



Neurocognition, psychiatric symptoms, and lifetime homelessness among veterans with a history of traumatic brain injury



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ABSTRACT

We retrospectively investigated archival clinical data, including correlates of lifetime homelessness, in 503 Veterans with a history of traumatic brain injuries (86.5% mild) who completed neuropsychological evaluations and passed performance validity tests. The 471 never-homeless and 32 ever-homeless Veterans were compared on demographic factors, TBI severity, psychiatric diagnosis, subjective symptoms, and neuropsychological functioning. Homelessness history was significantly associated with unemployment, lower disability income, more severe depressive, anxiety, posttraumatic stress disorder, and postconcussive symptoms, and lower performances on two of fifteen neurocognitive tests. In a multiple logistic regression model, current unemployment and substance use disorder remained significantly associated with lifetime homelessness.

1. Introduction

Ending homelessness among Veterans is a national priority. On a given night in January 2016, an estimated 40,000 Veterans were homeless (US HUD, 2016), and a large, population-based cohort study of Iraq/Afghanistan era Veterans showed a five-year homeless incidence rate of 3.7% (VA OIG, 2012). About half of homeless Veterans suffer from mental illness and 76% have substance use disorders (SUDs; Kuhn and Nakashima, 2011). Risk factors for homelessness among Veterans include SUDs, mental disorders, history of traumatic brain injury (TBI), younger age, Black and Hispanic race/ethnicity, unmarried status, shorter duration of separation from the military, lower education levels and military pay grades, and having received treatment for military sexual trauma. In contrast, there is conflicting evidence regarding whether higher level of service-connected disability is a risk or a protective factor (VA OIG, 2012; Edens et al., 2011; Blackstock et al., 2012). Recent Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn (OEF/OIF/OND) data indicate that 67% of these homeless Veterans were diagnosed with

posttraumatic stress disorder (PTSD), 57% were diagnosed with a mood disorder, and 38% were diagnosed with SUD (Tsai et al., 2013). It is estimated that approximately 20% of OEF/OIF/OND Veterans have a history of combat-related TBI (Tanielian and Jaycox, 2008), and Metraux et al. (2013) reported that the rate of TBI-related diagnoses was three times higher in those with a history of homelessness versus never-homeless OEF/OIF Veterans (3% vs. 1%, respectively).

Neurocognitive abilities may be impaired in up to 80% of homeless individuals, potentially limiting their ability to benefit from psychosocial interventions (Burra et al., 2009; Depp et al., 2015; Stergiopoulos et al., 2015). Cognitive deficits likely interfere with sustaining income to support housing and navigating/participating in rehabilitation. Such impairments may also interact with other mental health conditions to lessen treatment engagement and increase risk of sustained homelessness. On the other hand, improvements in housing have been associated with enhanced executive functioning (Caplan et al., 2006), suggesting that neurocognitive abilities be considered a target for future interventions.

We aimed to elucidate relationships between background risk

Abbreviations: TBI, Traumatic brain injury; PTSD, Posttraumatic stress disorder; SUDs, Substance use disorders; LOC, Loss of consciousness; VA, Department of Veterans Affairs; OEF/OIF/OND, Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn

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factors, psychiatric disorders, SUDs, and neuropsychological impairments in a real-world retrospective clinical sample of OEF/OIF/OND Veterans with a history of TBI and homelessness. Importantly, our sample was comprised exclusively of help-seeking Veterans who had completed neuropsychological evaluations as part of their clinical care and all reported results generalize most directly to this population. With this in mind, we hypothesized that homelessness history would be associated with the severity of psychiatric and SUD symptoms, TBI, and cognitive impairment.

2. Methods

2.1. Participants and procedure

This study was approved by the VA San Diego Healthcare System Institutional Review Board. Archival data were collected from the medical records of 689 OEF/OIF/OND Veterans who had been referred for clinical neuropsychological assessments of TBI-related cognitive complaints between 2007 and 2015. Fifty had been homeless at some point in their lives, as verified by a thorough clinical records review using relevant search terms (e.g., home, homeless). Those with invalid test results, as defined by failing one or more performance validity tests (Test of Memory Malingering, Tombaugh, 1997 Trial 2/Delay Recall <45, or California Verbal Learning Test-II Forced Choice <15, Delis et al., 2000) and those with no performance validity data were excluded (18 ever-homeless, 168 never-homeless). Demographic characteristics for the remaining 503 individuals (32 ever-homeless and 471 never-homeless) are presented in the Table 1. Importantly, the 186 excluded Veterans did not differ from the sample of 503 veterans on any measured demographic characteristics.

