Relations Among PTSD, Alcohol Misuse, and Sleep Difficulties In Post-9/11 Veterans

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RELATIONS AMONG PTSD, ALCOHOL MISUSE, AND SLEEP DIFFICULTIES IN POST-9/11 VETERANS

A Thesis
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The Department of Psychology
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by

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Abstract

Alcohol misuse, PTSD, and sleep disturbance often co-occur among veterans of post 9/11/2001 conflicts, however, the relations among these conditions have not been fully explored. The current study aimed to investigate the additive effects of PTSD and sleep disturbance on alcohol misuse. Participants included 110 veterans and active military personnel who served in a combat deployment following September 11th, 2001 (M_age=37.02, SD=7.74; 87% Male; 62% White). Bivariate correlations revealed total PTSD severity was significantly associated with sleep disturbance and with alcohol misuse, as expected; however, no significant association between sleep disturbance and alcohol misuse was observed, contrary to prior research. Additionally, regression analysis showed that sleep disturbance did not explain unique variance in alcohol use, beyond the role of PTSD severity. These findings suggest that an additive model does not fit the data from the present sample and a complex set of relations among these variables likely exists.
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RELATIONS AMONG PTSD, ALCOHOL MISUSE, AND SLEEP DIFFICULTIES IN POST-9/11 VETERANS

Over 2.7 million military personnel were deployed in response to the attacks on September 1st, 2001, and a majority served multiple deployments (Watson Institute for International and Public Affairs, 2015). The environment and stress associated with combat put service members at a greater risk of experiencing negative psychological sequelae, such as posttraumatic stress disorder (PTSD), sleep difficulties, and hazardous alcohol misuse upon return to civilian life (Conner et al., 2013; Kelsall et al. 2015). Estimates of PTSD among post-9/11 veterans suggest a prevalence rate of around 23% (Fulton et al., 2015; US Department of Veterans Affairs, 2019). PTSD is associated with high rates of comorbidity and substantial functional impairment. (Kessler, 2000). The most commonly reported symptom among veterans experiencing PTSD is sleep difficulties; with an estimated prevalence of approximately 90.5% among this veteran cohort (Plumb et al., 2014). Chronic sleep difficulties among veterans with PTSD can result in functional impairment across various domains of life (e.g., physical, emotional, social, and occupational), and can make coping with stressors related to reintegration and adaptation to civilian life significantly more difficult (Hughes et al., 2018). As a result, veterans may engage in less adaptive coping behaviors, such as engaging in substance use, in an effort to ameliorate these distressing experiences. Previous research has suggested a multidirectional association between PTSD, sleep difficulties, and alcohol misuse, and this has been referred to as a “troublesome triad” for veterans (Colvonen et al. 2018; Lande, 2012). A substantial body of literature has aimed to evaluate the relationship between PTSD and alcohol misuse, specifically, but the additive effect of sleep difficulties on alcohol misuse, beyond the effect of PTSD severity, has not yet been thoroughly explored.
Sleep Difficulties Associated with PTSD

Sleep difficulties can occur in the context of both PTSD and alcohol misuse (Colvonen et al., 2020; Jenkins et al., 2015). Specific aspects of sleep difficulties may include reduced duration of sleep, diminished sleep quality, frequent awakening, insomnia, nightmares, and lower next day functioning (Colvonen et al., 2018; Miller et al., 2019). A study conducted by Pigeon and colleagues (2013) reported that 60-90% of recent combat veterans currently enrolled as patients in the VA healthcare system reported experiencing insomnia in conjunction with PTSD symptoms. It is important to acknowledge the ways in which various factors may contribute to the experience of sleep difficulties in the context of PTSD. Two symptoms related to the experience of sleep difficulties (nightmares and difficulty falling or staying asleep), are included within the diagnostic criteria for PTSD (APA, 2013). The experience of other PTSD symptoms, such as those associated with alterations in arousal and reactivity, including hypervigilance and exaggerated startle response, may also result in disturbed sleep (Germain et al., 2013).

Previous research suggests a bidirectional causal relationship between PTSD and sleep difficulties. One theory suggests the experience of sleep difficulties following a traumatic event, classified as trauma-induced insomnia, may serve as a causal factor of PTSD development and maintenance, rather than just a secondary effect (Werner et al., 2020). Two theoretical pathways in the understanding of trauma-induced insomnia converge on the idea of a developed fear of sleep. Pathway 1 suggests the individual develops a fear related to loss of control which may stem from beliefs about one’s safety, overestimation of danger, or increased feelings of helplessness, resulting in an increased perceived risk of vulnerability during sleep. Pathway 2 suggests the developed fear is rooted in the re-experiencing of the traumatic event (e.g., nightmares, flashbacks), or a perceived combination of both. Thus, rather than the more
traditional understanding that sleep difficulties develop following a traumatic event and are maintained by core symptoms of PTSD, this model of trauma-induced insomnia suggests the symptoms are better conceptualized as a core feature of PTSD themselves, and must be targeted independently (Werner et al., 2020).

