Chapter 2.6

Traumatic Brain Injury in the Homeless Population: A Toronto Study

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Traumatic brain injury is caused by "a blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain" and most commonly results from falls, motor vehicle traffic crashes and assaults (National Center for Injury Prevention and Control, 2008). Traumatic brain injury is a leading cause of permanent disability in North America. Traumatic brain injury may be common in the homeless population (Waldmann, 2004). Exposure to physical abuse during childhood, which could result in traumatic brain injury, is a known risk factor for homelessness as an adult (Herman et al., 1997). Substance abuse increases the risk of homelessness (Susser et al., 1993) and the risk of traumatic brain injury (Corrigan, 1995). Homeless people experience high rates of injury of all types and are frequently victims of assault (Kushel et al., 2003; Zakrison et al., 2004). Finally, traumatic brain injury could be a factor contributing to the 3 to 8 percent prevalence of cognitive dysfunction among homeless adults (Kass & Silver, 1990; Spence et al., 2004).

Stephen W. Hwang, Angela Colantonio, Shirley Chiu, George Tolomiczenko, Alex Kiss, Laura Cowan, Donald A. Redelmeier, and Wendy Levinson. Traumatic Brain Injury in the Homeless Population: A Toronto Study. In: Hulchanski, J. David; Campsie, Philippa; Chau, Shirley; Hwang, Stephen; Paradis, Emily (eds.) *Finding Home: Policy Options for Addressing Homelessness in Canada* (e-book), Chapter 2.6. Toronto: Cities Centre, University of Toronto. www.homelesshub.ca/FindingHome

ISBN 978-0-7727-1475-6

Providing health care for homeless patients can be challenging for various reasons, including difficult behavioural patterns. These behaviours may be related in part to the unrecognized consequences of traumatic brain injury and may include cognitive impairment, attention deficits, disinhibition, impulsivity and emotional lability.[1] Appropriate support services may be able to minimize the adverse impact of these behaviours.

Two previous studies have reported the prevalence of traumatic brain injury among homeless people in London, England, and Milwaukee, Wisconsin. These studies were limited by small sample sizes, recruitment at a single shelter, and a lack of data from women (Bremner et al., 1996; Solliday-McRoy et al., 2004). We conducted this study to determine the lifetime prevalence of traumatic brain injury in a representative sample of homeless men and women across an entire city, and to identify the temporal relation between traumatic brain injury and the onset of homelessness. We also sought to characterize the association between a history of traumatic brain injury and current health problems in this population. Our primary hypothesis was that a history of traumatic brain injury would be associated with poor current health.

Survey and analysis

Study design and population

We used a cross-sectional survey design. We recruited a representative sample of homeless people in Toronto, Ontario, where about 5,000 people are homeless each night and about 29,000 people use shelters each year (Brown, 2006; City of Toronto, 2003). We defined homelessness as living within the last seven days at a shelter, public place, vehicle, abandoned building or someone else's home, and not having a home of one's own. Based on a pilot study, we determined that about 90 percent of homeless people in Toronto slept at shelters, and that 10 percent did not use shelters but did use meal programs (Hwang et al., 2005). We therefore recruited 90 percent of our study participants at shelters and 10 percent at meal programs.

We contacted every homeless shelter in Toronto and obtained permission to enrol participants at 50 (89 percent) out of 56 shelters (20 shelters for men, 12 for women, 6 for men and women, and 12 for youths aged 16–25

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years). The number of beds at each shelter ranged between 20 and 406. Recruitment at meal programs took place at 18 sites selected at random from 62 meal programs in Toronto that served homeless people. Because the goal of recruiting at meal programs was to enrol homeless people who did not use shelters, we excluded people at meal programs who had used a shelter within the last seven days.

We recruited participants over 12 consecutive months in 2004–2005. We stratified enrolment to achieve a 2:1 ratio of men to women. The number of participants recruited at each site was proportionate to the number of homeless people served monthly. We selected participants at random from bed lists or meal lines using a random number generator and assessed their eligibility. We excluded people who did not meet our definition of homelessness, who were unable to communicate in English, and who were unable to give informed consent. We also excluded homeless shelter users encountered at meal programs and those who did not have a valid Ontario health insurance number, which was required to track health care use after the recruitment interview.

