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High rates of head injury among homeless and low-income housed men: a retrospective cohort study

Tomislav Svoboda,[1,2] Jason T Ramsay[3]

[1]Department of Family and Community Medicine, University of Toronto, Toronto, Ontario, Canada
[2]Centre for Research on Inner-City Health, St Michael's Hospital, Toronto, Ontario, Canada
[3]Health Studies Program, Department of Anthropology, University of Toronto Scarborough, Ontario, Canada

Correspondence to
Dr Tomislav Svoboda, St Michael's Hospital, Centre for Research on Inner-City Health, 30 Bond Street, Toronto, Ontario, Canada M5B 1W8; tomislav.svoboda@utoronto.ca

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ABSTRACT

Objective To examine the predictors and temporal patterns of head injury (HI) presentation in the emergency department among cohorts of homeless and low-income housed men.

Methods Retrospective review and logistic regression of HIs found in emergency department records for three groups of men, those: (1) who were chronically homeless with drinking problems (CHDP) (n=50), (2) in the general homeless population (GH) (n=60) and (3) in low-income housing (LIH) (n=59).

Results The proportion of individuals with non-minimal HIs documented in the previous year were 28%, 3% and 5% with annual rates of 0.47, 0.017 and 0.037 among the CHDP, GH and LIH groups (p<0.0001). In the multivariate model, independent associations with having an HI included: an HI in the previous year (OR 11.8, 95% CI 3.83 to 36.4), drug dependence (OR 3.67, 95% CI 1.11 to 12.13) and seizures (OR 3.50, 95% CI 1.13 to 10.90), while mood-disorders were protective. Homelessness had a crude risk increase of HI (OR 3.15, 95% CI 1.21 to 8.23) but was not significant in the multivariate model. Among those with HIs, chronic homelessness with drinking problems was associated with a higher rate of HI. With each successive HI, the time interval to another HI was 12 days shorter (p=0.0004). The chronic subdural haematoma incidence in the under-65-year-old CHDP group was 11 per 1000 (95% CI 2.8 to 45).

Conclusions Having an HI is better predicted by previous head injuries, drug dependence or a seizure disorder than a history of homelessness or alcohol dependence. HIs may become more frequent with time.

BACKGROUND

In Canada, severe head injury (HI) is a significant clinical and public health problem with an annual incidence of 11.4 per 100 000.[1] The societal cost of brain injury in Canada has been estimated at roughly $1 billion per year for an estimated 18 000 injuries.[2 3] The risk of readmission to the hospital subsequent to HI is significant and increases the risk of further disability and death.[4 5] Reduced neurocognitive function is a common effect of HI.[6] Young adult men are at a greater risk of HI than women by a factor of four.[2] It is estimated that Canadian men have an annual severe HI rate of 17.1 per 100 000 per year.[1] Having suffered an HI increases the risk for a second HI threefold and a third eightfold.[7 8]

Men who are homeless or underhoused tend to experience a high rate of injury. Unintentional injury is a leading cause of death in men who were homeless or underhoused at the time.[9 10] Risk factors for chronic subdural haematoma (CSH) suggest that CSH rates could be higher among alcohol dependent homeless men who frequently have head injuries.[11]

Recently, Hwang *et al*[12] surveyed over 900 homeless Canadian individuals and found a 53% lifetime prevalence rate for self-reported mild to severe traumatic brain injury (TBI), with prevalence higher for men (58%) than for women (42%). This rate is approximately five times the rate of TBI in the normal population. Those with a history of TBI were more likely to be: men, white, and Canadian born; have become homeless at a younger age; have experienced longer periods of homelessness over their lifetime, and have seizures, poorer physical and mental health, and alcohol and drug problems. Hwang *et al*[12] reported that 70% of participants reported that their first instance of TBI occurred before their first instance of homelessness. This study relied exclusively on self-report data obtained through interview and relied on definitions of TBI predicated on self-judgment of alterations in consciousness, as opposed to medical documentation of head trauma. The authors were not able to determine the annual incidence rate and had no controls among those who were not homeless.

The purpose of this study was to examine the incidence of HI presentation to the emergency department (ED) among cohorts of low-income housed, homeless and chronically homeless alcohol dependent men with a direct comparison with those who are housed. Our analysis included an examination of the predictors and temporal patterns of HI and the incidence of CSHs in the vulnerable, chronically homeless, alcohol dependent population.