2.2. Measures

We collected data regarding demographic factors (age, education, gender, race/ethnicity, service connected disability rating), functional status (occupational/academic status), TBI severity (length of loss of consciousness [LOC] for the most severe TBI and number of lifetime TBIs), mental health diagnosis (SUD, PTSD, depression), subjective symptoms (depression, anxiety, PTSD, post-concussive symptoms), and neuropsychological functioning. Subjective symptom measures included the Beck Depression Inventory-II (BDI-II; Beck et al., 1996), Beck Anxiety Inventory (BAI; Beck and Steer, 1990), PTSD Checklist-Military (PCL-M) (Weathers et al., 1991), and Neurobehavioral Symptom Inventory (NSI; Cicerone and Kalmar, 1995) – a self-report measure of postconcussive symptoms.

Samples sizes for neuropsychological tests varied due to the clinical nature of the data collected, but a typical battery included the following measures: Wide Range Achievement Test-4 (WRAT-4; Wilkinson and Robertson, 2006 – premorbid IQ); Wechsler Adult Intelligence Scale-IV (WAIS-IV; Wechsler, 2008) Digit Span (attention/working memory); WAIS-IV Coding (processing speed); Rey–Osterrieth Complex Figure Test (Rey, 1941) copy and delayed recall conditions (visuoconstruction and visual memory); California Verbal Learning Test-II (CVLT-II; Delis et al., 2000) trials 1–5 total score and long delay free recall (verbal learning and memory); Delis-Kaplan Executive Function System (D-KEFS; Delis et al., 2001) Letter and Category Fluency tests (verbal fluency); D-KEFS Verbal Fluency Switching, Color Word Inhibition (Inhibition and Inhibition/Switching), Trails Number Letter Switching, and the Wisconsin Card Sorting Test (WCST; Berg, 1948 – executive functioning). All neuropsychological test scores were corrected for age; CVLT-II scores were corrected for age and gender.

2.3. Analyses

All variables were normally distributed, with the exception of length of LOC. We compared Veterans with a history of homelessness to never-

homeless Veterans using *t*-tests for continuous variables, χ^2 tests for categorical variables, and the Mann–Whitney *U* test for median length of LOC. Cohen's *d* and Cramer's *V* effect sizes are presented for statistically significant bivariate results. Multiple logistic regression entering bivariate-significant variables predicted homelessness status. The criterion for statistical significance was set at $\alpha = 0.05$.

3. Results

The rate of lifetime homelessness in the sample was 6.8% and approximately 86.5% of the sample sustained mild (as opposed to moderate-to-severe) TBIs. Ever-homeless Veterans were equally likely to fail the performance validity criterion relative to never-homeless Veterans, $\chi^2 = 1.73$, $p = .19$. Data pertaining to group differences are presented in the Table 1. No significant differences were found between ever-homeless and never-homeless Veterans on age, education, gender, race, or ethnicity (all $ps > 0.15$). Homelessness history was not associated with TBI severity indicators (all $ps > 0.28$).

Compared to never-homeless Veterans, Veterans with a history of homelessness were more likely to be unemployed (Cramer's *V* = 0.14), received lower levels of disability income (Cohen's *d* = 0.40), had more severe depressive ($d = 0.52$), anxiety ($d = 0.47$), PTSD ($d = 0.57$), and postconcussive ($d = 0.47$) symptoms, and were more likely to have diagnoses of depression (Cramer's *V* = 0.12), SUD ($V = 0.25$), and PTSD ($V = 0.11$). Only 2/15 neurocognitive tests (CVLT List A 1–5 total score, $d = 0.35$; WCST Total Errors, $d = 0.34$) were significantly lower in ever-homeless compared to never-homeless Veterans, although four additional tests approached significance ($ps < 0.10$) and mean scores for 13/15 of the tests were in the predicted direction (see the Table 1). In a multivariate logistic regression using the significant correlates as predictors of variance in homelessness status, current employment (Wald = 4.66, $df = 1$, $p = .031$) and SUD diagnosis (Wald = 4.30, $df = 1$, $p = .038$) remained statistically significant, predicting 26% of the variance in homelessness history.

