confidence intervals.

RESULTS

Sample Characteristics

We estimated that the WSIB covered 2 819 437 workers in 1998 (Table 1). Most of the Ontario workforce was younger than 49 years and almost 60% were males. In 1998, 114 836 injured workers had active lost-time claims and received lost-time benefits.

Table 2 presents the unweighted characteristics of the cohort of claimants used for the incidence analysis.

Annual Incidence of MTBI Related Claims in Ontario Workers

In 1998, the annual incidence of MTBI related lost-time claims in Ontario workers covered by the WSIB was 1.5 per 10 000 FTEs (95% CI: 1.3, 1.7) (Table 3). Using claimants with the concussion code only would have led to a large underestimation in the incidence. The incidence was higher in males (1.6 per 10 000 FTEs; 95% CI: 1.4, 1.9) than in females (1.2 per 10 000 FTEs; 95% CI: 1.1, 1.4). Among male workers, the incidence varied from 1.2 per 10 000 FTEs (95% CI: 1.0, 1.4) in the 40 to 49 year old group to 2.4 per 10 000 FTEs (95% CI: 2.1, 2.7) in 60-69 year olds. In female workers, the incidence varied from 1.0 per 10 000 FTEs (95% CI: 0.9, 1.2) in 30-49 year olds to 2.0 per 10 000 FTEs (95% CI: 1.8, 2.3) in 50-59 year olds.

Number and Duration of Disability Days of MTBI Lost-Time Claims in Ontario

Of the 816 injured workers making a MTBI claim between January 1, 1997 and December 31, 1998, 87% had a single episode of wage replacement benefits with median duration of 11 days (95% CI: 10, 12). The remaining 13% had at least two benefit periods with median time-on-benefits ranging from just over two months to more than seven months (Fig. 1). Kaplan-Meier analysis showed that 50% of the injured workers classified as MTBI cases were off benefits after 17 cumulated days and 75% were off benefits in 72 days. However, 5% still remained on benefits up to two years post-MTBI (Fig. 2). There was no gender effect, but a large age effect, with younger workers coming off benefits faster than older ones (Fig. 3).

DISCUSSION

Our study has three main findings. First, it provides evidence that MTBI is associated with a significant burden of disability in workers. Each year approximately 1.5 new claims per 10 000 FTEs will involve a MTBI. Second, our analysis demonstrates the importance of accurately identify-

Table 2. Unweighted Characteristics of 1998 Cohort of Injured Workers with Mandatory WSIB Coverage for Incidence Analysis*

	MTBI Classification	
	Concussion code only	All code combinations†
Sample size, n	326 (n, %)	848 (n, %)
<i>Age (years)</i>		
20-29	92 (28.2%)	256 (30.2%)
30-39	96 (29.4%)	250 (29.5%)
40-49	63 (19.3%)	165 (19.4%)
50-59	52 (16.0%)	114 (13.4%)
60-69	13 (4.0%)	36 (4.2%)
<i>Gender</i>		
Female	114 (35.0%)	279 (32.9%)
Male	212 (65.0%)	569 (67.1%)

*Percentages may not add to 100 due to rounding errors.

†Injuries related to the head region, cranial region, concussion code, and brain region.

Table 3. Weighted Incidence of Claims Involving MTBI (Per 10 000; 95% CI) in the WSIB Covered Population in 1998