DESIGN

Study design and data collection

This study is a subanalysis of a larger investigation examining the impact of a shelter based alcohol harm reduction programme for men who were chronically homeless with drinking problems (CHDP). Independent ethical review was obtained from the University of Toronto Research Ethics Board (REB) and three hospital REBs. A retrospective cohort approach was used in which interview data collected at the time of recruitment were linked to the previous almost 6 years of ED records (1 January 1994–14 April 1999) in all seven inner-city catchment area hospitals. All men in the Annex wet shelter programme were invited to participate in the study (n=50) (CHDP group). The Annex is a shelter that provides alcohol in a managed

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alcohol programme for men who are chronically homeless with severe problems related to heavy drinking who are unable to otherwise access shelter services due to their drinking behaviours.[13] Subjects were also sampled from two control groups using one-in-three systematic sampling with random start from a hostel for men in the general homeless population (n=60) (GH group) and three low-income housing sites (n=59) (LIH group). Recruited subjects consented to release hospital records and be interviewed using structured computer-assisted interviews to determine multiple measures of health and social status. Time of the most recent residency in Toronto was determined as the end of the time subjects last resided outside the inner-city service area for more than a year. The interview included validated instruments for meeting Diagnostic and Statistical Manual of Mental Disorders (DSM) III criteria for depression, generalised anxiety disorder, alcohol and drug dependence[14] and self-reported lifetime and previous year history of seizures using modified questions from Statistics Canada's National Population Health Survey (NPHS 1994). Research staff hand searched hospital records and matched them to interviews. Matching probabilities were calculated between hospital records and interview data (based on the prevalence of identifiers) by adapting methods described by Fellegi and Sunter.[15 16] Data with less than a 99% probability of matching the interviewed subject were excluded. Dates of ED visits and documented HIs and subdural haematomas as defined in a study data dictionary were recorded using computer-assisted data-entry forms. Two abstractions with different teams of two abstractors each were used to reduce abstraction errors and bias. Abstractors were blinded to group membership except for the physician researcher (TS) who was the physician to some of the subjects and participated in about 10% of the abstractions.

Identification of HI

Head injuries were recorded as occurrences of the terms 'head injury' or 'injury to head' describing problems at that emergency department encounter; otherwise, the following rules were used to infer presence of an HI: (1) fall with any of scalp/skull/face/head laceration, fracture, contusion/bruise, haematoma or abrasion; (2) fight/assault with any of scalp/skull/face/head fracture or contusion/bruise haematoma; (3) any mention of blow to head region (face, skull, scalp, or any part of these—nose, ear, eye, lip); or (4) any mention that any one of the following in the head region was due to a 'blow': laceration, fracture, contusion/bruise, haematoma or abrasion. HIs documented as being seen in previous ED visits were excluded. HIs were considered (1) minimal; (2) minor if associated with confusion, disorientation or a Glasgow Coma Scale (GCS) of 13–15 inclusive; (3) moderate if associated with GCS of 9–12 inclusive; and (4) severe if associated with GCS of 8 or less.

Statistical analyses

Chi-square and analyses of variance were used to determine group differences in demographic characteristics. T-tests compared rates of HI. Same-day HIs were excluded. Rates of HI for each subject in the year previous to the interview date (reference year) and the year prior to the reference year were compared using paired t tests and simple multivariate linear regression. Any HI and rate of HI in the previous year were modelled using univariate and multivariate logistic and simple linear regression respectively. All regressions were done using the backward model selection method (Proc Reg and Proc Logistic, SAS V.9.1.3) using demographic and health status indicator variables listed in table 1 (except for age group). Mean rates were calculated by fitting to Poisson distributions corrected for overdispersion by setting the scale to deviance (Proc Genmod, SAS V.9.1.3).

The time interval between each subsequent HI was determined for each subject during the 6 years prior to the interview date or since the time of the most recent residency in Toronto. A linear regression was performed of time interval versus HI order score where the latter was simply the order of HI treated as a continuous variable. For any given calculation, subjects with missing data were excluded from that analysis.

RESULTS

A total of 170 subjects agreed to participate (response rate 78%). Of those not recruited (n=48), 52% were not interested, 19% could not be found, 19% failed competency screening and 10.2% were excluded due to language barriers. Table 1 provides participant characteristics. Missing values for general anxiety disorder, drug dependence and alcohol dependence variables occurred for 1 (0.5%), 2 (1.1%) and 3 (1.7%) subjects.