Conversely, some research suggests that pre-trauma insomnia or other experiences of sleep difficulties can act as a risk factor for the development of PTSD. In a study of US Army soldiers, Wang and colleagues (2019) found that pre-deployment insomnia was associated with an increased risk of post-deployment PTSD, even after controlling for co-occurring pre-deployment risk factors, such as depression, prior experience of PTSD, and suicidal ideation. Short et al. (2020) posited two mechanisms through which pre-trauma insomnia symptoms may predict the development of PTSD. First, they suggested that pre-trauma insomnia may result in increased peri-traumatic distress due to increased emotional reactivity to stressors and difficulty with downregulation of negative emotional responses, both of which are found to be associated with sleep difficulties (Mauss et al., 2013; Minkel et al., 2012; Short et al., 2018). Secondly, they hypothesized that pre-trauma insomnia may interfere with or prevent natural post-trauma recovery. In this model, pre-trauma insomnia could lead to higher levels of distress following the trauma, triggering greater motivation to suppress or avoid trauma reminders. However, deliberate attempts to suppress trauma related cognitions or avoid trauma cues may lead to paradoxical rebounds in PTSD symptoms (Shiperd & Beck, 2005; Short et al., 2020).

Comorbidity of PTSD and Alcohol Misuse

As previously mentioned, the comorbidity of PTSD and alcohol misuse is fairly common among veterans. In a nationally representative study of veteran health and resilience, researchers found that 55% to 68% of veterans with probable PTSD also met criteria for Alcohol Use
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Disorder (AUD) (Dworkin et al., 2018; Smith et al., 2016; Wisco et al., 2014;). Similarly, based on VA electronic medical records, 63% of veterans diagnosed with probable AUD had also been diagnosed with PTSD (Dworkin et al., 2018; Seal et al., 2011). The frequency of association between these conditions serves to further complicate veteran psychological health outcomes when considering that individuals with a comorbid diagnosis are more likely to re-engage in substance use than those with substance use disorders alone (Brown et al., 1996).

This high rate of comorbidity has often been conceptualized as a maladaptive coping pattern, articulated as the “self-medication hypothesis” (Khantzian, 1997) which proposes that individuals with PTSD often develop problematic drinking patterns due to the anxiolytic effects of alcohol. Paradoxically, however, although alcohol may result in a short-term reduction in anxiety or negative affect, it does not effectively ameliorate PTSD symptoms, and may actually exacerbate them. Although the self-medication hypothesis is widely studied, and some aspects of the model have been supported, criticisms of the model suggest it may not be a complete explanation of the high rate of comorbidity; in addition, it would be impossible to conduct the type of longitudinal study needed to fully validate the hypothesis (Lembke, 2012).

A systematic review conducted by Hawn, Cusack, & Amstadter (2020) highlighted two other etiological models of PTSD-substance misuse comorbidity that may prove to be relevant for veterans. The mutual maintenance model (Stewart et al., 1998) and the common factors model (Danovitch, 2016) both conceptualize the comorbidity of PTSD and substance use disorder occurring due to the influence of shared factors serving to exacerbate both disorders, bidirectionally.

Sleep Difficulties Associated with Alcohol Use Disorder
As one of the most common complaints among those with AUD, prevalence estimates of co-occurring sleep difficulties are as high as 91%, similar to those observed in PTSD (Chakravorty, 2016). The established relationship between AUD and sleep difficulties is associated with a wide range of adverse outcomes, such as increased likelihood of re-engaging in alcohol use for those who are abstinent, psychosocial impairment (e.g., social conflict, impulse control, and employment problems), reduced quality of life, and increased suicidal ideation (Chakravorty, 2016; Inkelis et al., 2020). Research on the neurobiological underpinnings of the relationship between sleep disturbance and alcohol misuse has suggested that alcohol promotes an acute neurotoxic effect on receptors important in sleep generation (please see work by Cederbaum (2012) or Miller and colleagues (2019) for a more robust explanation).

One widely proposed behavioral association between AUD and sleep difficulties is the use of alcohol to ameliorate sleep-related symptoms. Alcohol is a sedative, due to its effect on the gamma-aminobutyric acid (GABA) neurotransmitter system in the brain, and thus can reduce the delay in sleep onset, a hallmark of sleep difficulties. However, as alcohol is metabolized, its sedative effects decrease, paradoxically resulting in more disrupted and less restful sleep (Cederbaum, 2012). Additionally, Brower (2003) posited that the association between alcohol use and sleep difficulties perpetuates a vicious cycle in which insomnia may motivate alcohol use, which can become problematic, and in turn contribute to sleep disturbance. However, although alcohol can worsen sleep difficulties, the initial anxiolytic effect may result in the perception that alcohol promotes sleep, thus continuing the vicious cycle. This cyclical model parallels the self-medication hypothesis posited for PTSD-AUD comorbidity. However, to our knowledge, no prior research has investigated the additive effects of PTSD and sleep disturbance on alcohol misuse.
The Current Study

Although relations among PTSD, sleep disturbance, and alcohol misuse have been established, it remains unclear how sleep disturbance uniquely contributes to alcohol misuse, beyond the effect of the other PTSD symptoms. Thus, the current study aims to investigate the additive contribution of sleep disturbance to alcohol misuse beyond the effect explained by PTSD symptom severity in a sample of military veterans.