	Concussion code only	All code combinations *
Cumulative	1.1 (0.9, 1.2)	1.5 (1.3, 1.7)
Gender-specific		
Female	0.9 (0.8, 1.0)	1.2 (1.1, 1.4)
Male	1.1 (1.0, 1.3)	1.6 (1.4, 1.9)
Age-specific		
20-29	1.2 (1.1, 1.3)	1.7 (1.5, 2.0)
30-39	1.0 (0.9, 1.1)	1.4 (1.3, 1.6)
40-49	0.8 (0.7, 0.9)	1.1 (1.0, 1.2)
50-59	1.2 (1.0, 1.3)	1.6 (1.4, 1.8)
60-69	1.4 (1.2, 1.6)	2.0 (1.8, 2.3)
Age- and gender-specific		
Female		
20-29	0.8 (0.7, 0.9)	1.2 (1.1, 1.4)
30-39	0.8 (0.7, 0.9)	1.0 (0.9, 1.2)
40-49	0.7 (0.6, 0.8)	1.0 (0.9, 1.1)
50-59	1.6 (1.4, 1.8)	2.0 (1.8, 2.3)
60-69	0.6 (0.6, 0.7)	1.3 (1.0, 1.6)
Male		
20-29	1.5 (1.3, 1.6)	2.2 (1.9, 2.4)
30-39	1.2 (1.0, 1.3)	1.7 (1.5, 1.9)
40-49	0.8 (0.7, 0.9)	1.2 (1.0, 1.4)
50-59	0.9 (0.8, 1.0)	1.3 (1.1, 1.4)
60-69	1.8 (1.6, 2.0)	2.4 (2.1, 2.7)

*Injuries related to the head region, cranial region, concussion code, and brain region.

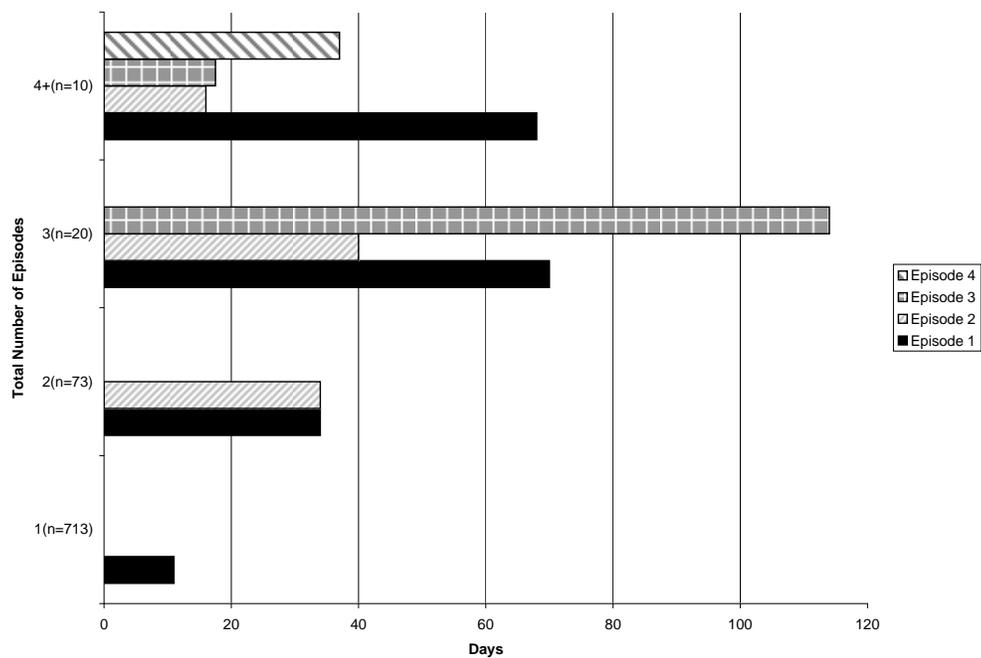


Fig. (1). Median duration of each episode as a function of total number of episodes experienced within two years of loss time claim (N=816).

