Subjective Sleep Disturbance in Veterans Receiving Care in the Veterans Affairs Polytrauma System Following Blast-Related Mild Traumatic Brain Injury

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ABSTRACT Objectives: This investigation sought to characterize prevalence and factors associated with subjective sleep disturbance (SSD) in a clinical sample of veterans with blast-related mild traumatic brain injury (mTBI). Methods: Adult veterans with history of blast-related mTBI were enrolled in a cross-sectional study. Data on demographics, injury, and current symptoms, including SSD, were obtained. Descriptive and univariate analyses investigated prevalence of SSD and associated factors. Results: Participants were 114 veterans with blast-related mTBI (96% male; mean age = 31 years, SD = 8; mean number of days since injury =1,044, SD = 538). 78% screened positive for post-traumatic stress disorder and 77% reported SSD. Loss of consciousness at time of injury, current nightmares, depression, headache, fatigue, and positive screen for post-traumatic stress disorder were significantly associated with SSD ($p < 0.05$). Conclusions: SSD was pervasive in this clinical sample and was significantly associated with multiple modifiable emotional symptoms as well as headache and fatigue; this is consistent with previous literature including samples with history of nonblast-related mTBI. Future research incorporating objective measurement of SSD and associated symptoms is needed to inform evidence-based screening, assessment, and treatment efforts for veterans with history of mTBI.

INTRODUCTION

Traumatic brain injury (TBI) is known as the hallmark injury of Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF).[1] Although the exact number of those affected is unknown, the Defense and Veterans Brain Injury Center (DVBIC) estimates that U.S. military service members have sustained 266,810 TBIs between 2000 and 2012.[2] Approximately 82% of these TBIs have been classified as "mild" TBI (mTBI), otherwise known as concussion.[2] The Departments of Defense and Veterans Affairs classify mTBI according to American College of Rehabilitation Medicine guidelines.[3] Specifically, mTBI involves loss of consciousness for 0 to 30 minutes, alteration of consciousness momentarily or for less than 24 hours, post-traumatic amnesia for 0 to 1 day, normal structural imaging, and a Glasgow Coma Scale rating of 13 to 15. Mild TBI can be caused by blunt force (i.e., a blow to the head) or blast or pressure wave emitted from an explosion or blast, such as those emitted from a rocket-propelled grenade or improvised explosive device. Approximately, 11% to 23% of veterans from OEF and OIF have history of mTBI caused by exposure to explosion or blasts.[4–7]

Veterans with mTBI of both blast and nonblast etiologies are known to experience cognitive, emotional, and physical symptoms referred to collectively as postconcussion symptoms.[4,8–11] Although these symptoms of anxiety, dizziness, irritability, loss of concentration and memory, noise sensitivity, depression, headache, and fatigue typically abate within 3 to 6 months, 10% to 20% of veterans with TBI of any severity and/or etiology go on to experience post-concussive syndrome.[12–15] One of the most prominent symptoms is sleep disturbance of the insomnia type—difficulty falling and/or staying asleep.[16,17] This is somewhat consistent with what has been observed in the civilian sector. Civilians with history of nonblast-related TBI have been known to experience high levels of depression, pain, sleep disturbance, and fatigue.[18,19] Although it appears postconcussive symptoms affect those with mTBI of both blast and nonblast etiologies, few investigations have focused exclusively on identifying prevalence of and risk factors for sleep disturbance in clinical samples of veterans with blast-related mTBI. Yet, recent research suggests sleep disturbance is pervasive among previously deployed veterans of OEF/OIF who are likely to have sustained some blast exposure[20] and may predict onset of and/or exacerbation of depression, post-traumatic stress disorder (PTSD), and suicidal ideation and behaviors during the postdeployment period.[21,22]

Sleep disturbance has important functional ramifications for healthy populations and for those with TBI. In the civilian population, sleep disturbance of the insomnia type (e.g., difficulty falling and staying asleep) has been associated with decreased quality of life, greater work absenteeism, depressive symptoms, medical comorbidities, and increased health care usage.[23–25] It is important to develop a better understanding of prevalence and risk factors for sleep disturbance in veterans with history of blast-related mTBI to help guide clinical screening, assessment, and treatment practices in the Veterans Affairs system.