The study spanned 641 observation years with an average of 3.8 years per subject. Table 1 summarises group HI rates. In the previous year, 23% had any HI, 9% had a minor HI and over the study period an average of 0.6% had a severe HI per year. Among all subjects, the annual rate was 0.61 (95% CI 0.47 to 0.80) for all HI's and 0.16 (95% CI 0.12 to 0.21) for minor, moderate and severe HIs. The mean annual rate of non-minimal HIs in the previous year was 0.48 (95% CI 0.32 to 0.72), 0.017 (95% CI 0.0087 to 0.034) and 0.037 (95% CI 0.021 to 0.067) for the CHDP, GH and LIH groups respectively. This rate was 17 (95% CI 8.5 to 37) times higher in the CHDP group than the other two combined. The annual rate of severe HI in the CHDP group was 0.029 (95% CI 0.015 to 0.054). HI rate did not change significantly for individuals over the 2 years preceding the interview by univariate or multivariate analyses that included time. Table 2 presents the odds, adjusted in a multivariate backward stepwise regression model along with crude odds, of experiencing an HI. Mental health gained while alcohol dependence and homelessness lost significance when HI in prior year was added to the model. CHDP group membership and HI in the year prior were predictive of HI rate (table 3) following a backward stepwise linear regression including demographic variables (table 1), alcohol and drug dependence, HI in the prior year, mental health disorder and group membership variables. Upon removing the CHDP group variable from the analysis, the two variables left in the model were HI in prior year ($p<0.0001$) and drug dependence ($p=0.001$).

The mean interval between HIs was 231 days. This interval decreased by an average of 11.8 days (95% CI 5.1 to 18.6, $p=0.0006$) with each subsequent HI. Sensitivity analyses in which the last one or two observations were removed from a subset of subjects who exceeded the median number of five HIs (range 6–22) as well as such a removal from all subjects showed reductions of a similar magnitude.

Two cases of subdural haematoma were found among those under 65 (n=45) over 222 observation years in the CHDP group, giving an incidence of 11 per 1000 (95% CI 2.8 to 45).

DISCUSSION

This study is the first to compare patterns of HI between housed and homeless men and those with severe drinking problems that did not rely exclusively on self-reported data. We found annual rates of HI to be 17 times higher among those who are CHDP than those who are homeless and low-income housed. Previous HIs, drug dependence or a seizure disorder better predicted HI in the previous year than a history of

Table 1 Description of the cohort*

	All	Chronically homeless alcohol dependent (n=50)	General homeless (n=61)	Low-income housed (n=59)	p Value
Demographics					
Mean age (SD), years	43.7 (12.1)	50 (11)	36 (9.5)	46 (12)	*<0.001*
Age, years					*<0.001*
≤39	72 (42)	10 (20)	41 (67)	21 (36)	
40–49	43 (25)	16 (32)	12 (20)	15 (25)	
≥50	55 (32)	24 (48)	8 (13)	23 (39)	
Place of birth					*<0.001*
Canada	128 (75)	48 (96)	41 (67)	39 (66)	
Outside of Canada	42 (25)	2 (4)	20 (33)	20 (34)	
Education					*0.25*
Some high school or less	50 (29)	13 (26)	19 (31)	18 (31)	
High school or equivalent	14 (8)	6 (12)	3 (5)	5 (8)	
Vocational training/college or above	106 (63)	31 (62)	39 (64)	36 (61)	
Marital status					*<0.0001*
Single/never married	104 (62)	20 (41)	44 (72)	40 (68)	
Divorced/separated	48 (28)	20 (41)	16 (26)	12 (20)	
Married/partnered	9 (5)	3 (6)	1 (2)	5 (8)	
Widowed	8 (5)	6 (12)	0 (0)	2 (3)	
Mean (SD) total years homeless in lifetime	6.5 (8.4)	14 (10)	5.0 (6.4)	2.5 (3.8)	*<0.001*
Self-reported lifetime history of seizure	44 (26)	31 (62)	7 (11.5)	6 (10.2)	*<0.0001*
Mental health problem	40 (24)	10 (20)	15 (25)	15 (25)	*0.78*
Alcohol dependence	79 (46)	43 (86)	19 (31)	17 (29)	*<0.0001*
Drug dependence	32 (18)	13 (26)	13 (21)	6 (10)	*0.09*
ED visit with HI in previous year	39 (23)	23 (46)	9 (15)	7 (12)	*<0.0001*
Minimal or unspecified HI	31 (18)	18 (36)	7 (11)	6 (10)	*0.0005*
Non-minimal HI	19 (11)	14 (28)	2 (3)	3 (5)	*0.0003*
Minor HI	16 (9)	14 (28)	1 (2)	2 (3)	*<0.0001*
Moderate HI	6 (4)	4 (8)	1 (2)	1 (2)	*0.0004*
Severe HI†	1 (0.6)	1 (2)	0	0	*0.002*
Number of HI in the past year	0.50 (1.2)	1.2 (1.7)	0.19 (0.66)	0.21 (0.77)	*<0.0001*
Mean (SD) minimal or unspecified HI‡	0.34 (0.82)	0.75 (0.95)	0.17 (0.65)	0.17 (0.74)	*<0.0001*
Mean (SD) non-minimal HI‡	0.16 (0.52)	0.47 (0.87)	0.017 (0.11)	0.037 (0.14)	*<0.0001*
Mean (SD) minor HI‡	0.12 (0.42)	0.36 (0.70)	0.003 (0.02)	0.033 (0.14)	*<0.0001*
Mean (SD) moderate HI‡	0.030 (0.13)	0.082 (0.21)	0.014 (0.11)	0.003 (0.02)	*0.0003*
Mean (SD) severe HI‡	0.002 (0.01)	0.03 (0.1)	0	0	0.006

