

POSTTRAUMATIC STRESS, ALCOHOL USE, AND ALCOHOL USE MOTIVES IN  
FIREFIGHTERS: THE ROLE OF SLEEP DISTURBANCE

---

A Thesis

Presented to

The Faculty of the Department

of Psychology

University of Houston

---

In Partial Fulfillment

Of the Requirements for the Degree of

Master of Arts

---

By

Lia J. Smith

May, 2018

POSTTRAUMATIC STRESS, ALCOHOL USE, AND ALCOHOL USE MOTIVES IN  
FIREFIGHTERS: THE ROLE OF SLEEP DISTURBANCE

---

Lia J. Smith, B.A.

**APPROVED:**

---

Anka A. Vujanovic, Ph.D.  
Committee Chair  
Department of Psychology  
University of Houston

---

Matthew W. Gallagher, Ph.D.  
Department of Psychology  
University of Houston

---

Jana K. Tran, Ph.D.  
Firefighter Support Network  
Houston Fire Department

---

Antonio D. Tillis, Ph.D.  
Dean, College of Liberal Arts and Social Sciences  
Department of Hispanic Studies

POSTTRAUMATIC STRESS, ALCOHOL USE, AND ALCOHOL USE MOTIVES IN  
FIREFIGHTERS: THE ROLE OF SLEEP DISTURBANCE

---

An Abstract of a Thesis

Presented to

The Faculty of the Department

of Psychology

University of Houston

---

In Partial Fulfillment

Of the Requirements for the Degree of

Master of Arts

---

By

Lia J. Smith

May, 2018

## ABSTRACT

Firefighters are at an elevated risk for posttraumatic stress symptomatology and alcohol use, with research demonstrating that individuals with posttraumatic stress may be more likely to use alcohol as a coping strategy. A behavioral mechanism of great clinical relevance to these associations is sleep disturbance. Thus, the current study examined associations among posttraumatic stress symptom severity, sleep disturbance, and alcohol use severity and alcohol use motives in a sample of 639 urban firefighters (93.6% male;  $M_{\text{age}} = 38.5$ ,  $SD = 8.6$ ). Structural equation modeling was employed to examine the study hypotheses, including: 1) posttraumatic stress symptom severity will predict alcohol use severity and alcohol use coping motives; 2) sleep disturbance will predict alcohol use severity and alcohol use coping motives; and 3) the interactive effect of posttraumatic stress symptom severity and sleep disturbance will predict alcohol use severity and alcohol use coping motives. These effects were not anticipated for other alcohol use motives (i.e., conformity, enhancement, social), and all effects were expected above and beyond the theoretically-relevant covariates of years in the fire department and occupational stress. Results demonstrated that posttraumatic stress symptom severity and sleep disturbance severity were significantly, positively associated with alcohol use severity and alcohol use motives. After accounting for covariates and main effects, the interaction of posttraumatic stress symptom severity and sleep disturbance was a significant predictor of alcohol use severity and alcohol use coping motives, but not other alcohol use motives. Clinical and research implications are discussed.

**TABLE OF CONTENTS**

**INTRODUCTION**.....4  
Alcohol Use and Alcohol Use Motives among Firefighters.....4  
Posttraumatic Stress Symptoms and Alcohol Use and Motives .....7  
Posttraumatic Stress Symptomatology and Sleep Disturbance .....9  
Sleep Disturbance and Alcohol Use .....11  
Theoretical Model.....13  
Limitations of Previous Research .....14  
Present Study Aims and Hypotheses .....16  
**METHOD** .....17  
Participants.....17  
Measures .....18  
Procedures.....24  
Data Analytic Plan .....25  
**RESULTS** .....26  
Descriptive Statistics and Bivariate Correlations .....26  
Measurement Model of Latent Variables .....27  
Base Associations of Covariates with Alcohol Use Outcomes .....28  
Main Effects of Posttraumatic Stress Symptom Severity and Sleep Disturbance on  
Alcohol Use Outcomes .....28  
Interactive Effect of Posttraumatic Stress Symptom Severity and Sleep Disturbance on  
Alcohol Use Outcomes .....29  
**DISCUSSION** .....30  
Posttraumatic Stress – Alcohol Use and Motives: Main Effects .....30  
Sleep Disturbance – Alcohol Use and Motives: Main Effects .....32  
Interactive Effects .....34  
Bivariate Associations .....37  
Additional Findings .....38  
Limitations .....39  
Empirical Contributions.....40  
Conclusions.....41  
**REFERENCES**.....42  
**TABLES**.....65  
**FIGURES**.....70