Hypotheses

The following hypotheses were explored in the present study:

1. It was hypothesized that PTSD severity would be positively correlated with measures of both alcohol misuse and sleep difficulties, such that veterans who experienced more severe PTSD symptoms would report consuming higher levels of alcohol, experiencing more alcohol-related negative consequences, and would also report more severe sleep difficulties, including insomnia and sleep related impairment (e.g., increased sleepiness, functional impairment).

2. It was hypothesized that sleep-related disturbance and impairment would predict unique variance in alcohol use as well as hazardous drinking, beyond the variance explained by PTSD severity, measured by the PTSD Checklist for DSM-5.

Method

Participants

Participants were 110 veterans and active military personnel ($M_{age} = 37.02$ years, $SD = 7.74$) who served in a combat deployment following September 11th, 2001. Total N varied between 110 and 114 due to a technical issue in which 4 participants’ data were not recorded during a baseline re-administration of the PCL-5, resulting in four cases missing all PCL-5 data,
including total score, and were thus excluded from the analyses, resulting in the final N = 110 sample. 87% (n = 96) of participants identified as male; 13% (n = 14) identified as female. Four percent (n = 4) of participants identified as Hispanic. 62% (n = 70) of participants identified as White, 31% (n = 33) as Black or African American, two percent (n = 2) as Asian or Asian American, and five percent as Other (n = 5). 61% (n = 66) of participants reported Army as their branch of service, 16% (n = 18) as the Navy, 13% (n = 15) as the Marines, 9% (n = 10) as the Air Force, and one percent (n = 1) as the Coast Guard. 81% (n = 88) of participants identified as veterans or retired from service. 11% (n = 12) were currently reservists, five percent (n = 6) were in the national guard and four percent (n = 4) were currently serving in active duty. 69% (n = 78) of participants met criteria for PTSD based on the Clinician Administered PTSD Scale for the DSM-5 (CAPS-5). 36% (n = 41) screened positive for hazardous drinking based on recommended cut off score of 8 for the AUDIT.

Measures

PTSD Checklist for DSM-5 (PCL-5; Weathers et al., 2013). The PCL-5 is a 20-item self-report measure of PTSD, corresponding to DSM-5 criteria (APA, 2013). Each PTSD symptom is reflected in a separate item, and respondents are asked to rate how much they have been bothered by that symptom in the past month on a five-point scale (0 = Not at all, 4 = Extremely). Items are summed for PCL-5 total scores ranging from 0-80. Cut-off scores of 31-33 have been found to be efficient for determining likely PTSD diagnosis (Bovin et al., 2016). Previous research has determined that the PCL-5 has strong psychometric properties, including test-retest reliability, convergent and discriminant validity, as well as excellent internal consistency in the measurement of PTSD symptomology in a veteran sample (Blevins et al., 2015; LeardMann et al., 2021; Wortmann et al., 2016). For analyses where we wanted to isolate
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the effect of sleep disturbance, we created a modified PCL-5 score that omitted the two sleep-related items (i.e., item 2: Repeated, disturbing dreams of the stressful experience(s), and item 20: Trouble falling or staying asleep). Internal consistency for the full PCL-5 in the present study was excellent (α = 0.91).

**Clinician Administered PTSD Scale** for DSM-5 (CAPS-5; Blake et al., 1995). The CAPS-5 is a structured diagnostic interview that assesses an individual’s experience of a Criterion A traumatic event as well as each of the twenty core symptoms of PTSD, corresponding to the four symptom clusters of B.) re-experiencing, C.) avoidance, D.) negative alterations in cognition and mood, and E.) alterations in arousal and reactivity. Severity of symptoms are rated on a 0 to 4 scale (0 = Absent/non-applicable to 4 = Extreme/incapacitating). The CAPS-5 also includes items beyond the initial 20 that comprise the diagnostic criteria that allow interviewers to evaluate onset and duration of symptoms, subjective distress, impact of symptoms on social and occupational functioning, response validity, overall PTSD severity, and specifications for dissociative subtype. Scores derived from the CAPS-5 can be presented dichotomously to reflect if the individual does or does not meet criteria for PTSD or continuously as a sum score. For the purpose of this study, we will be using the dichotomous score to represent a categorical diagnosis based on the DSM-5 algorithm. The psychometric properties of the CAPS-5 have been evaluated in veteran samples and found to be statistically sound in the assessment of PTSD (α = 0.88; Weathers et al., 2017). Internal consistency for the present study was good (α = 0.82).