*All data are presented as a number and per cent, unless otherwise specified.
†There were no severe HIs in previous year, figures given are an average for the entire study period.
‡The mean rates are the mean of the rates calculated separately for each individual.
HI, head injury.

homelessness or alcohol dependence, while having depression and anxiety were found to be protective; however, among those who did have an HI, membership in a group of individuals who are CHDP was predictive of higher rates of HI.

Previous studies suggest that men who are homeless face a higher risk of injury than the general population.[9 12] These studies were not controlled, making indirect comparisons with general population rates. Picket *et al*[2] found the non-minimal HI rate for different age groups of adult men to range from 11 to 13 per 10 000 in a nearby Canadian urban population. Our study suggests that the GH had rates about 14 times higher and that those who were low-income housed had similar rates. The subgroup of individuals who are chronically homeless and have drinking problems had rates about 400 times higher. The rate of severe HI was 170 times higher than average Canadian men found by Zygun *et al*.[1] These findings are important from a clinical and policy perspective as, unlike previous studies, this study suggests that the much larger group of those who are low-income housed may be just as vulnerable to increased rates of HI as the homeless, while among the homeless, the chronically homeless and problem-drinking group is exceptionally vulnerable. The large difference from the general population could be due to variations in study definitions and data sources. Alcohol intoxication can mimic symptoms of HI but our data suggested that alcohol dependence was not predictive of HI. Including CT scan data could help correctly classify severe HI but not minor or moderate HI.

We found that HI in the previous year, drug dependence and seizures in the past year were significant predictors of suffering an HI. Being homeless or low-income housed may make one prone to HI due to increased risk factors such as substance dependence, seizures or behaviour problems. Findings in this study that having an HI is a significant predictor of a subsequent HI and predictive of higher rates of HI agree with previous research.[7 12] This study's new finding that being CHDP is highly predictive of higher rates of HI is consistent with

Table 2 Associated risk factors for HI in the previous year

Characteristic	OR (95% CI) Crude	Adjusted in multivariate model
Currently homeless	3.15 (1.21 to 8.23)	Not in model*
Lifetime years homeless	0.95 (0.92 to 0.99)	Not in model*
Seizure in the past year	6.45 (2.67 to 15.6)	3.50 (1.13 to 10.90)
Mental health disorder	0.64 (0.24 to 1.71)	0.23 (0.06 to 0.93)
Alcohol dependence	4.04 (1.80 to 9.09)	Not in model*
Drug dependence	4.46 (1.73 to 11.52)	3.67 (1.11 to 12.13)
HI in year prior to previous year	10.98 (4.45 to 27.1)	11.81 (3.83 to 36.4)

*The backward stepwise selection process (Proc Logistic) did not keep these variables in the model.
HI, head injury.

anecdotal accounts.[17] Findings of accelerated HI rates over time are suggestive of progressive neurological impairment. A 12-day reduction in a mean HI interval of 231 may be significant for those who are CHDP with an HI rate of 1.2 per year. The decreasing interval between HIs was not confirmed by a comparison of HI rates over two successive years. Such accelerations may only be apparent over longer periods of time. The shortening interval may be an artefact caused by right censoring of long intervals. Sensitivity analyses looking at subsets of individuals with fixed number of HIs and removal of the last one or two HIs of all subjects continued to show the same effect making such an explanation unlikely. This finding needs confirmation with larger prospective studies.