## LIST OF TABLES

<b>TABLES</b> .....	65
Table 1. Participant Characteristics .....	65
Table 2. Descriptive statistics and bivariate correlations for study variables (n=639) .....	67
Table 3. Descriptive statistics and bivariate correlations for indicator variables (n=639) .....	68
Table 4. Structural model unstandardized parameter estimates predicting alcohol use outcomes .....	69
<b>FIGURES</b> .....	70
Figure 1. Theoretical Model .....	70
Figure 2. Measurement model with standardized factor loadings .....	71
Figure 3. Interaction of PTSD symptom severity with sleep disturbance in predicting alcohol use severity.....	73
Figure 4. Interaction of PTSD symptom severity with sleep disturbance in predicting coping use motives.....	73
Figure 5. Interactive path analysis model utilizing the standardized effects .....	74

## **Introduction**

### **Alcohol Use and Alcohol Use Motives among Firefighters**

Firefighters are a particularly vulnerable population with regard to alcohol misuse and alcohol use disorder (AUD; Boxer & Wild, 1993; Carey, Al-Zaiti, Dean, Sessanna, & Finnell, 2011; Haddock et al., 2012; Jones, 2017; North, Tivis, McMillen, Pfefferbaum, Spitznagel, et al., 2002; Tomaka, Magoc, Morales-Monks, & Reyes, 2017).

Approximately 50% of firefighters report excessive alcohol use (Haddock, Day, Poston, Jahnke, & Jitnarin, 2015), and one-third report heavy episodic drinking (Carey et al., 2011; Haddock et al., 2015; Piazza-Gardner et al., 2014). Research has indicated that elevated levels of problematic alcohol use (measured via self-report) are particularly concerning among career versus volunteer firefighters (Haddock et al., 2012; Stanley, Boffa, Hom, Kimbrel, & Joiner, 2017). Overall, lifetime AUD prevalence rates of approximately 47% have been documented among firefighters (North, Tivis, McMillen, Pfefferbaum, Spitznagel, et al., 2002), and available longitudinal work indicates that alcohol consumption among firefighters may be relatively stable over time (e.g. Murphy, Beaton, Pike, & Johnson, 1999). These rates of lifetime AUD are significantly higher than the 29.1% lifetime AUD prevalence documented in the general population (Grant et al., 2015). The significant prevalence of AUD among firefighters underscores the importance of better understanding motivations for alcohol use among this unique population so as to inform intervention efforts.

Theoretically, motivations for alcohol use rest upon two foundational premises. First, individuals consume alcohol in order to attain certain valued outcomes, such as achieving peer approval (e.g. Cox & Klinger, 1988). Second, drinking behavior is