Previous studies have shown that homeless parents with dependent children differ substantially from homeless people without children. Homeless parents have lower rates of mental illness and substance abuse and are more likely than those without children to have become homeless for purely economic reasons (Robertson & Winkleby, 1996; Shinn et al., 1998). Because of these differences, this report does not include homeless parents with dependent children who were enrolled in the study.

Each participant provided written informed consent and received $15 for completing the survey. This study was approved by the research ethics board at St. Michael's Hospital.

Survey instrument

Research team members administered the survey to each participant by a face-to-face interview conducted immediately after recruitment at shelters and meal programs. We obtained information on demographic characteristics and health conditions. We collected data on ethnic background because previous studies have reported racial disparities in rates of traumatic brain injury. Participants self-identified their ethnic background from categories adapted from the Statistics Canada Ethnic Diversity Survey (Statistics

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Canada, 2002). The most commonly selected categories were white, black, and First Nations. All other categories were classified as "other."

Mental health problems, alcohol problems and drug problems in the last 30 days were assessed using the Addiction Severity Index (McGahan et al., 1986; McLellan et al., 1992). The Addiction Severity Index has been validated with homeless people and used in numerous studies, including a nationwide survey of homeless people in the United States (Burt et al., 2001; Drake et al., 1995; Joyner et al., 1996; Zanis et al., 1994). Problems were dichotomized as present or absent by use of cut-off scores established for homeless populations (Burt et al., 1999).

We classified participants as having mental health problems if their mental health score on the Addiction Severity Index was ≥ 0.25. They were classified as having alcohol problems if their alcohol score was ≥ 0.17 and were classified as having drug problems if their drug score was ≥ 0.10 (Burt et al., 1999). We used the SF-12 health survey, a health status instrument that has been validated in homeless populations (Larson, 2002), to generate scores for the physical and mental component subscales (Ware et al., 1995). These scores range continuously from 0 to 100 (best), standardized to a mean of 50 and standard deviation of 10 in the general population in the United States (Ware et al, 1995).

We determined a history of traumatic brain injury using questions from a study of prison inmates (Slaughter et al., 2003). Lifetime prevalence of traumatic brain injury was determined using the question, "Have you ever had an injury to the head which knocked you out or at least left you dazed, confused or disoriented?" Participants were asked how many such injuries they had over their lifetime.

For the first injury and up to two subsequent injuries, we obtained the date or age at injury, whether the injury resulted in unconsciousness, and the duration of unconsciousness. We used the age at which the participant first experienced homelessness to determine the temporal relation between the first traumatic brain injury and the onset of homelessness. A mild traumatic brain injury was defined as a head injury that left the person dazed, confused, or disoriented, but resulted in no unconsciousness or unconsciousness for less than 30 minutes. A moderate or severe traumatic brain injury was defined as a head injury that resulted in unconsciousness

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for more than 30 minutes. These definitions are consistent with standardized consensus criteria (Kay et al., 1993).

Statistical analyses

We compared the characteristics of people with and without a history of traumatic brain injury using chi-square and T tests. We developed regression models to determine if a history of traumatic brain injury was associated with health conditions and health status indicators, after adjustment for sex, age, ethnic background, place of birth, education and lifetime years of homelessness. We used generalized estimating equations to account for possible clustering of the sample within shelters or meal programs.

History of traumatic brain injury was entered into models as a categorical variable representing the severity of the worst traumatic brain injury ever experienced (none, mild or unknown, or moderate or severe). In our secondary analyses, both severity of the worst traumatic brain injury and the lifetime number of traumatic brain injuries were entered into models. We assessed independent variables for multicolinearity before the analyses, and no problems were detected. Analyses were conducted with unweighted data.

Of 1,679 people screened at homeless shelters and meal programs, we included 904 people in our study. In total, 489 (29 percent) were ineligible for inclusion: 222 (13 percent) did not meet our definition of homelessness, 61 (4 percent) were unable to communicate in English, 54 (3 percent) were homeless shelter users encountered at meal programs, and 51 (3 percent) were unable to give informed consent. Because this study was part of a larger study of the use of health care services by homeless people, we excluded 101 people (6 percent) because they did not have an Ontario health insurance number. Most of these 101 people were refugees, refugee claimants or had recently migrated to Ontario.

Of 1,190 eligible people, 283 declined to participate. We enrolled 907 (76 percent of eligible people) in the study. We obtained information about traumatic brain injury for 904 participants. The characteristics of the study participants are shown in Table 1.