**Alcohol Use Disorders Identification Test** (AUDIT; Saunders et al., 1993) The AUDIT is a 10-item questionnaire assessing hazardous alcohol use over the past year. Item scores range from 0 to 4 and are summed to derive a score ranging from 0 to 40, with higher scores reflecting
a greater likelihood of hazardous alcohol use. The AUDIT has demonstrated good internal consistency and test-retest reliability when assessing for alcohol-related impairment in veteran and military populations (Searle et al., 2015; Forkus et al., 2019). Internal consistency in the current study was good ($\alpha = 0.88$).

**Timeline Followback** (TLFB; Sobell & Sobell, 1996) The TLFB is an interviewer-administered calendar-based measure of alcohol and other substance use. In the present study, we assessed alcohol consumption over the past 30 days. Participants were asked to report on the number of standard drinks consumed each day. When administered this way, the TLFB can be used to derive values for the quantity and frequency of alcohol use (total number of drinks, and total number of drinking days, respectively). The TLFB has well established psychometric properties regarding reliability and validity for assessing alcohol consumption, including good internal consistency, test-retest reliability, and convergent validity with other alcohol assessment measures (Fals-Stewart et al., 2000).

**Insomnia Severity Index** (ISI; Morin, 1993) The ISI is a 7-item self-report measure that assesses difficulty initiating and maintaining sleep, daytime consequences of insomnia, worry about sleep, and satisfaction with sleep quality. Each item uses a 5-point Likert type scale ranging from 0 to 4, with higher numbers corresponding to greater sleep problems. The items sum to produce a total score (range 0 – 28). The ISI has shown excellent internal consistency and construct validity in samples similar to the current study ($\alpha = 0.92$, Kaufmann et al., 2019), and in the general population ($\alpha = 0.90$, Morin et al., 2011). Internal consistency for the present study was good ($\alpha = 0.89$).

**Patient-Reported Outcomes Measurement Information System Sleep-Related Impairment and Sleep Disturbance** (PROMIS; Yu et al., 2012) The PROMIS is a 16-item self-
report questionnaire comprised of two scales assessing past-week sleep disturbance and sleep-related impairment. The Sleep Disturbance (SD) subscale consists of 8 items assessing difficulty falling asleep, sleep problems, restlessness, and overall quality of sleep. Four items are scored on a 5-point response scale with response options ranging from 1 (not at all) to 5 (very much) for questions assessing difficulty falling asleep, sleep problems, and restlessness. Four items (“I was satisfied with my sleep”, “My sleep was refreshing”, and “I got enough sleep”) are reverse scored, with responses ranging from 5 (not at all) to 1 (very much). The final question of the measure (“My sleep quality was…” is also reverse scored, with response options ranging from 5 (very poor) to 1 (very good). The Sleep-Related Impairment (SRI) subscale consists of 8 items assessing, sleepiness, tiredness, functional impairments associated with sleep problems, and self-reported alertness. Seven items are scored on a 5-point response scale with response options ranging from 1 (not at all) to 5 (very much). One item (“I felt alert when I woke up”) is reverse scored, with responses ranging from 5 (not at all) to 1 (very much). Item scores are summed, and total raw scores are then converted to a standardized T-score, using conversion tables published on the PROMIS website, with higher scores indicating greater sleep disturbance or sleep-related impairment. Both PROMIS SD ($\alpha = 0.84$) and SRI ($\alpha = 0.91$) have demonstrated strong internal consistency, (Lei et al., 2020). However, this measure has not been psychometrically evaluated in a veteran sample previously. Internal consistency for the present study was good for both SRI ($\alpha = 0.91$) and SD ($\alpha = 0.89$).

**Procedure**

Data were collected as part of a larger study across multiple time points, however, the present study used data only from the baseline assessment session. Participants were recruited via posted flyers, social media advertisements, and in-person recruitment events at health fairs.
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and veterans’ events in the community. Potential participants were screened in person, over the phone, or online, using the PCL-5 and a set of questions to confirm eligibility. Interested participants were screened for eligibility via phone, online, or in person. Those who were between the ages of 18 and 65 years old who reported a post-9/11 deployment, a criterion A traumatic event during deployment, and who obtained a PCL-5 score of at least 25 were invited to come to our research offices for a comprehensive assessment, which included a thorough evaluation, including clinical interview-based measures of PTSD and other psychological conditions, as well as questionnaires asking about military history, health history, health behaviors and personality characteristics. Participants were compensated $25 for this assessment.

Data Analysis Plan

Prior to analyzing data, variables were screened for appropriateness using recommendations by Tabachnik and Fidell (2013). Data were evaluated for properties of normality using recommendations by Kline (2011); < |2| threshold for skew and < |10| threshold for kurtosis. The Timeline Followback variable assessing total number of drinks in the past month was positively skewed and thus, a log10 transformation was performed. Following this, evaluations of skewness and kurtosis were within recommended normal limits for all variables.