4. Discussion

The lifetime prevalence of homelessness in our OEF/OIF/OND TBI sample was approximately 7%, which is consistent with a prior report on the rate of lifetime homelessness in Veterans (Tsai et al., 2016). Most of the Veterans in the current study sustained mild TBIs (86.5%) and so our results generalize primarily to this population. Lifetime homelessness was associated with unemployment, more severe depressive, anxiety, PTSD, and postconcussive symptoms, higher rates of depression, PTSD, and SUD diagnoses, and lower performances on only 2/15 neurocognitive tests. In the presence of multiple variables, however, only current unemployment and SUD diagnosis remained significant predictors of variance in homelessness history. Despite indications of higher levels of impairment and disability in the ever-homeless Veterans, they were, on average, receiving lower levels of service-connected disability income than were never-homeless Veterans. Our results are broadly consistent with previous literature on risk factors for homelessness in Veterans (Blackstock et al., 2012; Metraux et al., 2013) and suggest that interventions for SUDs (Edens et al., 2011) and unemployment (Rosenheck and Mares, 2007) may help reduce homelessness in this population.

It should be noted that the majority of Veterans in our sample (86.5%) had sustained mild TBIs with very brief LOC. Given the expectation that individuals who sustain mild TBIs should return to their baseline level of functioning (McCrea et al., 2009), it is possible that TBI history does not independently increase risk of homelessness, although it may be associated with other factors (e.g., psychiatric symptom severity or SUD). Studying a non-TBI comparison group would clarify the nature of TBI-related correlates of homelessness.

Our study had several limitations that must be considered. First, the number of ever-homeless Veterans in our sample ($n = 32$) was small in

Table 1
Group differences in demographic, TBI-related, psychiatric, and cognitive variables for ever-homeless versus never-homeless Veterans.

Demographic and functional variables	Ever-homeless (SD) (n)	Never-homeless (SD) (n)	Test statistic	df	p-value
Age, years	34.88 (10.88) (32)	33.83 (9.97) (471)	$t = 0.57$	501	.569
Education, years	12.78 (1.52) (32)	13.15 (1.73) (471)	$t = 1.18$	501	.240
Sex: % Male	100.0 (32)	92.80 (437)	$\chi^2 = 2.48$	1	.154
Race: % Caucasian	59.40 (32)	65.80 (471)	$\chi^2 = 2.78$	5	.734
Ethnicity: % Hispanic	31.30 (32)	29.70 (470)	$\chi^2 = 0.03$	1	.844
Service connected disability rating	48.13 (37.45) (32)	61.88 (31.68) (468)	$t = 2.35$	498	.001
Currently in school (%)	28.10 (32)	36.50 (471)	$\chi^2 = 0.92$	1	.224
Currently working (%)	15.60 (32)	43.90 (467)	$\chi^2 = 10.10$	1	.001
TBI-related variables	Ever-homeless (SD)(n)	Never-homeless (SD)(n)	Test statistic	df	p-value
Length of LOC of worst TBI, minutes (median)	0.29 (22)	0.50 (378)	$U = 4115.00$	–	.467
Number of lifetime TBIs	2.07 (1.53) (30)	2.29 (2.05) (452)	$t = -0.59$	480	.277
Psychiatric variables	Ever-homeless (SD)(n)	Never-homeless (SD)(n)	Test statistic	df	p-value
Beck Depression Inventory-II Total Score	27.34 (11.75) (32)	21.34 (11.25) (458)	$t = 2.91$	488	.002
Beck Anxiety Inventory Total Score	22.06 (11.87) (31)	16.59 (11.52) (376)	$t = 2.54$	405	.006
PTSD Checklist-Military Total Score	61.73 (14.40) (20)	53.09 (15.77) (403)	$t = 2.91$	431	.002
Neurobehavioral Symptom Inventory Total Score	44.66 (17.43) (29)	37.11 (14.65) (360)	$t = 2.63$	387	.005
Depression Diagnosis (%)	78.10 (25)	52.70 (470)	$\chi^2 = 7.77$	1	.004
PTSD Diagnosis (%)	87.50 (28)	66.90 (471)	$\chi^2 = 5.87$	1	.009
Alcohol/Substance Use Disorder Diagnosis (%)	53.10 (31)	13.80 (465)	$\chi^2 = 30.13$	1	<0.001
Neuropsychological variables	Ever-homeless (SD)(n)	Never-homeless (SD)(n)	Test statistic	df	p-value
WRAT-4 Reading Standard Score	97.48 (9.90) (31)	98.06 (10.34) (465)	$t = 0.30$	494	.382
WAIS-IV Digit Span Scaled Score	8.69 (2.40) (26)	8.74 (2.53) (308)	$t = 0.10$	332	.461
WAIS-IV Coding Scaled Score	8.24 (2.40) (25)	8.56 (2.35) (298)	$t = 0.66$	321	.255
Rey-Osterreith Complex Figure Copy percentile	55.58 (27.14) (31)	53.96 (31.32) (448)	$t = 0.28$	477	.390
Rey-Osterreith Complex Figure Delayed Recall percentile	44.87 (28.91) (31)	50.14 (28.86) (448)	$t = 0.98$	477	.163
CVLT-II List A 1–5 total T-score	42.66 (11.08) (32)	46.44 (10.70) (469)	$t = 1.93$	499	.025
CVLT-II Long Delay Free Recall Z-Score	-0.84 (1.22) (32)	-0.53 (1.11) (468)	$t = 1.52$	498	.065
D-KEFS Letter Fluency Scaled Score	10.26 (3.12) (31)	9.47 (3.22) (462)	$t = 1.32$	491	.095
D-KEFS Category Fluency Scaled Score	10.06 (3.77) (31)	10.33 (3.65) (460)	$t = 0.39$	489	.349
D-KEFS Verbal Fluency Switching Scaled Score	8.71 (2.97) (31)	9.70 (3.27) (461)	$t = 1.64$	490	.051
D-KEFS Color-Word Inhibition Scaled Score	8.95 (3.00) (22)	9.02 (3.41) (255)	$t = 0.08$	275	.468
D-KEFS Color-Word Inhibition Switching Scaled Score	8.27 (2.98) (22)	8.65 (3.45) (255)	$t = 0.49$	275	.312
D-KEFS Trails Number/Letter Switching Scaled Score	8.59 (3.17) (32)	9.00 (2.98) (458)	$t = 0.73$	488	.231
Wisconsin Card Sorting Test Total Errors T-score	45.70 (8.88) (30)	48.87 (9.58) (451)	$t = 1.76$	479	.040

