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Longitudinal Associations between Sleep, Intrusive Thoughts, and Alcohol Problems among Veterans

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Abstract

Background: Research suggests bidirectional associations between symptoms of posttraumatic stress disorder (PTSD) and sleep disturbance, both of which have been associated with alcohol problems. However, few studies have examined the interplay of these conditions in predicting alcohol problems over time. This study tested two competing models: (a) sleep disturbance as a mediator of the association between intrusive thoughts about trauma and alcohol problems and (b) intrusion symptoms as the mediator of the sleep/alcohol problems association.

Methods: Veterans ($N=325$, 93% male, 81% White) completed assessments at baseline, 6 months, and 12 months as part of a larger observational study. Zero-inflated negative binomial models were used to examine indirect effects of baseline predictors on (a) yes/no likelihood and (b) number of 12-month alcohol problems through 6-month mediators. Models controlled for past-year cannabis use and drinks consumed per week at baseline.

Results: The only significant predictor of alcohol problem likelihood was baseline drinking quantity. Baseline PTSD intrusions had a direct effect on number of alcohol problems at 12 months, with no indirect (mediated) effect through 6-month sleep disturbance. In the competing model, baseline sleep disturbance had a marginally significant direct effect on 12-month alcohol problems, with a significant indirect effect through 6-month PTSD intrusions.

Conclusions: PTSD intrusions are associated with more alcohol problems and help explain the long-term association between sleep and alcohol problems among Veterans. Because sleep disturbances are associated with more intrusive thoughts about trauma, we recommend that treatments targeting sleep in the context of PTSD and alcohol use include a cognitive component.

Keywords

alcohol; drinking; PTSD; mental health; Veterans

Introduction

Post-traumatic stress disorder (PTSD) and alcohol use are common, frequently comorbid disorders among veterans (Lehavot et al., 2018, Boden and Hoggatt, 2018). Despite research examining the impact of PTSD symptoms on alcohol problems, few studies have examined potential mechanisms of this association, particularly over time (Gilpin and Weiner, 2017). Sleep disturbance – operationalized as sleep of poor quality, timing, efficiency, or duration (Buysse, 2014) – co-occurs with both PTSD and alcohol use and is more prevalent among veterans than the general population (Jenkins et al., 2015). Thus, sleep may be particularly relevant to PTSD- and alcohol-related problems among veterans.

PTSD and Alcohol Problems

Separate lines of research have documented associations between PTSD and alcohol problems, sleep and alcohol problems, and PTSD and sleep. In cross-sectional models, PTSD symptoms are associated with more frequent binge drinking (Calhoun et al., 2016, Adams et al., 2016) and problems such as passing out or taking foolish risks as a result of drinking (Fuehrlein et al., 2014). Similarly, at the daily level, daytime PTSD symptoms are associated with greater alcohol consumption and more alcohol-related problems (e.g., fighting) that night (Gaher et al., 2014, Langdon et al., 2016). The association between PTSD and alcohol use is often attributed to self-medication, or use of alcohol to cope with distress; however, PTSD is associated with alcohol-related problems independent of alcohol consumption (Gaher et al., 2014), indicating that the association between PTSD and alcohol problems is not due solely to increased drinking quantity.

Sleep and Alcohol Problems

Sleep disturbance also increases risk for alcohol-related problems (Chaudhary et al., 2015). Both poor sleep quality (Swinkels et al., 2013) and short sleep duration (Luxton et al., 2011) predict heavy drinking among returning veterans, and more severe insomnia symptoms are associated with more alcohol-related problems (Wright et al., 2011). While the mechanism(s) linking sleep to alcohol involvement are not well understood, sleep disturbance has been linked to impairments in executive functioning (Baglioni et al., 2010). Thus, sleep disturbance may contribute to poor cognitive control, resulting in poor decision-making and more problems in the context of alcohol use. Moreover, drinking is associated with more alcohol consequences in the context of sleep disturbance – as opposed to no sleep disturbance – in veterans (Miller et al., 2017a). Thus, sleep disturbance appears to contribute uniquely to alcohol-related problems above and beyond heavy drinking.