Univariate outliers were first evaluated based on the recommended z score threshold of >|3.29| (Tabachnik and Fidell, 2013). Although two cases exceeded this threshold on the AUDIT total, using the Tukey Outlier Labeling Rule, which states that outliers are values greater than 1.5 times the interquartile range from the quartiles, it was determined that neither case was considered an outlier (Tukey, 1977). No cases were identified as multivariate outliers based on the Mahalanobis distance method recommended by Tabachnik and Fidell (2013). Missing data
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were further evaluated using Little’s Missing Completely at Random test (MCAR). Missing data appear to be MCAR ($p = 0.38$).

To test our first hypothesis, we conducted bivariate Pearson correlations. To test the second hypothesis, we conducted three hierarchical regression models to examine the extent to which sleep disturbance (ISI and PROMIS) explained unique variance in alcohol consumption on the TLFB as well as hazardous drinking assessed by the AUDIT, beyond the variance explained by PCL-5 score. Decisions about which measures of sleep disturbance/impairment to enter in step 2, and which alcohol-related measure to use as the dependent variable were made based on our a priori hypotheses and based on observed bivariate relations among these variables. This resulted in our conducting three regression models. Prior to conducting these regression analyses, we investigated relations between a set of demographic variables (age, race, and gender) and the dependent variables to determine if any of these should be included as covariates.

**Results**

Descriptive statistics for all measures are listed in Table 1. To test our first hypothesis, that PCL-5 score would be significantly associated with measures of sleep disturbance and impairment (the ISI and PROMIS-SD and PROMIS-SRI), as well as with quantity and frequency of alcohol consumption (measured by the TLFB) and hazardous drinking (measured by the AUDIT), we conducted correlational analyses for all variables. These correlation analyses showed, as expected, significant and positive relationships between PCL-5 total score (and the modified PCL-5 that omitted sleep items), and all three sleep variables, and between PCL-5 Total score and AUDIT Total score. Exploratory correlational analyses were also conducted for PCL-5 cluster scores. Re-experiencing symptoms (omitting the nightmare item) and arousal
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symptoms (omitting the sleep disturbance item) were significantly and positively correlated with all three sleep variables. Avoidance symptoms were also significantly and positively correlated with ISI and PROMIS Sleep Disturbance. The negative alterations in cognition and mood symptom cluster was significantly and positively correlated with AUDIT Total, and both PROMIS scales. Table 2 presents full correlation results.

We conducted three hierarchical regression models, to test the contribution of sleep disturbance/impairment on alcohol use and misuse, after accounting for the role of PTSD severity. In each model, modified PCL-5 Total score was entered at step 1. We investigated demographic characteristics of age and gender as potential covariates and no significant relationships were found, and thus no covariates were included in these regression models.

In the first model, predicting AUDIT Total score, PCL-5 total (without sleep items) was entered in step 1, followed by ISI Total score in step two. ISI Total score was not a significant predictor of AUDIT score. Full regression results are provided in Table 3.

In the second model, predicting TLFB Number of Drinking Days, we entered the modified PCL-5 Total score in step 1, and PROMIS Sleep-Related Impairment in step 2. The final model, including both modified PCL-5 Total and PROMIS Sleep-Related Impairment, significantly predicted TLFB number of drinking days in the past month, although only PROMIS-Sleep Impairment was a significant predictor. Full regression results are provided in Table 4.

In the third model, predicting TLFB- Total Drinks, we entered the modified PCL-5 Total score in step 1, followed by PROMIS Sleep-Related Impairment in step 2. The final model, including both modified PCL-5 Total and PROMIS Sleep Impairment, significantly predicted
total number of drinks in the past month, although only PROMIS-Sleep-Related Impairment was a significant predictor. Full regression results are provided in Table 5.

**Discussion**

The present study sought to explore the extent to which PTSD and sleep-related disturbance and impairment each contributed to alcohol use and misuse in a sample of combat veterans with post-9/11/01 deployments. We hypothesized that PTSD would be related to both sleep disturbance/impairment as well as alcohol use and misuse. Further, we predicted that sleep difficulties would contribute to alcohol use, beyond the variance explained by PTSD severity.