motivated by different needs or serves various functions characterized by unique patterns of antecedents and consequences (e.g. Cutter & O'Farrell, 1984). Specifically, approach-oriented alcohol use motives include social motives (i.e., drinking to obtain social rewards, such as bonding with others or improving social gatherings) and enhancement motives (i.e., drinking to enhance positive mood or wellbeing; Cooper, Kuntsche, Levitt, Barbar, & Wolf, 2016). Avoidance-oriented alcohol use motives, on the other hand, include coping motives (i.e., drinking to reduce or regulate negative emotions) and conformity motives (i.e., drinking to avoid social censure or rejection; Cooper et al., 2016). Although approach-oriented alcohol use motives are generally more likely to be endorsed (e.g., Cooper et al., 2016; Cooper, Russel, Skinner, & Windel, 1992; Crutzen & Kuntsche, 2013), drinking motivated by internal avoidance goals (i.e., coping motives) has been consistently linked to drinking problems, including AUD, in longitudinal and prospective studies where assessment of motives clearly preceded alcohol outcomes in time (e.g., Beseler, Aharonovich, Keyes, & Hasin, 2008; Cooper et al., 2008; Holahan, Moos, Holahan, Cronkite, & Randall, 2001; Richman, Flaherty, & Pyskoty, 1992). Drinking driven by coping motives is often theorized as an effort to regulate negative mood states and has been identified as a strategy to cope with stress or other negative emotions (Todd, 2005). Accordingly, individuals who chronically use alcohol to cope may do so because they lack other more adaptive ways to regulate their emotions (Cooper et al., 2016). For instance, alcohol use coping motives have been positively linked to drinking at home and drinking alone and negatively linked to drinking in social or celebratory situations (Cooper, 1994; Cooper, Russel, Skinner, & Windel, 1992; Kuntsche, Knibbe, Engels, & Gmel, 2010).



Research regarding alcohol use motives within first responder populations has focused primarily on police officers; but the literature is scant and limited by methodological concerns, such as single-item measurement of coping (i.e., "When you feel worried, anxious, tense or nervous, do you sometimes drink alcohol to better manage the situation?"; Sterud, Hem, Ekeberg, & Lau, 2007). Nevertheless, this work among police officers demonstrates that stress and alcohol use are positively associated (Dietrich & Smith, 1986; Violanti, Marshall, & Howe, 1985), and drinking to cope with stress is related to increased alcohol consumption (Burke, 1993) and alcohol use problems (Sterud et al., 2007). Further, this work has highlighted the need for specialized alcohol misuse/AUD intervention programs for police officers to target coping-oriented alcohol use (Smith, Devine, Leggat, & Ishitake, 2005). With regard to firefighters, specifically, there are only three studies to date that have explicitly examined motivations for alcohol use. A large study of 1,481 firefighters suggests that firefighters are more likely to endorse using alcohol to cope with distress in situations of low overall within-unit social support (Bacharach, Bamberger, & Doveh, 2008). Second, a study examining 740 municipal firefighters found that alcohol use coping motives and drinking to cope mediated associations between posttraumatic stress symptoms and problem drinking (Tomaka et al., 2017). Third, a study of 181 firefighters, who responded to the 1995 Oklahoma City bombing, found that alcohol use was one of the most frequently reported coping strategies for managing upsetting and negative emotions after the bombing. Furthermore, this study demonstrated that workers with post-disaster AUD reported lower satisfaction with work performance and overall job satisfaction, compared to those without post-disaster AUD (North, Tivis, McMillen, Pfefferbaum, Cox, et al., 2002).

Overall, the literature on alcohol use motives among firefighters suggests that firefighters may be using alcohol to cope with the various and unique stressors that they encounter. Thus, given the substantial prevalence of alcohol misuse and AUD among firefighters, it is imperative to better understand psychological processes related to alcohol use and alcohol use motives within this vulnerable population.

### **Posttraumatic Stress Symptoms and Alcohol Use and Motives**

Posttraumatic stress symptomatology provides one important avenue for better understanding alcohol use and alcohol use motives among firefighters. Indeed, firefighters are at elevated risk for exposure to traumatic events as well as the development of posttraumatic stress symptomatology (e.g., Beaton & Murphy, 1993; Jones, 2017; Lee, Lee, Kim, Jeon, & Sim, 2017; McFarlane & Papay, 1992), which is a significant risk and maintenance factor for AUD (Bremner, Southwick, Darnell, & Charney, 1996; Breslau, Davis, Andreski, & Peterson, 1991; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995; Stewart, Pihl, Conrod, & Dongier, 1998). Trauma exposure among firefighters has been estimated to be 91.5%, with nearly one-third reporting three or more lifetime traumatic events (Meyer et al., 2012). Moreover, the estimated prevalence of posttraumatic stress disorder (PTSD) in firefighters may be as high as 22.2% (Corneil, Beaton, Murphy, Johnson, & Pike, 1999). Many more firefighters may suffer from subclinical posttraumatic stress symptoms, which are associated with similar levels of impairment as observed in those with PTSD (Bergman, Przeworski, & Feeny, 2016; Pietrzak, Goldstein, Southwick, & Grant, 2011a, 2011b; Zlotnick, Franklin, & Zimmerman, 2002). The comorbidity of PTSD and AUD is prevalent, complex, and difficult to treat (McCauley, Killeen, Gros, Brady, & Back, 2012). In fact, PTSD-AUD