PTSD and Sleep

Individuals with PTSD experience more arousals from sleep (Capaldi et al., 2011), sleep for shorter amounts of time (Seelig et al., 2010), and report worse quality sleep (King et al.,

2017, Lind et al., 2017) than those without PTSD. Indeed, trouble falling or staying asleep is the most commonly-reported symptom of PTSD after deployment (McLay et al., 2010) and persists following effective treatment of PTSD (Zayfert and DeViva, 2004). Thus, PTSD symptoms likely contribute to subsequent sleep disturbance. Intrusive thoughts about traumatic events (referred to throughout as “PTSD intrusions”) may be particularly detrimental to sleep, as intrusive thoughts and worry are characteristic of the cognitive arousal processes that contribute to insomnia (Harvey, 2005, Spielman, 1987).

However, the association between PTSD and sleep seems to be bidirectional, such that sleep disturbance may also complicate the trajectory of PTSD symptoms. In cross-sectional studies, sleep disturbance has been associated with increased odds (Swinkels et al., 2013) and severity of PTSD symptoms (Wallace et al., 2011, Cox et al., 2018). Specifically among veterans, those with insomnia report more symptoms of PTSD than those without insomnia (Pigeon et al., 2013). Similarly, among individuals with PTSD, sleep disturbance has been associated with elevations in PTSD symptoms the next day (Short et al., 2017). Again, the mechanism(s) underlying this association are unclear; however, sleep disturbance may lead to difficulty managing/controlling thoughts or emotions (Baglioni et al., 2010), which may exacerbate PTSD symptoms.

The Current Study

Given the established link between PTSD and sleep disturbance and, in turn, the link between sleep disturbance and alcohol use, we hypothesized that sleep disturbance would partially account for the longitudinal association between PTSD intrusions and alcohol problems (i.e., 6-month sleep disturbance would mediate the association between baseline PTSD intrusions and 12-month alcohol-related problems). We focused specifically on PTSD intrusions (as opposed to other symptoms of PTSD, such as avoidance) because theoretical models of insomnia identify intrusive thoughts as a mechanism for sleep disturbance (Spielman, 1987, Harvey, 2005). Because the association between PTSD and sleep disturbance may be bidirectional, we also examined 6-month PTSD intrusions as a mediator of the association between baseline sleep disturbance and 12-month alcohol problems. This extends previous research by examining the interplay of PTSD symptoms and sleep disturbance in predicting subsequent alcohol-problems, accounting for the temporal precedence of each variable.

Materials and Methods

Participants and Procedure

Veterans ($N=361$) were recruited through a VA to participate in a larger observational study examining post-deployment health behaviors among returning veterans (Metrik et al., 2016). Individuals were eligible if they were 18+ years and deployed post-9/11/2001. Because the primary aim of the larger study was to examine trajectories of cannabis use and problems over time, eligible participants also reported lifetime use of cannabis. Participants were excluded if they reported (a) suicide risk in the past 2 weeks, (b) psychotic symptoms in the past month, (c) cognitive impairment, as indicated by scores ≤ 23 on the Mini Mental Status Exam; or (d) active military duty at baseline. Of those who participated in the larger study,

325 reported alcohol use at baseline and were included in the analytic sample (93% male; see Tables 1–2).

Participants completed in-person assessments and a semi-structured diagnostic clinical interview with a trained research assistant at baseline, 6 months ($n=283$, 87%), and 12 months ($n=282$, 87%). All procedures were approved by university and VA Institutional Review Boards.

Measures

Demographics.—Participants indicated their age, gender, race/ethnicity, and marital status at baseline. They also indicated (*yes/no*) if they had been exposed to each of 13 potential combat experiences (e.g., being attacked or ambushed) (Hoge et al., 2004).

Substance use.—Quantity and frequency of alcohol and cannabis use were assessed using the Timeline Followback interview (Sobell & Sobell, 1992), which has been established as a reliable measure of alcohol and cannabis use in clinical and non-clinical samples (Robinson et al., 2014; Sobell & Sobell, 2003). Participants indicated the number of drinks/joints they consumed on each day in the past six months at baseline, 6 months, and 12 months. Memory aids (e.g., Thanksgiving) were included on the calendar to enhance recall. Research staff assisted in calculation of standard drinks/joints. In addition to the TLFB, participants indicated (*yes/no*) at baseline if they had used cannabis in their lifetime (study eligibility criterion) or in the past year.