The correlational findings provided partial support of our hypotheses, although PTSD severity was not associated with quantity or frequency of alcohol consumption, it was significantly correlated with hazardous alcohol use, although the effect size was small. Investigating the aspects of PTSD that were driving this correlation, it was only the Negative Alterations in Cognition and Mood symptom cluster that was significantly correlated with hazardous drinking; although again, the magnitude of the correlation was only just over the threshold of statistical significance, and was only marginally greater than the correlation with re-experiencing symptoms, which was non-significant. The measures of sleep-related disturbance and impairment showed a strong pattern of correlations with the PTSD severity scores (both including and excluding the sleep items). Quantity and frequency of alcohol use were correlated with sleep-related impairment, but not with the scales assessing disturbed sleep. Hazardous drinking was not significantly related to any aspect of sleep disruption or sleep-related impairment that we assessed. This pattern of correlations suggests that a more complex set of relations exists among these variables than we had expected. PTSD severity was more related to hazardous drinking than to frequency and quantity of alcohol consumption whereas the converse
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was true for sleep-related impairment. This suggests that sleep-related impairment may be related to a higher level of consumption, but not hazardous drinking *per se*. The construct of hazardous drinking is conceptualized as including patterns of drinking that are associated with increased risk of adverse health outcomes and instances of harm, beyond merely higher alcohol consumption (Saunders et al., 1993). The measure of hazardous drinking used in this study, the AUDIT, includes questions assessing blackouts, functional impairment due to alcohol use, loss of control over drinking, physiological dependence, injuries (self/others) due to drinking, expressions of concern from others, and feelings of guilt or remorse after drinking. A potential explanation for the association observed between PTSD and hazardous alcohol use may be that those with PTSD are engaging in an overall more reckless or risky manner of drinking, irrespective of frequency or quantity. Secondly, it is possible that hazardous drinking reflects a general recklessness that has been observed among individuals with PTSD (Armour et al., 2020; Contractor et al., 2020) and is now included in the PTSD criteria (APA, 2013), such that PTSD may be associated with a tendency to be less cognizant of the consequences of one’s drinking. It is also possible that the negative affect associated with hazardous drinking, referred to in an AUDIT item referencing “guilt or remorse” plays a role in this association, given that these same emotions are also common in PTSD and are referenced on the PCL-5 (Bannister et al., 2018; Kubany, 1994).

Turning to the relations between sleep variables and alcohol consumption; the scale we used to assess sleep-related impairment includes questions reflecting experiences that one may have following an episode of poor sleep (e.g., “I felt tired”, “I had problems during the day because of poor sleep”). Thus, the significant association between sleep-related impairment and alcohol consumption may reflect a phenomenon where ratings of “sleep-related impairment” are
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at least in part reflective of the effects of excessive alcohol consumption (e.g., tiredness).

Further, it is possible that sleep-related impairment ratings reflect poor sleep quality, even in the absence of shorter sleep duration, and that excess alcohol consumption undermines sleep quality, reflective of previously established models of the deleterious cycle often created by sleep and alcohol use (Brower, 2003). Thus, ratings of greater sleep-related impairment may be associated with higher frequency and quantity of alcohol consumption, which contribute to poor sleep quality as well as sleep-related impairment, but not drinking patterns that are otherwise risky (e.g., blackouts, injuring self or others).

The observed pattern of correlations did not correspond to previous findings suggesting bidirectional associations between PTSD, alcohol use, and sleep difficulties amongst veterans. For example, in a sample of active-duty service members, Lande (2012) found significant associations among PTSD, hazardous alcohol use (measured by the AUDIT), and insomnia.

Further, Lande highlighted the importance of these results, as they provide added emphasis of the “interrelated nature” of these variables and the culminating effect of PTSD, alcohol use, and sleep disturbance may have on veterans’ psychosocial outcomes (e.g., increased risk of suicide).

Additionally, in a help-seeking sample recruited from the community, Waldrop and colleagues (2008) found that both PTSD and alcohol consumption (measured by the Timeline Followback), were associated with forms of sleep disturbance (e.g., early morning awakening, longer sleep latency) and sleep-related impairment (e.g., daytime sleepiness). They also reported that there was no significant direct relationship between alcohol use severity and sleep disturbance, contrary to their hypothesis, but similar to the present findings.

Interestingly, the only significant association found between the PTSD symptom clusters and alcohol use in the present study was the correlation between negative alterations in cognition
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and mood (NACM) and hazardous drinking. This finding is somewhat unusual in the context of other published research in this area; several prior studies have reported significant relations between all four PTSD symptom cluster scores and hazardous drinking (Livingston et al., 2021; Saba et al., 2021; Walton et al., 2018). Clusters in veteran samples (Livingston et al., 2021; Saba et al., 2021; Walton et al., 2018). In the present sample, only the NACM cluster was statistically significant, but, as previously mentioned, the magnitude of the correlation between this cluster and the AUDIT is only marginally larger than the coefficients for the re-experiencing and avoidance clusters. In a larger sample, the correlations between both the re-experiencing and avoidance clusters and the AUDIT might have been statistically significant.

The set of regression models we conducted were based both on our a priori hypotheses as well as observed bivariate correlations. Given the correlational findings, we expected that the regression analysis testing the contribution of sleep-related disturbance to alcohol consumption, beyond the effect of PTSD, would not support our hypothesis. In models two and three, sleep-related impairment significantly predicted both measures of alcohol consumption, but PTSD did not. However, similarly to what was observed in the correlations, the magnitude of the effect that sleep-related impairment has on both models is small. Nevertheless, to understand the discrepancies between our findings and prior studies in the literature, it is important to consider some characteristics of the present sample. This was not a clinical or help-seeking sample, as the participants were recruited primarily via advertisements in the community and on social media. This likely resulted in a less-severe and less-impaired sample than we might have recruited in a clinical setting, which may have contributed to weaker (or absent) relationships among variables that have demonstrated significant correlations in clinical samples. For example, the sample used in Lande’s analysis (2012), was referred to the VA for treatment of combat related PTSD, which
may have impacted the nature of his findings. Additionally, the use of measures across this literature is inconsistent making the extrapolation of results somewhat difficult.