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To this end, this study aimed to provide a prevalence estimate of subjective sleep disturbance (SSD) following blast-related mTBI in one clinical sample of veterans who were receiving care for postconcussive symptoms in the Veterans Affairs Polytrauma System of Care. Further, this study sought to identify modifiable factors associated with SSD in this sample.

METHODS

Study Design

This was a cross-sectional substudy of the ongoing Defense and Veterans Brain Injury Center: Prospective Traumatic Brain Injury Tracking Protocol study. The parent study is ongoing and conducted by DVBIC in collaboration with several Veterans Affairs Medical Centers (VAMCs) and military treatment facilities across the nation with Hunter Holmes McGuire VAMC in Richmond, Virginia (McGuire VAMC) being one study site. The Institutional Review Board at the McGuire VAMC approved the study. Participants were not compensated for their time or effort.

Participants

All adult male and female veterans with history of medically documented TBI that occurred within the previous 10 years and who presented for rehabilitation care within the Polytrauma System of Care at the McGuire VAMC were eligible for the parent study. The Polytrauma System of Care includes the inpatient Polytrauma Rehabilitation Center, the inpatient Polytrauma Transitional Rehabilitation Program, and the outpatient Polytrauma Network Site clinic. Medically documented TBI was determined as per the Veterans Affairs second level screening which uses the American College of Rehabilitation Medicine guidelines.[3]

The sole exclusion criterion was a lifetime history of other focal acquired brain injury that caused sustained work or activity loss of 6 months or longer, such as tumor or stroke. Consecutive patients meeting eligibility criteria and consenting to participation were enrolled. This substudy selected data for all participants with physician-diagnosed mTBI who reported blast to be the primary cause of their injury, who were enrolled in the parent study between 2008 and 2012, and who completed all measures in entirety. At the time of this analysis, 424 participants had enrolled in the parent study. The total number of participants selected for this substudy was 114.

Procedures

Recruitment

A waiver of informed consent was obtained to enable research assistants to screen veterans' medical records to determine eligibility for the parent study. Research assistants invited veterans meeting all eligibility criteria to participate in the informed consent process and enroll, if interested.

Assessment and Chart Review

Participants completed a 25 minute structured interview with trained research assistants and completed two self-report measures of postconcussive symptoms and symptoms of PTSD. These self-report measures required approximately 10 minutes to complete. Computerized records of the VAMC were examined to complete all other variables.

Measures

Clinical Tracking Form

The Clinical Tracking Form (CTF) is a 59-item combination structured interview and chart review form developed by DVBIC. The structured interview portion gathers demographic characteristics (e.g., age, service branch, gender, marital status), index injury characteristics (e.g., blast as injury mechanism, date of injury, loss of consciousness, use of combat helmet at injury). Clinical data about TBI (i.e., diagnosis of mTBI) were gathered via chart review.[26]

Neurobehavioral Symptoms Inventory

The Neurobehavioral Symptoms Inventory (NSI) is a validated 22-item self-report measure that assesses degree of disturbance in the past 2 weeks with regard to a variety of commonly reported postconcussive symptoms.[27] Each item is rated on a 5 point scale (0 = none; 4 = very severe). Item 20 asks about degree of disturbance because of depression. Item 4 asks about degree of disturbance because of headache. Item 17 asks about degree of disturbance because of fatigue.

Post-Traumatic Stress Disorder Checklist-Civilian

The Post-Traumatic Stress Disorder Checklist-Civilian (PCL-C) is a validated 17-item self-report measure used to screen for presence and severity of symptoms associated with post-traumatic stress on a 5-point rating scale (1 = not at all; 2 = a little bit; 3 = moderately; 4 = quite a bit; 5 = extremely; 9 = unknown.[28] Total scores can range from 17 to 85. The Veterans Affairs system recommends a total cut point score of 45 to 50 to indicate the need for further screening and or diagnostic testing in Veterans Affairs system mental health clinics.[29] Two items on the PCL-C assess sleep disturbance (i.e., item 2: "Please indicate how much you have been bothered by repeated, disturbing dreams of a stressful experience from the past in the past month." And item 13: "Please indicate how much you have been bothered by trouble falling and staying asleep in the past month."). The civilian version was chosen because the military version is written with the assumption that the most stressful life event was related to military service. We wished to avoid this constraint; the two versions are otherwise identical.