Drug dependence, seizures and HI in the past year significantly predict HI rate. Two systematic reviews have estimated the preinjury drug dependence rate at 9%–37% and the postinjury rate at 2%–20%, although these rates may suffer from under-reported illegal behaviours.[18 19] Drug dependence, seizures and HI are independently associated with disturbances in neuropsychological functioning that may be mild to severe. Taken together these variables could put a person at risk for HI due to deficits in balance, motor control and increased risk taking behaviours. The reduced HI rate among those with mood disorders in the previous year could be due to a reduction in predisposing situations or behaviours. This result needs further confirmation.

The odds of HI and the rate of HI in the previous year are different measures. Alcohol dependence was associated with both the likelihood and rate of HIs in the previous year. In a multivariate model it was only predictive of HI rate. This finding is consistent with previous findings of alcohol abuse contributing to the incidence of HI[19] and increased alcohol misuse in TBI survivors, estimated at about 50%.[20 21] The distinction between the rate and the odds may be a real finding needing further confirmation. The correlation between HI in the previous year and alcohol dependence in our data set (Pearson $r=0.27$, $p=0.0003$) could explain alcohol dependence dropping out of the multivariate model after HI in the previous year was added.

Table 3 Linear regression predicting rate of HI

Variable	Parameter estimate (SE)	p Value
Intercept	0.039 (0.074)	0.60
Chronically homeless with drinking problem	0.33 (0.14)	0.020
HI in year prior to previous year	0.76 (0.17)	<0.0001

HI, head injury.

CSHs are frequently caused by HIs and are more likely in alcoholics.[11] The CSH incidence of 11 per 1000 in the under-65-year-old CHDP group is much higher than general community rates of 3.4 per 100 000 and 8–58 per 100 000 in those over 65 years of age.[22–24] This CSH rate is likely an underestimate given that outpatient investigations were not included. A higher rate could be the basis for modifying the indications for CTs of the head in this high-risk group. A study of CT head scans over a period of time could better determine this rate.

Our study had several strengths. It is the first of its kind to investigate and compare predictors of HI rates in currently homeless and low-income housed men where HI was confirmed through medical documentation. The data, from a hard-to-track population, are objective and longitudinal.

Limitations include generalisability of samples from single shelter programmes to broader populations that include other shelters or men who were currently homeless but did not participate in the shelter system (eg, camping or 'living rough'). We do not report neuroimaging examination results; however, TBI can be strongly inferred from GCS data. We did not obtain data on neuropsychological test performance from the participants. Lack of prospective data and baseline information on potentially causative variables makes it difficult to infer causal relationships with the exception of HI in the previous year.

Our results suggest that the call of Hwang *et al* for clinicians to screen men who were currently homeless for a history of HI and related neuropsychological deficits may need to be extended to those who are low-income housed while being especially true for those who are chronically homeless and have drinking problems.[12] Care providers should more vigorously address predisposing factors such as harmful substance abuse to reduce the risk of further HI and subsequent deterioration of neuropsychological function.

The particularly high rate of HI in the CHDP group suggests that chronic homelessness may be caused or perpetuated by HI. Appropriate rehabilitation and assessment programmes sensitive to the needs of men who were currently homeless or low-income housed, as well as appropriate referral to such programmes from the ED, may need to be developed to address the neuropsychological needs of this population to prevent more chronic and severe problems. Accelerated HI rates over time need to be further investigated and point to the need for developing risk reduction strategies for these groups.

CONCLUSIONS

Men who are homeless and low-income housed appear to have similar rates of HI that are higher than the general population while those who are CHDP suffer particularly high rates. Drug, dependence, a history of a seizures and an HI in the previous, year are predictive of having an HI in a particular year, while having a mood disorder is protective. Previous HI and being CHDP are more predictive of a higher HI rate. HI rates may accelerate with each subsequent HI and are associated with being a member of those who are chronically homeless with drinking problems; a group that may also have high rates of CSHs. These findings need to be verified with larger, more

representative samples. The differential needs of men who are currently homeless or low-income housed may require different approaches to the assessment, management and rehabilitation of HI. Finally, examining the relationship of neuropsychological impairment and HI in this population is warranted.

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Notes