**Limitations and Future Directions**

It is important to acknowledge limitations of the present study. First, this was a cross-sectional study, and we cannot infer directionality nor causality of any of the associations we found. However, the larger study from which the data was derived, is longitudinal, and thus, may allow for a more comprehensive evaluation and inferences of directionality. Secondly, the sample was predominantly male, with only 13% of participants describing their gender as female. Although gender inequality is a common characteristic of veteran samples, it limits the generalizability of our findings as our current findings may not be representative of the female veteran experience. Further, the size of this sample did not permit investigation of these relations within different racial/ethnic groups. The pursuit of a more comprehensive evaluation of alcohol use, sleep difficulties, and PTSD in samples of both gender and ethnic minority veterans is imperative to furthering our understanding of this particularly deleterious combination of negative outcomes larger impact on veteran health, following trauma exposure.

**Conclusions**

The present study adds to the literature describing the relations among PTSD, alcohol use/misuse, and sleep disturbance/impairment among military veterans. Although our hypotheses were not fully supported, the significant relationships between PTSD and hazardous drinking, but not quantity and frequency of alcohol consumption suggest that there are aspects of hazardous drinking, aside from sheer quantity that may show functional relationships to PTSD dimensions. As PTSD, alcohol use, and sleep difficulties seem to interact in complex ways, and all contribute to poorer health outcomes, a thorough understanding of the interplay between these
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experiences will be important for the development of effective interventions. Future studies further examining this association, including possible moderating factors are necessary.
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References


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The PTSD Checklist for DSM-5 (PCL-5). Scale available from the National Center for PTSD.


Table 1  
*Means and Standard Deviations of PTSD, Alcohol, and Sleep Variables*

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCL-5 total</td>
<td>35.33</td>
<td>13.83</td>
</tr>
<tr>
<td><em>without sleep items</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCL-5 total</td>
<td>39.67</td>
<td>15.20</td>
</tr>
<tr>
<td><em>with sleep items</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAPS-5 total</td>
<td>29.27</td>
<td>10.38</td>
</tr>
<tr>
<td>AUDIT</td>
<td>7.22</td>
<td>7.52</td>
</tr>
<tr>
<td>Timeline Followback Drinking Days</td>
<td>0.56</td>
<td>0.50</td>
</tr>
<tr>
<td>Timeline Followback Total Drinks Past Month</td>
<td>0.80</td>
<td>0.72</td>
</tr>
<tr>
<td>Insomnia Severity Index</td>
<td>16.65</td>
<td>6.26</td>
</tr>
<tr>
<td>PROMIS Sleep Disturbance</td>
<td>30.75</td>
<td>5.91</td>
</tr>
<tr>
<td>PROMIS Sleep Impairment</td>
<td>25.94</td>
<td>7.42</td>
</tr>
</tbody>
</table>

*Note.* M = Mean; SD = Standard deviation; PCL-5 = PTSD Checklist for DSM-5; CAPS-5 = Clinician Administered PTSD Scale for DSM-5; AUDIT = Alcohol Use Identification Test; TLFB = Timeline Followback; ISI = Insomnia Severity Inventory; PROMIS Sleep Disturbance = Patient-Reported Outcome Measurement Information System -Sleep Disturbance subscale; PROMIS Sleep Impairment = Patient-Reported Outcome Measurement Information System -Sleep Impairment subscale
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Table 2
Correlations of PTSD, Alcohol, and Sleep Variables

<table>
<thead>
<tr>
<th></th>
<th>PCL-5</th>
<th>PCL-5 without sleep items</th>
<th>AUDIT</th>
<th>TLFB Drinking Days</th>
<th>TLFB Total Drinks</th>
<th>ISI</th>
<th>PROMIS SD</th>
<th>PROMIS SRI</th>
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<tbody>
<tr>
<td>PCL-5</td>
<td>-</td>
<td>.99**</td>
<td>.19**</td>
<td>.02</td>
<td>.03</td>
<td>.56**</td>
<td>.52**</td>
<td>.38**</td>
</tr>
<tr>
<td>PCL-5 without sleep items</td>
<td>-</td>
<td>.19*</td>
<td>.28**</td>
<td>.39**</td>
<td>.51**</td>
<td>.49**</td>
<td>.36**</td>
<td></td>
</tr>
<tr>
<td>AUDIT</td>
<td>-</td>
<td></td>
<td>.28**</td>
<td>.39</td>
<td>.51**</td>
<td>.49**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLFB Drinking Days</td>
<td>-</td>
<td></td>
<td></td>
<td>.96**</td>
<td>.08</td>
<td>.20**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLFB Total Drinks</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td>.08</td>
<td>.20**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISI</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.59**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROMIS SD</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROMIS SRI</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PCL-5 based cluster scores