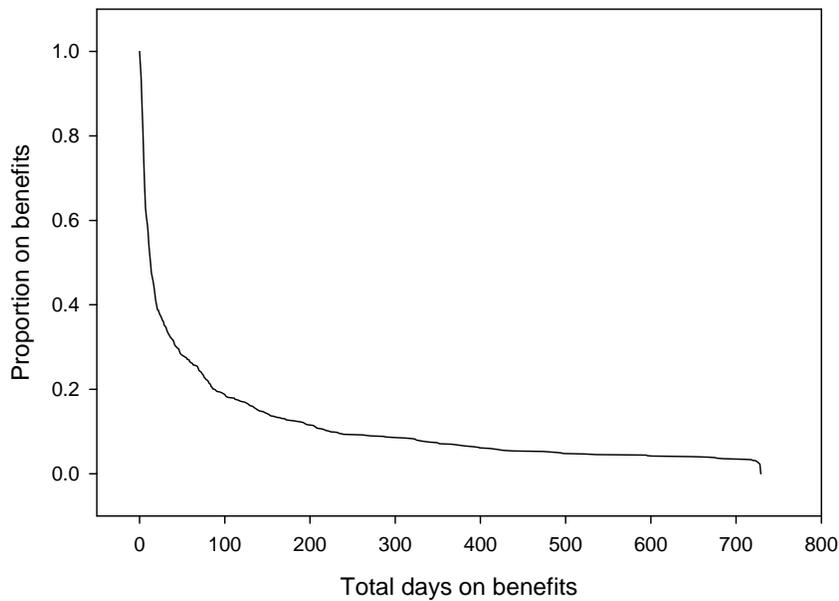


Fig. (2). Cumulative number of days on benefit for MTBI lost-time claimants (N=816).

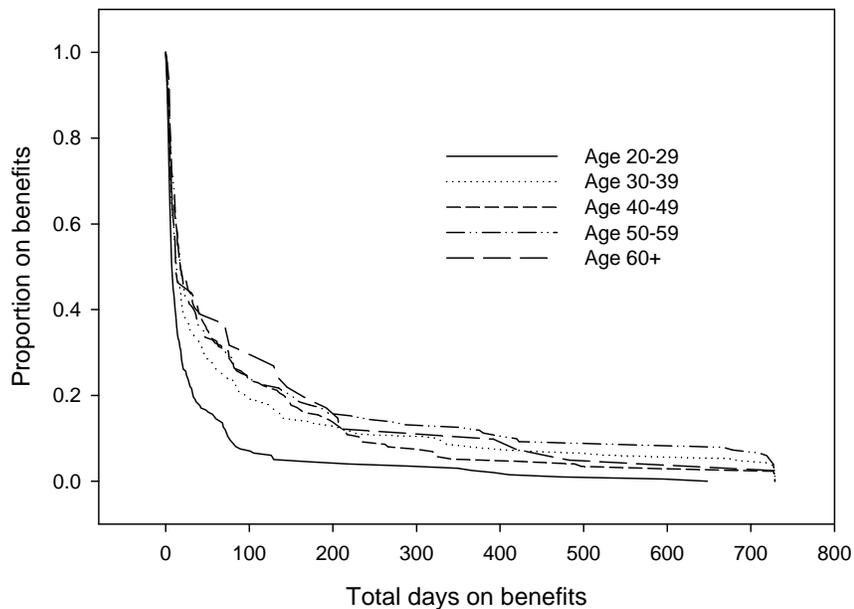


Fig. (3). Cumulative number of days on benefit for MTBI lost-time claimants by age (N=816).

ing codes that capture MTBI. Relying solely on the codes used by compensation boards can result in underestimates of the burden of MTBI in workers. Third, our results indicate that most claims involving MTBI result in a single episode of wage replacement of approximately 11 days duration; however, a small proportion go on to develop chronic disability (defined here as greater than one year on benefits) and are still on benefits up to two years post-MTBI.

To our knowledge, this is the first study determining the incidence and number and duration of work disability days related to MTBI solely in the working population. Other studies of disability have used hospital-based cohorts that likely included non-working individuals at the time of injury [2,13-15]. Thornhill *et al.* [2] reported an annual incidence of

disability in adults with head injuries admitted to hospital of 100-150 per 100 000 individuals. We reported an annual incidence of MTBI work disability in the Ontario working population of 15 per 100 000. Therefore compensation data may indicate less of a burden of work disability than expected when using hospital admissions data as a referent group. However, it is important to consider that there are two other main methodological differences between our study and that of Thornhill *et al.* First, Thornhill *et al.* used GCS to discern severity of injury with a GCS of 13-15 indicating a mild injury [2]. In contrast, we did not have GCS information available, so we used an operational definition based on recommendations from the World Health Organization's Task Force on MTBI [7]. Second, we defined work disability as receiving benefits from WSIB accepted lost-time claims.