Alcohol-related problems.—Alcohol problems were assessed using the Short Index of Problems (Miller et al., 1995). Participants indicated how often in the past three months they had experienced 15 consequences, such as harm to physical health or damage to a close relationship, as a result of drinking. Response options ranged from 0 (*never*) to 3 (*daily or almost daily*). This measure has demonstrated strong internal consistency and concurrent validity (Alterman et al., 2009). Reliability in this sample was high ($\alpha=.90$).

Sleep disturbance.—Sleep disturbance was assessed using the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989). Participants rated their sleep in the past month on seven dimensions: (a) sleep quality, from very good to very bad; (b) sleep latency, or the time required to fall asleep; (c) sleep duration; (d) sleep efficiency, or amount of time spent in bed that was actually spent sleeping; (e) sleep disturbances, such as difficulty breathing or bad dreams; (f) use of sleep medication; and (g) daytime dysfunction, or frequency/severity of problems such as trouble staying awake. Subscale scores ($\alpha=.74$) were combined to create a ‘sleep disturbance’ total score (range 0–21), which was used in analyses. Scores greater than 5 demonstrate good sensitivity and specificity in distinguishing poor sleepers from good sleepers (Buysse et al., 1989).

PTSD intrusions.—The Traumatic Intrusions subscale (IDAS-TI) of the Inventory of Depression and Anxiety Symptoms scale (Watson et al., 2007) was used to assess intrusive thoughts about trauma. Participants indicated the extent to which they experienced four traumatic symptoms (e.g., “I got upset thinking about something bad that happened”) in the past two weeks on a scale from 1 (*not at all*) to 5 (*extremely*). This subscale demonstrates

strong convergent and discriminant validity in predicting PTSD assessed using clinical interview (Watson et al., 2008). Items demonstrated good internal consistency at all assessments ($\alpha=.86-.89$).

Participants also completed the Clinician Administered PTSD Scale (Blake et al., 1995) with a trained research assistant. This measure was used to diagnose PTSD but could not be used to generate a symptom count because a skip-out assessment pattern was used to reduce participant burden (e.g., numbing symptoms were only assessed if the participant endorsed a sufficient number of avoidance symptoms). For descriptive purposes, the number of participants who met DSM-IV criteria for past-month PTSD is depicted in Table 1.

Data Screening and Analysis Plan

Analyses were conducted in *Mplus* version 8. Data for our outcome variable (12-month alcohol problems) were zero-inflated and over-dispersed; therefore, a zero-inflated mixed model with a negative binomial distribution (ZINB) was used (Atkins et al., 2013, Hu et al., 2011). ZINB models simultaneously evaluate two different distributions of data. The logistic portion of the model estimates a binary outcome (likelihood of being an excess zero; i.e., not experiencing alcohol problems). The count portion of the model estimates a count/continuous outcome (number of alcohol problems), including only the proportion of zeros that would be expected in a negative binomial distribution with the given sample mean and variance. Analyses utilized maximum likelihood estimation with standard errors that are robust to non-normality. Full maximum likelihood estimation was used to model missing data (Muthén and Muthén, 2017).

Mediation was tested using bootstrapped joint significance tests for indirect effects (MacKinnon et al., 2004). Briefly, mediation analysis involves examining associations between the independent variable and mediator (*a*-path); the mediator and outcome, controlling for the independent variable (*b*-path); the independent variable and outcome (*c*-path); and the independent variable and outcome, controlling for the mediator (*c'*-path; see Figure 1). We first examined the indirect effect of baseline PTSD intrusions on 12-month alcohol problems through 6-month sleep disturbance. We then examined a competing model: the indirect effect of baseline sleep disturbance on 12-month alcohol problems through 6-month PTSD intrusions. Analyses controlled for past-year cannabis use at baseline (*yes/no*) and baseline drinks consumed per week. Bivariate correlations among study variables are depicted in Table 3, and standardized effects and fit statistics for each model are presented in Table 4.

Results

Baseline Demographics

Participants were Veterans of the Iraq/Afghanistan era who reported a lifetime history of cannabis use and alcohol use in the past 6 months. As depicted in Table 1, 70 participants (22%) met criteria for a moderate to severe alcohol use disorder at baseline and 21 (6%) met criteria for a moderate to severe cannabis use disorder. Sixty participants reported combat

experience, with 40 (12%) meeting criteria for current (past month) PTSD. Three out of four participants (76%) screened positive for sleep disturbance at baseline.