Subjective Sleep Disturbance

Item 13 on the PCL-C was selected to measure SSD for this study. Item 13 asks, "Please indicate how much you have been bothered by trouble falling and staying asleep in the

past month." Answer choices are the following: 1 = not at all; 2 = a little bit; 3 = moderately; 4 = quite a bit; and 5 = extremely. A prevalence estimate of SSD was determined by identifying the proportion of participants in the total sample who endorsed 4 = quite a bit and 5 = extremely. This cut point was chosen because we believe it to be clinically meaningful. It is likely that those who endorsed being "quite a bit" or "extremely" bothered by trouble falling and staying asleep represent a subsample of veterans who might present in clinics to request management of sleep disturbance.

Statistical Analyses

Frequency and descriptive statistics were performed to assess demographic characteristics (age, service branch, gender, and marital status), injury characteristics (days since injury, loss of consciousness at the time of injury [yes/no], and use of combat helmet at time of injury [yes/no]) and symptom characteristics (nightmares [score on item 2 on PCL-C], PTSD screen outcome, depression [score on item 20 on the NSI], headaches [score on item 4 on the NSI], and fatigue [score on item 17 on the NSI]), as well as SSD. The PCL-C total score was transformed to a dichotomous variable called PTSD screen result (positive if ≥45 or negative if <45). All demographic, injury, and symptom characteristics were assessed for association with SSD using χ^2, independent samples Mann–Whitney *U* test, and independent samples *t*-test, as appropriate. All computations were performed with IBM Statistical Package for Social Sciences, Version 20. Alpha was set at 0.05 for all analyses.

RESULTS

Demographics

Demographic characteristics of the sample are shown in Table I for the full sample ($N = 114$) and for the sample with SSD and no SSD. The sample was predominantly male (96%) and the mean age was 31 years (SD = 8). Most were Army veterans (68%) and about half (49%) were married.

Injury characteristics

Injury characteristics and current symptoms are shown in Table II for the full sample and for participants with SSD and no SSD. In the full sample, the mean number of days since injury was 1,044 (SD = 538). Most (65%) wore a helmet at time of injury.

Current symptoms

Participants' average rating of "how much they have been bothered by repeated, disturbing dreams of a stressful experience from the past" was 3.40 (SD = 1.40), suggesting that, on average, participants were more than "moderately" bothered by nightmares. The mean participant rating for being "disturbed by depression" was 1.90 (SD = 1.30), suggesting they were almost "moderately" disturbed, on average. The mean participant rating for being "disturbed by headaches" was 2.50 (SD = 1.20), suggesting they were more than "moderately" disturbed, on average. The mean participant rating for being "disturbed by fatigue" was 2.10 (SD = 1.20), suggesting they were more than "moderately" disturbed, on average.

The mean total score on the PCL-C was 58.87 (SD = 16.78). With sleep items (2 and 13) removed, the mean score on the PCL-C was 51.35 (SD = 14.88). About 78.10% of participants screened positive for PTSD with total scores ≥45. With sleep items removed, 71.90% screened positive for PTSD. Together, this suggests the sample was highly distressed by symptoms of PTSD.

Sleep disturbance

The majority of participants (77%) reported SSD. Age, marital status, and days since injury were not significantly associated with SSD ($p \leq 0.05$). Participants were more likely (odds ratio

TABLE I. Demographics and SSD ($N = 114$)

Variables	No SSD, *n* (%)	SSD, *n* (%)	Total Sample, *N* (%)
n	26 (23)	88 (77)	114
Sex[a]			
Female	0 (0)	5 (6)	5 (4)
Male	26 (100)	83 (94)	109 (96)
Marital Status			
Single	12 (46)	42 (48)	54 (47)
Married	14 (54)	42 (48)	56 (49)
Military Branch[a]			
Army	16 (62)	62 (71)	78 (68)
Air Force	0 (0)	2 (2)	2 (2)
Army National Guard	2 (8)	3 (3)	5 (4)
Marine Corps	7 (27)	20 (23)	27 (24)
Navy	1 (4)	1 (1)	2 (2)

Displays mean (SD) for continuous variables and *n* (%) for discrete variables. **Statistically significant difference between groups were found via χ^2 analyses (discrete independent variables and dependent variables) and independent samples Mann–Whitney *U* tests and *t*-tests for continuous independent variables ($p < 0.05$). Some cells do not sum to 100% because some participants did not respond to all items. [a]Not tested in univariate analyses.