(continued on next page)

Table 1 (continued)

Neuropsychological variables	Ever-homeless (SD)(n)	Never-homeless (SD)(n)	Test statistic	df	p-value
Wisconsin Card Sorting Test Perseverative Responses T-score	45.23 (7.91) (30)	47.57 (9.01) (451)	$t = 1.39$	479	.083

Note. p -values $< .05$ are in bold font.

CVLT-II = California Verbal Learning Test-II; D-KEFS = Delis-Kaplan Executive Function System; LOC = loss of consciousness; PTSD = posttraumatic stress disorder; TBI = traumatic brain injury; WAIS-IV = Wechsler Adult Intelligence Scale-IV; WRAT-4 = Wide Range Achievement Test-4.

comparison with the never-homeless Veterans ($n = 471$), which limited statistical power. This may partially explain the paucity of statistically significant neurocognitive test differences (2/15), which is in contrast with prior literature (e.g., Stergiopoulos et al., 2015). Second, due to the real-world nature of the clinical data, we were unable to collect a fully random sample of OEF/OIF/OND Veterans. That is, similar to any archival investigation of a clinical dataset, our results are limited to those individuals who were referred for and completed clinical evaluations, thereby constraining generalizability. Third, given that the cognitive testing took place in the context of routine clinical practice, sample sizes varied slightly across measures of interest, however, there were low overall rates of missing cognitive test data (ever-homeless, 13%; never-homeless, 10%). Fourth, we were unable to control for all potential confounding variables (e.g., combat exposure), which may have differed between the groups. Fifth, we were unable to verify the accuracy of data collected from the Veterans' medical records; however, this is a limitation of any retrospective analysis of clinical data. While it may contribute to a higher degree of random error compared to a tightly controlled lab-based experiment, it does not negate the clinical significance of the findings. Finally, our study was cross-sectional, so we were unable to infer directionality (e.g., whether psychiatric symptom severity was a cause or consequence of homelessness). Larger, prospective samples of Veterans are needed to determine the pathways between psychiatric symptoms, substance abuse, homelessness, and functional disability.

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Conflict of interest

The authors report no conflicts of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.psychres.2018.11.049](https://doi.org/10.1016/j.psychres.2018.11.049).

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