B: Re-experiencing | .85** | .84** | .19 | .00 | .01 | .44** | .38** | .25**
C: Avoidance      | .67** | .68** | .17 | .10 | .10 | .27** | .21*  | .06
D: Neg Alterations in Cognition and Mood | .86** | .88** | .21* | .00 | .02 | .40** | .39** | .30**
E: Arousal        | .85** | .83** | .06 | -.04 | -.01 | .54** | .56** | .49**

Note. PCL-5 = PTSD Checklist for the DSM-5; AUDIT = Alcohol Use Identification Test; TLFB = Timeline Followback; ISI = Insomnia Severity Index; PROMIS SD = Patient-Reported Outcome Measurement Information System -Sleep Disturbance subscale; PROMIS SRI = Patient-Reported Outcome Measurement Information System -Sleep Impairment subscale; *p < .05, **p < .01
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Table 3
Hierarchical regression analyses testing unique contribution of ISI scores to AUDIT total score, beyond the effect of modified PCL-5 total scores

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>S.E.</th>
<th>C.I.</th>
<th>β</th>
<th>t</th>
<th>p</th>
<th>ΔR²</th>
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</thead>
<tbody>
<tr>
<td>Model 1</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Step 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCL-5</td>
<td>0.10</td>
<td>0.05</td>
<td>[0.00, 0.21]</td>
<td>0.19</td>
<td>2.02</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>without sleep items</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Step 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCL-5</td>
<td>0.07</td>
<td>0.06</td>
<td>[-0.05, 0.19]</td>
<td>0.13</td>
<td>1.18</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>without sleep items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISI</td>
<td>0.15</td>
<td>0.13</td>
<td>[-0.12, 0.41]</td>
<td>0.12</td>
<td>1.10</td>
<td>0.28</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Note. PCL-5 = PTSD Checklist for the DSM-5, modified to exclude sleep related items; ISI = Insomnia Severity Index; AUDIT = Alcohol Use Identification Test; *p < .05
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Table 4
Hierarchical regression analyses testing unique contribution of PROMIS Sleep Impairment scores to TLFB number of drinking days over the past month, beyond the effect of modified PCL-5 total scores

<table>
<thead>
<tr>
<th>Model 2</th>
<th>$b$</th>
<th>S.E.</th>
<th>C.I.</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
<th>$\Delta R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>PCL-5 without sleep items</td>
<td>0.00</td>
<td>0.00</td>
<td>[-0.01, 0.01]</td>
<td>0.01</td>
<td>0.06</td>
<td>0.95</td>
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<tr>
<td><strong>Step 2</strong></td>
<td></td>
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<tr>
<td>PCL-5 without sleep items</td>
<td>-0.00</td>
<td>0.00</td>
<td>[-0.01, 0.00]</td>
<td>-0.08</td>
<td>-0.75</td>
<td>0.45</td>
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<tr>
<td>PROMIS Sleep Impairment</td>
<td>0.02</td>
<td>0.01</td>
<td>[0.00, 0.03]</td>
<td>0.23</td>
<td>2.22</td>
<td>0.03</td>
<td>0.04*</td>
</tr>
</tbody>
</table>

*Note. PCL-5 = PTSD Checklist for the DSM-5, modified to excluded sleep related items; PROMIS Sleep Impairment = Patient-Reported Outcome Measurement Information System - Sleep Impairment subscale; TLFB = Timeline Followback; *$p < .05$*
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Table 5
Hierarchical regression analyses testing unique contribution of PROMIS Sleep Impairment scores to TLFB total number of drinks in the past month, beyond the effect of modified PCL-5 total scores

Note. PCL-5 = PTSD Checklist for the DSM-5, modified to excluded sleep related items; PROMIS Sleep Impairment = Patient-Reported Outcome Measurement Information System - Sleep Impairment subscale; TLFB = Timeline Followback; *p < .05

<table>
<thead>
<tr>
<th>Model 3</th>
<th>b</th>
<th>S.E.</th>
<th>C.I.</th>
<th>β</th>
<th>t</th>
<th>p</th>
<th>ΔR²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCL-5 without sleep items</td>
<td>0.00</td>
<td>0.01</td>
<td>[-0.01, 0.01]</td>
<td>0.02</td>
<td>0.23</td>
<td>0.82</td>
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<tr>
<td>PCL-5 without sleep items</td>
<td>-0.00</td>
<td>0.00</td>
<td>[-0.01, 0.01]</td>
<td>-0.06</td>
<td>-0.58</td>
<td>0.56</td>
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</tr>
<tr>
<td>PROMIS Sleep Impairment</td>
<td>0.02</td>
<td>0.01</td>
<td>[0.00, 0.04]</td>
<td>0.22</td>
<td>2.19</td>
<td>0.03</td>
<td>0.04*</td>
</tr>
</tbody>
</table>