TABLE II. Injury Characteristics, Current Symptoms, and SSD

Variables	No SSD	SSD	Total Sample, *N* (%)	*p* Value
n	26 (23%)	88 (77%)	114	n/a
Injury Characteristics				
Days Since Injury	935 ± 551	1,076 ± 533	1,044 ± 538	0.27
Experienced Loss of Consciousness**	12 (46%)	63 (72%)	75 (66%)	0.02
Wearing Helmet at Time of Injury[a]				n/a
Yes	16 (62%)	58 (66%)	74 (65%)	
No	9 (35%)	22 (25%)	31 (23%)	
Unsure	1 (4%)	8 (9%)	9 (8%)	
Current Symptoms**				
Positive PTSD Screen	9 (35%)	80 (91%)	89 (78%)	0.00
Nightmares	2.00	4.00	3.50	0.00
Depression	0.00	2.00	2.00	0.00
Headaches	2.00	3.00	3.00	0.01
Fatigue	1.00	3.00	2.00	0.00

Displays medians for continuous variables and *n* (%) for discrete variables. **Statistically significant difference between groups were found via χ^2 analyses (discrete independent variables and dependent variables) and independent samples Mann–Whitney *U* tests for continuous independent variables ($p < 0.05$). Some cells do not sum to 100% because some participants did not respond to all items. [a]Not tested in univariate analyses.

[OR] = 2.93) to have SSD if they lost consciousness at injury than were participants who did not lose consciousness; this was a significant difference χ^2 (1, N = 114) = 5.77, $p < 0.05$. Participants were more likely (OR = 18.89) to have SSD if they screened positive for PTSD than if they did not screen positive; this was a significant difference χ^2 (1, N = 114) = 37.15, $p < 0.01$. Furthermore, participants with SSD had significantly higher median nightmare scores (U = 1949.50, $p < 0.01$), median depression scores (U = 1863, $p < 0.01$) and median headache scores (U = 1512, $p < 0.05$) than participants without SSD (Tables I and II).

Ninety-one percent of participants with SSD screened positive for PTSD and when sleep variables were removed from the PCL-C total score, 84.09% screened positive for PTSD. Therefore, we explored associations between current symptom variables and PTSD. Participants who screened positive for PTSD had significantly higher median nightmare scores (median = 4) than participants who did not screen positive (median = 2; U = 2066.50, $p < 0.05$). Participants who screened positive for PTSD also had significantly higher median depression scores (median = 2) than those who did not screen positive (median = 0; U = 5994.50, $p < 0.01$). Median fatigue scores were significantly higher in those who screened positive for PTSD (median = 3) compared to those who did not (median = 1; U = 5774, $p < 0.01$). Median headache scores did not differ significantly between those who screened positive for PTSD (median = 3) compared to those who did not (median = 2; $p \leq 0.05$). Participants who lost consciousness at injury were more likely (OR = 3.25) than those who did not lose consciousness to screen positive for PTSD; this was a statistically significant difference, χ^2 (1, N = 114) = 6.76, $p < 0.05$.

DISCUSSION

SSD was found in a large majority (77%) of this mostly male clinical sample of veterans with blast-related mTBI occurring, on average, almost 3 years before this assessment. Veterans with SSD were significantly more likely than those without SSD to endorse loss of consciousness at the time mTBI. Those with SSD were more likely than those without to be currently bothered by the following potentially modifiable symptoms: nightmares; depression; headaches; and fatigue. Further, those with SSD were much more likely to screen positive for PTSD than those without SSD. When we explored associations with PTSD, we found those who lost consciousness at injury were more likely to screen positive for PTSD. Participants who screened positive for PTSD were more bothered by nightmares, fatigue, and depression than those who did not screen positive for PTSD. Participants who screen positive for PTSD, and those who did not, were equally bothered by headache.