Sleep Disturbance as Mediator

The total effect (*c*-path) of baseline PTSD diagnosis on alcohol-related problems was significant when examining number of alcohol problems experienced at 12 months, but not likelihood of experiencing alcohol problems at 12 months (see Table 4). Baseline PTSD intrusions were positively associated with 6-month sleep disturbance (*a*-path; $\beta=0.40$, $SE=0.05$, $p<.001$); however, 6-month sleep disturbance was not associated with likelihood or number of alcohol problems at 12 months (*b*-path; see Table 4). In the logistic portion of the model, there was no direct (*c'*-path) or indirect (mediated) effect of PTSD intrusions on likelihood of alcohol problems. In the count portion of the model, there was a direct (*c'*-path) effect of baseline PTSD intrusions on number of alcohol problems at 12 months, with no indirect effect through 6-month sleep disturbance.

PTSD Intrusions as Mediator

The total effect (*c*-path) of baseline sleep disturbance on alcohol-related problems was also significant in the count but not logistic portion of the model (see Table 4). Baseline sleep disturbance was positively associated with 6-month PTSD intrusions (*a*-path; $\beta=0.41$, $SE=0.05$, $p<.001$). In turn, 6-month PTSD intrusions were positively associated with number but not likelihood of alcohol-related problems at 12 months (*b*-path; see Table 4). There was no direct (*c'*-path) or indirect effect of sleep disturbance on likelihood of alcohol problems. However, baseline sleep disturbance had an indirect (mediated) effect on number of 12-month alcohol problems through 6-month PTSD intrusions (see Table 4).

Discussion

Separate lines of research have documented associations between PTSD and alcohol problems, sleep and alcohol problems, and PTSD and sleep. This study extends this research by documenting the interplay of sleep and PTSD intrusions in predicting alcohol-related problems over time. PTSD intrusions at baseline were associated with more alcohol problems at 12 months, regardless of sleep disturbance. In contrast, sleep was associated with alcohol problems through its influence on PTSD intrusions. Specifically, sleep disturbance at baseline was associated with more intrusive thoughts about trauma at 6 months, which in turn were associated with more alcohol problems at 12 months. Thus, PTSD intrusions account in part for the longitudinal association between sleep and alcohol problems among Veterans. Because all models controlled for typical alcohol consumption, none of these associations can be attributed to drinking quantity.

Given the wealth of research linking PTSD symptoms to alcohol use and related problems (Miller et al., 2017b, Gaher et al., 2014), the direct effect of PTSD intrusions on alcohol problems was expected. However, the finding that sleep disturbance failed to account for this association was surprising. Instead, intrusive thoughts about trauma helped explain the association between sleep disturbance and alcohol-related problems. Sleep deprivation and disturbance have been linked to impairments in executive functioning and emotional

reactivity (Baglioni et al., 2010, Nilsson et al., 2005), which in turn have been linked to alcohol use and related problems (Berking et al., 2011, Witkiewitz et al., 2015). Thus, we speculate that sleep-related impairments in cognitive/emotional functioning may lead to difficulty managing thoughts of PTSD, further compounding risk for alcohol-related problems.

Beyond their respective associations with alcohol-related problems, there was also a bidirectional association between sleep disturbance and PTSD intrusions in this sample. Specifically, baseline PTSD intrusions were associated with 6-month sleep disturbance, and baseline sleep disturbance was associated with 6-month PTSD intrusions. Although the temporal ordering of data in this study is a strength, the relative onset of PTSD versus sleep disturbance is unclear. For example, it is possible that baseline sleep disturbance was the result of trauma experienced prior to baseline. Without examining PTSD symptoms in individuals who are free from sleep disturbance at baseline (or vice versa), the true directionality of these associations cannot be determined. Research examining changes in sleep or PTSD symptoms among individuals who have not yet developed symptoms of the other disorder may help disentangle the bidirectionality of these constructs. Alternatively, daily diary or ecological momentary assessment studies may help characterize the extent to which these constructs fluctuate or interact with one another.