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Results

The lifetime prevalence of traumatic brain injury was 53 percent. The prevalence was significantly higher among men (58 percent) than among women (42 percent, $p < 0.001$). Those with a history of traumatic brain injury were more likely to be male, white and born in Canada; to have become homeless for the first time at a younger age; and to have experienced more years of homelessness over their lifetime. Compared to those without a history of traumatic brain injury, participants with a history of traumatic brain injury had a significantly higher lifetime prevalence of seizures (8 percent v. 22 percent, $p <0.001$); higher prevalence of mental health problems (33 percent v. 43 percent, $p = 0.001$), alcohol problems (28 percent v. 42 percent, $p < 0.001$) and drug problems (40 percent v. 57 percent, $p < 0.001$). They also had poorer mental health (mean score 43.8 v. 39.0, $p < 0.001$) and physical health (mean score 48.1 v. 43.9, $p < 0.001$) as measured by the SF-12 health survey (Table 1).

The mean age at first traumatic brain injury was 17.8 years. Although 40 percent of participants with traumatic brain injuries reported only 1 such injury, 21 percent reported 2 injuries, 12 percent reported 3 injuries, 7 percent reported 4 injuries, and 20 percent reported 5 or more injuries. The severity of the worst traumatic brain injury was mild for 66 percent of participants, moderate or severe for 23 percent and unknown for 11 percent. In all analyses involving traumatic brain injury severity, we grouped injuries of unknown severity with mild injuries. Analyses in which injuries of unknown severity were considered to be a separate category gave essentially identical results.

The temporal relation between the first traumatic brain injury and the first episode of homelessness is shown in Figure 1. For 70 percent of participants, the first traumatic brain injury occurred before the onset of homelessness. The injury occurred in the same year as the onset of homelessness for 7 percent of participants, and after the onset of homelessness for 22 percent. We could not determine the relation between the first traumatic brain injury and the first episode of homelessness for 2 percent of participants.

When we considered the influence of sex, age, ethnic background, place of birth, education and lifetime years of homelessness, a history of traumatic brain injury was significantly associated with seizures, mental

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health and drug problems, and poorer physical and mental health status (Table 2). In additional models that included both the severity of the worst traumatic brain injury and the total lifetime number of traumatic brain inju-

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ries as covariables, a higher number of traumatic brain injuries was associated with significantly increased odds of seizures and mental health, alcohol and drug problems.

Table 1: Characteristics of 904 homeless participants with or without traumatic brain injury

Characteristic	Total no. (%)* of participants *n = 904*	Traumatic brain injury; no. (%) of participants*		*p* value
		Present *n = 475*	Absent *n = 429*	
Age, yr, mean (SD)	37.4 (12.9)	37.6 (11.9)	37.1 (13.9)	0.59
Sex				< 0.001
Male	601 (67)	348 (73)	253 (59)	
Female	303 (34)	127 (27)	176 (41)	
Ethnic background†				< 0.001
White	547 (61)	322 (68)	225 (52)	
Black	166 (18)	49 (10)	117 (27)	
First Nations	89 (10)	54 (11)	35 (8)	
Other	102 (11)	50 (10)	52 (12)	
Place of birth				< 0.001
Canada	663 (73)	390 (82)	273 (64)	
Outside Canada	241 (27)	85 (18)	156 (36)	
Education				0.70
Some high school or less	476 (53)	252 (53)	224 (52)	
High school or equivalent	187 (21)	93 (20)	94 (22)	
Vocational training, college or above	239 (27)	128 (27)	111 (26)	
Marital status				0.48
Single or never married	611 (68)	322 (68)	289 (67)	
Divorced or separated	221 (25)	111 (23)	110 (26)	
Married or partnered	53 (6)	29 (6)	24 (6)	
Widowed	19 (2)	13 (3)	6 (1)	
Age at first episode of homelessness, yr, mean (SD)	28.5 (13.8)	27.5 (13.3)	29.6 (14.2)	0.02
Lifetime years of homelessness, mean (SD)	4.4 (5.9)	4.9 (6.3)	3.8 (5.4)	0.006
Seizures (ever experienced in lifetime)	139 (15)	103 (22)	36 (8)	< 0.001
Mental health problems in the last 30 days	344 (38)	204 (43)	140 (33)	0.001
Alcohol problems in the last 30 days	322 (36)	201 (42)	121 (28)	< 0.001
Drug problems in the last 30 days	442 (49)	269 (57)	173 (40)	< 0.001
Mental component subscale score‡, mean (SD)	41.3 (13.2)	39.0 (12.7)	43.8 (13.2)	< 0.001
Physical component subscale score‡, mean (SD)	45.9 (11.1)	43.9 (11.4)	48.1 (10.3)	< 0.001

Note: SD = standard deviation.
*Unless otherwise indicated.
†Ethnic background was self-identified by participants.
‡Measured using the SF-12 health survey.