Thornhill *et al.* [2] assessed disability using the Glasgow outcome scale [16,17]. It is likely that our compensation data identified a less severe group of injuries than the hospital admissions data.

More males received compensation for MTBI related claims than females. Males may be more likely to take on hazardous, physically demanding work, especially at a young age. The age distributions in both males and females tend to be “U” shaped, with more MTBI related claims in the younger and older age groups. This is most likely due to the “healthy worker” effect where more susceptible workers experience injury earlier in their careers causing them to move out of the profession. The “healthier” workers continue and experience a lower rate of injury mid-career. As both males and females age, the physical effects of age may make them more susceptible to injury, hence the “U” shaped curve.

Duration of disability appears consistent. Englander *et al.* [13] reported 88% of medically insured individuals admitted to hospital who sustained a MTBI returned to work or school within one to three months. Paniak *et al.* [14] found that 73.7% of MTBI patients drawn from consecutive admissions to hospital emergency wards returned to full-time pre-injury vocational status after three to four months. They also noted older age was associated with longer periods of disability. Thornhill *et al.* [2] followed 362 MTBI patients identified from acute hospitals in Glasgow and reported that 63.2% had returned to work after one year. Despite significant methodological differences between our study and these, we reported similar numbers coming off benefits (75% after two to three months post-injury) and similar associated factors (older age). There are two main differences between our study and these, beyond population differences. First, we followed 816 lost-time claimants for two years post-injury. The sample sizes of the other studies were small, ranging from 77 to 362 with varying follow-up periods. Second, the criteria for defining MTBI varied. We defined MTBI based on World Health Organization task force recommendations [7]. Englander *et al.* [13] and Thornhill *et al.* [2] used GCS, while Paniak *et al.* [14] used consensus criteria from the American Congress of Rehabilitation.

It is important to note that our outcome was time on benefit, not actual return to work. Return to work is complicated and multi-factorial. The MTBI may have been the mitigating reason for filing the lost-time claim, but not necessarily the reason for extended stays on benefits. Other factors, such as personal, workplace or compensation system factors may influence the time on benefits.

Although we used a population-based cohort of considerable size, our study has limitations. First, we likely undercounted MTBI in the workplace by examining only WSIB lost-time claims. Since MTBI is a mild injury, it is unlikely that all cases result in lost-time claims through the WSIB. Second, we could not use a “true” denominator of the workers at risk of being off work because we were unable to exclude workers with prevalent lost-time claims involving MTBI. Although underestimating the incidence of MTBI, the bias was likely minimal. The number of prevalent MTBI cases to be excluded from the denominator is insignificant compared to the size of the population covered by the WSIB. Finally, the use of administrative data required us to use

time-on-benefits as a proxy for work disability associated with MTBI. Benefits may be paid to claimants for reasons not directly attributable to MTBI, such as co-injury, which may have occurred at the time of the MTBI. Since the WSIB codes only one injury, and MTBI is the first coded, it is possible that many of the MTBIs occurred in conjunction with other injuries.

CONCLUSION

In summary, this study highlights MTBI as a potentially disabling condition in the compensated working population. The 1998 annual incidence of MTBI related lost-time claims in Ontario workers covered by the WSIB was 1.5 per 10 000 FTEs. Eighty-seven percent of MTBI related lost-time claims had a single episode of wage replacement benefits with a median duration of 11 days. Twenty-five percent will still be off work two to three months post-injury and a small proportion will remain off work for at least two years. Future work should focus on understanding this chronically disabled group.

ABBREVIATIONS

CI	=	Confidence interval
FTE	=	Full time equivalent
MTBI	=	Mild traumatic brain injury
NOI	=	Nature of injury
POB	=	Part of body
WSIB	=	Workplace Safety and Insurance Board

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