The prevalence and negative impact of sleep disturbance among Veterans warrants increased efforts to address sleep disturbance when treating comorbid conditions. Behavioral treatments for PTSD-related sleep disturbance have been associated with improvements in sleep quality, nightmares, and PTSD symptom severity (Germain et al., 2007, Margolies et al., 2013). Moreover, veterans report greater willingness to seek treatment for sleep than PTSD (Gutner et al., 2018). Thus, providers are encouraged to include sleep as a treatment target among patients with comorbid symptoms of PTSD. However, data from the current study suggest that sleep disturbance is associated with alcohol problems due in part to its association with intrusive thoughts about trauma. The association between sleep disturbance and intrusive thoughts is not novel, as cognitive arousal is conceptualized as a perpetuating factor in insomnia disorder (Harvey, 2005, Spielman, 1987). Nevertheless, the idea that sleep disturbance may influence intrusive thoughts about trauma extends previous studies indicating that this cognitive arousal process is not specific to thoughts about sleep. Indeed, several studies have documented associations between trauma- or stress-related intrusive thoughts and sleep disturbance (Kliewer and Lepore, 2015, Hall et al., 2000, Wright et al., 2010). Based on these findings, the cognitive component of therapy for insomnia (Harvey et al., 2014) may be particularly important among patients with comorbid PTSD and alcohol use disorders.

This study examined novel paths to alcohol problems using a longitudinal research design. However, there were limitations. Data were collected from primarily White, male veterans who reported a lifetime history of cannabis use. Approximately 62% of returning veterans report a lifetime history of cannabis use, with higher incidence rates (68%) among those with PTSD (Grant et al., 2016). Given these prevalence rates, findings are generalizable to a large number of returning U.S. veterans. That being said, research examining these longitudinal associations in more diverse samples, particularly women and non-White

Veterans, is needed. The timeframe for assessments also varied across measures; for example, participants were queried on sleep disturbance over a one-month period and PTSD intrusions over a 2-week period. Given this inconsistency and the relatively long durations of time between assessments (6 months), studies examining day-to-day associations among variables are needed to determine if variables fluctuate in sync with one another. Because concurrent associations between variables (e.g., 12mo sleep problems to 12mo alcohol problems) were stronger than the lagged associations (6mo sleep problems to 12mo alcohol problems), studies may also examine the growth or decay of these associations over time. Similarly, the PSQI measures a variety of sleep disturbances (e.g., insomnia, nightmares, pain), some of which may be more strongly associated with intrusive thoughts and alcohol-related problems than others. Thus, future research may examine the specific aspects of sleep disturbance that drive these associations. Finally, data reflect longitudinal associations but do not establish causal effects. Randomized trials designed to manipulate PTSD/sleep are needed to determine if either PTSD intrusions or sleep cause change in alcohol-related problems (Kazdin, 2007).

Data from the current study suggest that the prospective association between sleep and alcohol-related problems is due in part to its association with intrusive thoughts about trauma. Given the negative impact of sleep disturbance on health outcomes and veterans' willingness to seek treatment for sleep over treatment for other mental health disorders, sleep may be an important treatment target for veterans presenting with comorbid symptoms of PTSD and alcohol use disorder. In particular, the association between sleep and intrusive thoughts about trauma may inform clinical practice. Research examining the causal associations between sleep, PTSD, and alcohol problems in diverse samples is warranted.