Table 2: Association between history of traumatic brain injury and health status

Traumatic brain injury	Health status indicator; adjusted* odds ratio (95% CI)				SF-12 subscale score, mean difference (95% CI)	
	Seizures†	Mental health‡	Alcohol‡	Drugs‡	Mental component	Physical component
None (reference)	1.0	1.0	1.0	1.0	0.0	0.0
Mild or unknown severity	2.5 (1.5 to 4.2)	1.3 (1.0 to 1.8)	1.4 (1.0 to 2.0)	1.8 (1.3 to 2.5)	–4.7 (–6.6 to –2.8)	–3.9 (–5.5 to –2.3)
Moderate or severe	3.2 (1.8 to 5.6)	2.5 (1.5 to 4.1)	1.6 (1.0 to 2.7)	1.6 (1.1 to 2.5)	–8.3 (–11.1 to –5.5)	–6.0 (–8.3 to –3.7)

Note: CI = confidence interval.
*Adjusted for sex, age, ethnic background, place of birth, education and lifetime years of homelessness.
†Ever experienced.
‡In the past 30 days.

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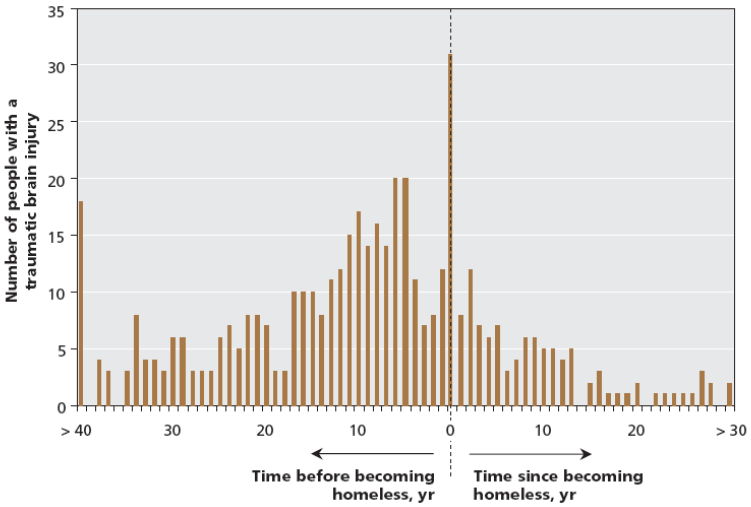

Figure 1: Homeless participants (*n* = 461) who experienced a traumatic brain injury before or after becoming homeless.

Interpretation

We found a high prevalence of traumatic brain injury in a representative sample of homeless people. A history of traumatic brain injury was more common among homeless men (58 percent) than among homeless women (42 percent). These rates are five or more times greater than the 8.5 percent lifetime prevalence rate of traumatic brain injury in the general population in the United States (Silver et al., 2001) and are within the range reported in studies of traumatic brain injury among prison inmates (Morrell et al., 1998; Schofield et al., 2006; Slaughter et al., 2003).

Only two previous studies have reported the prevalence of traumatic brain injury among homeless people. In a study of 80 consecutive entrants to a men's shelter in London, England, 46 percent of entrants had a lifetime history of head injury severe enough to cause unconsciousness (Bremner et al., 1996). A study of 90 homeless men at a shelter in Milwaukee, Wisconsin, found that 80 percent of participants had possible cognitive impairment and 48 percent had a history of traumatic brain injury involving loss of con-

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sciousness (Solliday-McRoy et al., 2004). In both studies, the sample size was small, and participants were recruited at a single shelter rather than at a broad range of shelters across an entire city. In addition, homeless women and homeless people who did not use shelters were excluded.