These findings are generally consistent with previous research conducted with civilians and veterans with TBI of mixed severity (i.e., mild, moderate, and severe) and etiology (i.e., blast and nonblast-related mTBI).[12,16,18,19,30] It appears that emotional distress (in this case, symptoms of depression and PTSD, including nightmares), pain (in this case, headache), and fatigue may chronically coexist with SSD in persons who have history of blast-related mTBI, not only in the acute phase.[12] Evidence-based therapies to address modifiable factors are widely available in the Veterans Affairs system and outlined in Clinical Practice Guidelines published by the Department of Veterans Affairs and Department of Defense.[31–33] In addition, the Department of Veterans Affairs recommends and provides Cognitive Behavioral Therapy for Insomnia to treat SSD of the insomnia type.[34,35] Further, veterans with history of mTBI plus current SSD, headache, PTSD, and neurological deficits may benefit from a sleep hygiene counseling intervention plus prazosin; Ruff et al[36] noted improvement in sleep was associated with improvements in headache and PTSD symptom severity in a one-arm observational study.

In addition to the emotional and pain variables, loss of consciousness was also shown to be related to SSD. This tentatively suggests that residual effects of the brain injury also contribute to the development of sleep problems in a blast-injured and distressed population. Schreiber et al[37] found abnormal sleep architecture using polysomnography in participants with history of nonblast-related mTBI relative to healthy controls, suggesting sleep physiology may be affected by the injury. Another study found participants with PTSD and participants with both PTSD and mTBI of mixed etiology had similar sleep architecture but those with PTSD and mTBI had greater amounts of hypersomnia (subjective daytime sleepiness and napping) than those with PTSD only.[30] Thus, in the context of comorbid PTSD as in the present sample, mTBI may affect the ability of the individual to recover from disturbed sleep.

Overall, findings from this study agree with previous findings suggesting SSD is prevalent in veterans with blast and nonblast-related mTBI and that SSD is associated with emotional, and possibly physical, sequelae. However, this study provides only a snapshot into this complex clinical picture. It is recommended that future research use more refined and objective measures of sleep such as polysomnography and actigraphy[30] and the self-report Pittsburgh Sleep Quality Index,[38] to assess seven components of sleep quality and disturbance (i.e., sleep quality, latency, duration, efficiency, disturbances, medication use, and daytime dysfunction) and enable calculation of a global sleep score—the sum of all seven components.

Limitations

It is important to note several limitations to this study. First, participants were not provided compensation for their participation and this may have introduced selection bias; these participants may not be completely representative of veterans receiving care for mTBI in the VAMC system. Also, although all participants reported experiencing at least one blast-related mTBI, participants' specific injury experiences were likely heterogeneous. The study did not capture data on number of blast exposures and these likely differed between participants.[39,40] Therefore, the current study was unable to ascertain whether or how number and timing of previous blast injuries may relate to SSD. In addition, although at least one clinician-confirmed blast-related mTBI was required for inclusion, participants may have had multiple other mTBIs of either blast-related or nonblast-related etiology and these data were not captured. Further, imaging data were not available and neither were data on number of deployments, duration of deployments, and rank. These variables may be associated with SSD in veterans with history of mTBI—either directly or indirectly.

An additional weakness of this study was that the measure of SSD was derived from only a single question. Finally, this study used all self-report measures that can be susceptible to social desirability bias as well as recall bias.[41,42] In addition, the measures and variables available to researchers conducting this study did not match exactly those used in previous research with civilian samples; although this limitation restricts researchers from making direct comparisons between the two studies, these findings providing insight for future research.

Strengths

Despite these limitations, this study's findings have important implications. This study contributes to the growing body of literature investigating prevalence of SSD in veterans with a history of blast-related mTBI. Our findings suggest SSD is a pervasive problem that is associated with loss of consciousness at the time of injury and potentially modifiable symptoms including nightmares, depression, headaches, and fatigue, as well as symptoms of PTSD.

CONCLUSIONS

These findings suggest SSD is pervasive in clinical samples of veterans with history of blast-related mTBI. As previous research has found, SSD is associated with modifiable co-occurring symptoms. Although preliminary, these findings invite further research using more objective methods to quantify specific types of sleep disturbance and modifiable co-occurring symptoms in veterans with history of mTBI. Those later findings could be used by the Veterans Affairs system to inform modification of existing screening protocols, diagnostic techniques, and evidence-based treatments to address specific patterns of SSD experienced by veterans with history of mTBI.

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