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Figure 1 Panel A

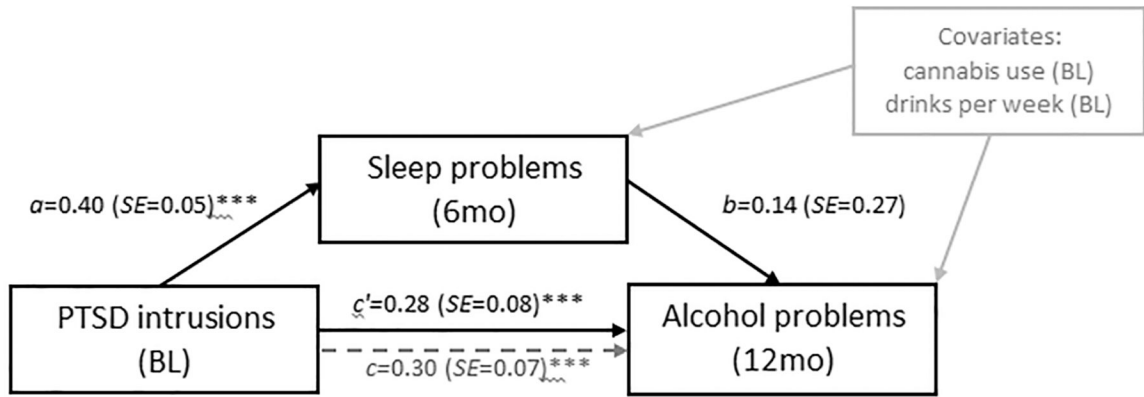


Figure 1 Panel B

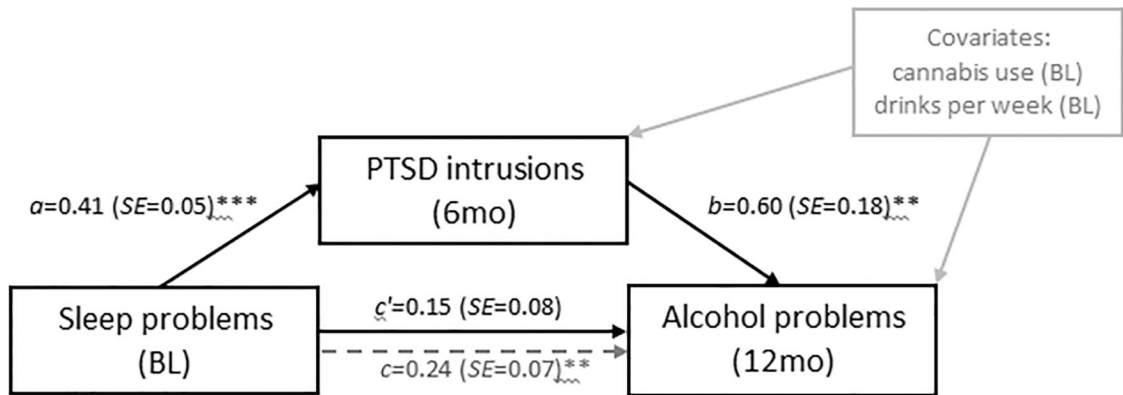


Figure 1. Standardized estimates for models examining sleep disturbance as a mediator of the association between PTSD intrusions and alcohol problems (panel A) and PTSD intrusions as a mediator of the association between sleep disturbance and number of alcohol problems (panel B).

Table 1

Baseline demographics (N=325).

Age in years, <i>M</i> (<i>SD</i>)	33.3 (9.4)
Male, <i>n</i> (%)	303 (93%)
Race/Ethnicity, <i>n</i> (%)	---
Asian American	5 (2%)
Black/African American	14 (4%)
Multiracial	15 (5%)
Native American or Native Alaskan	1 (<1%)
Native Hawaiian or Pacific Islander	2 (<1%)
Not reported	2 (<1%)
Other	24 (7%)
White/Caucasian	262 (81%)
Married, <i>n</i> (%)	130 (40%)
Experienced combat, <i>n</i> (%)	60 (88%)
Number of combat experiences, <i>M</i> (<i>SD</i>)	5.2 (3.9)
PTSD diagnosis, current (CAPS)	40 (12%)
Alcohol use disorder, current (SCID)	111 (34%)
Mild (2–3 symptoms)	41 (13%)
Moderate (4–5 symptoms)	29 (9%)
Severe (6+ symptoms)	41 (13%)
Cannabis use disorder, current (SCID)	48 (15%)
Mild (2–3 symptoms)	27 (8%)
Moderate (4–5 symptoms)	11 (3%)
Severe (6+ symptoms)	10 (3%)

Table 2

Variables at each assessment.