Data from the United States have demonstrated higher rates of traumatic brain injury among African-Americans (National Center for Injury Prevention and Control, 2008). In contrast, our study found a significantly lower prevalence of traumatic brain injury among homeless people who were black (30 percent) compared with those who were white (59 percent). This difference is possibly explained by the fact that traumatic brain injury was much less common among immigrants than among people born in Canada. In our study, 69 percent of participants who were black were immigrants to Canada.

Among homeless people, the first experience of traumatic brain injury often occurred at a young age and usually occurred before the person's first episode of homelessness. This finding suggests that, in some cases, traumatic brain injury may be a causal factor that contributes to the onset of homelessness, possibly though cognitive or behavioural consequences of traumatic brain injury. Future research could explore this hypothesis.

A history of traumatic brain injury was strongly associated with many adverse health outcomes among homeless people, including seizures, mental health problems, drug problems, and poorer physical and mental health status. A history of moderate or severe traumatic brain injury had particularly strong associations with both the presence of mental health problems within the past 30 days (OR 2.5, 95 percent; CI 1.5–4.1) and poorer mental health status (–8.3 points on the SF-12 mental component sub-scale[1]). Our cross-sectional study was unable to ascertain the causal pathways responsible for these associations. Although the cognitive effects of traumatic brain injury may increase the risk of subsequent mental health and drug problems, it is equally plausible that pre-existing mental health, alcohol and drug problems increase the risk of experiencing traumatic brain injury (Parry-Jones et al., 2006). Likewise, homelessness could be both a contributing cause and a consequence of traumatic brain injury. Clarification of

1 10 points equals 1 standard deviation in the general population.

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these issues would require data from a prospective longitudinal study of people with traumatic brain injury.

Strengths and limitations

Our study has a number of important strengths. We enrolled a large representative sample of both homeless men and women in a major North American city, including both those who used and those who did not use shelters. We used rigorous methods to select participants randomly at each site. We achieved a high response rate, and successfully recruited 76 percent of eligible people. History of traumatic brain injury was assessed using a series of questions from a previously validated survey of prison inmates (Slaughter et al., 2003).

Certain limitations of this study should be noted. We did not enrol a control group of non-homeless people. Our findings may not reflect rates of traumatic brain injury among homeless parents with dependent children or homeless persons who do not use shelters or meal programs. The requirement that study participants have an Ontario health insurance number resulted primarily in the exclusion of refugees and refugee claimants, whose history of traumatic brain injury may be different from that of other homeless people. We did not collect information about the mechanism or circumstances of traumatic brain injury. Prevalence and severity of traumatic brain injury as well as age at the time of traumatic brain injury were self-reported by participants and are subject to recall errors. Confirmation of these self-reports through the review of health records was beyond the scope of our study.

Recently, the Traumatic Brain Injury Questionnaire has been described as a promising interview-based instrument to assess the history of traumatic brain injury in incarcerated adults (Diamond et al., 2007). Future studies including homeless people should consider using this instrument. Finally, participants did not undergo formal testing for neuropsychological dysfunction that may have resulted from brain injuries.

Conclusion

Our study's findings underscore the need for clinicians to routinely ask patients who are homeless about a history of traumatic brain injury. Given

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the apparent dose–response relation between injury severity and current health, clinicians should assess injury severity based on information such as self-reported duration of unconsciousness, admission to hospital after the injury, collateral history and medical records. For people with a history of traumatic brain injury, brief neuropsychological screening can provide valuable information on cognitive function. People with moderate or severe cognitive impairment may be eligible for disability benefits. Referral to rehabilitation and other appropriate community services should be considered, as recent studies have shown that rehabilitation interventions improve community integration and other outcomes among people with traumatic brain injury (Gordon et al., 2006). Moreover, appropriate living environments are fundamental to community integration and are particularly important for people with more severe injuries (Kelly & Winkler, 2007). Treatment of concurrent alcohol or substance abuse should also be considered.

Future research should expand these findings by using medical records to confirm self-reported traumatic brain injury among homeless people and by correlating a history of traumatic brain injury with objectively assessed cognitive function. Cohort studies would be helpful to clarify the causal pathways that account for the high prevalence of traumatic brain injury among homeless people. Finally, research should examine the possible benefits of appropriate supportive living environments for homeless people with moderate cognitive dysfunction due to traumatic brain injury.

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ISBN 978-0-7727-1475-6

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