	Baseline (N=325)	6 months (n=283)	12 months (n=282)
Alcohol use in past 6mo, <i>n</i> (%)	325 (100%)	266 (94%)	264 (94%)
Drinks per week, <i>M</i> (<i>SD</i>)	9.3 (12.3)	9.4 (13.9)	9.5 (15.0)
Cannabis use in the past year, <i>n</i> (%)	132 (40.6%)	---	---
% cannabis use days in past 6mo, <i>M</i> (<i>SD</i>)	16.0 (32.4)	16.2 (33.2)	16.4 (32.7)
IDAS-TI PTSD intrusions, <i>M</i> (<i>SD</i>)	8.3 (4.1)	7.4 (3.5)	7.3 (3.6)
Positive screen for sleep disturbance, <i>n</i> (%)	246 (76%)	216 (77%)	206 (74%)
Number of sleep disturbance, <i>M</i> (<i>SD</i>)	9.0 (4.1)	8.8 (3.9)	8.4 (3.8)
Reported alcohol problems, <i>n</i> (%)	150 (46%)	135 (48%)	120 (43%)
Number of alcohol problems, <i>M</i> (<i>SD</i>)	2.5 (4.9)	2.9 (5.1)	1.9 (3.3)

Note. IDAS-TI = Inventory of Depression and Anxiety Symptoms Traumatic Intrusions subscale.

Table 3

Zero-order correlations among variables (N=325).

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Drinks per week (BL)	---										
2. Cannabis use (BL)	0.07	---									
3. Sleep disturbance (BL)	0.07	0.18*	---								
4. Sleep disturbance (6mo)	0.06	0.15*	0.68*	---							
5. Sleep disturbance (12mo)	0.10	0.16*	0.69*	0.70*	---						
6. PTSD intrusions (BL)	0.12*	0.23*	0.47*	0.41*	0.41*	---					
7. PTSD intrusions (6mo)	0.13*	0.18*	0.39*	0.45*	0.42*	0.72*	---				
8. PTSD intrusion (12mo)	0.13*	0.14*	0.38*	0.44*	0.47*	0.68*	0.70*	---			
9. No. alcohol problems (BL)	0.36*	0.05	0.27*	0.23*	0.26*	0.33*	0.24*	0.24*	---		
10. No. alcohol problems (6mo)	0.35*	0.06	0.22*	0.25*	0.18*	0.34*	0.30*	0.25*	0.61*	---	
11. No. alcohol problems (12mo)	0.36*	-0.01	0.18*	0.13*	0.22*	0.23*	0.26*	0.16*	0.46*	0.62*	---
12. Y/N alcohol problems (12mo)	0.33*	0.07	0.15*	0.08	0.10	0.16*	0.16*	0.12	0.28*	0.39*	0.66*

Note.

* $p < .05$. BL = baseline. Mo = months. PTSD = posttraumatic stress disorder. Y/N = yes/no.

Table 4

Standardized effects of variables predicting 12-month alcohol problems (N=325).

	Likelihood of NOT Having Alcohol Problems at 12mo			Number of Alcohol Problems at 12mo		
	β	β_{SE}	<i>p</i>	β	β_{SE}	<i>p</i>
Intrusions > Sleep > Alcohol Problems						
Intercept	0.19	0.10	.05	-0.26	0.73	.73
BL cannabis use	-0.04	0.04	.26	-0.35	0.22	.11
BL drinks per week	-0.98	0.02	<.001	0.52	0.16	.001
BL PTSD intrusions	0.01	0.04	.80	0.76	0.17	<.001
6mo sleep disturbance (<i>b</i> -path)	-0.001	0.04	.98	0.14	0.27	.61
Total direct effect (<i>c'</i> -path)	0.01	0.04	.80	0.28	0.08	<.001
Total indirect (mediated) effect	<.001	0.02	.98	0.02	0.04	.62
Total effect (<i>c</i> -path)	0.01	0.04	.80	0.30	0.07	<.001
AIC	2620.25					
BIC	2673.22					
Sleep > Intrusions > Alcohol Problems						
Intercept	0.22	0.10	.03	-0.63	0.62	.31
BL cannabis use	-0.04	0.03	.25	-0.33	0.21	.12
BL drinks per week	-0.98	0.02	<.001	0.49	0.14	.001
BL sleep disturbance	0.01	0.03	.77	0.40	0.19	.03
6mo PTSD intrusions (<i>b</i> -path)	-0.02	0.03	.53	0.60	0.18	.001
Total direct effect (<i>c'</i> -path)	0.01	0.03	.77	0.15	0.08	.05
Total indirect (mediated) effect	-0.01	0.01	.53	0.09	0.03	.01
Total effect (<i>c</i> -path)	0.002	0.03	.94	0.24	0.07	.001
AIC	2548.31					
BIC	2601.28					

Note. AIC=Akaike Information Criterion. BIC=Bayesian Information Criterion.