comorbidity has been well-documented among the general population (Grant et al., 2015; Kessler, Chiu, Demler, & Walters, 2005) and military veterans (Fuehrlein et al., 2016; McCauley et al., 2012; Milliken, Auchterlonie, & Hoge, 2007), with emerging work suggesting that this comorbidity is also of particular concern within firefighter populations (e.g. Arbona, Fan, & Noor, 2016; Arbona & Schwartz, 2016; Harvey et al., 2016; Paulus, Vujanovic, Schuhmann, Smith, & Tran, 2017; Tomaka et al., 2017).

A leading explanatory model for the association between posttraumatic stress symptomatology and alcohol misuse is the self-medication model of comorbidity, which suggests that individuals with posttraumatic stress symptomatology are at a heightened risk for alcohol misuse and AUD due to a tendency to use alcohol as a means of coping with negative affect (Khantzian, 1999; Simpson, Stappenbeck, Luterek, Lehavot, & Kaysen, 2014). In support of this model, research has demonstrated that individuals with, compared to those without, posttraumatic stress symptomatology are more likely to use alcohol as a coping strategy, generally, or to specifically cope with symptoms of posttraumatic stress (Simpson et al., 2014; Waldrop, Back, Verduin, & Brady, 2007). In addition, coping-oriented alcohol use has been shown to partially mediate the association between posttraumatic stress symptoms and increased alcohol consumption among the general population (O'Hare & Sherrer, 2011; Yeater, Austin, Green, & Smith, 2010), and among firefighters (Tomaka et al., 2017), specifically. Results of daily monitoring studies, for example, have supported associations between increased posttraumatic stress symptom severity and negative mood with increases in alcohol consumption, particularly among those individuals endorsing high levels of coping motives for alcohol use (Dvorak, Pearson, & Day, 2014; Simpson et al., 2014). To illustrate, for individuals

scoring higher on alcohol use coping motives, a one standard deviation increase in posttraumatic stress symptom severity has been associated with a 37% increase in the amount of alcohol consumed the same day (Simpson et al., 2014). However, among individuals in this same study who scored low on alcohol use coping motives, a one standard deviation increase in posttraumatic stress symptom severity was associated with only a 10% increase in alcohol consumption (Simpson et al., 2014). Finally, within this same study, individuals with elevated posttraumatic stress symptoms were more likely to exhibit greater alcohol use on that same day and on the following day, while drinking did not predict next-day posttraumatic stress symptoms (Simpson et al., 2014). Overall, alcohol use among trauma-exposed individuals with posttraumatic stress symptoms may be a means by which to cope with psychological distress. In fact, recent research has demonstrated a significant positive linear relationship between the number of fatal incidents attended and rates of PTSD and heavy drinking among current and retired firefighters (Harvey et al., 2016). Thus, as trauma exposure and posttraumatic stress symptomatology are common among firefighters, posttraumatic stress symptom severity is likely to be significantly related to alcohol use and alcohol use coping motives in this vulnerable population. Given the complexity of this comorbidity, it is important to better understand potential behavioral processes that may be related to these associations between posttraumatic stress symptom severity and alcohol use and coping motives in firefighters.

### **Posttraumatic Stress Symptomatology and Sleep Disturbance**

A behavioral mechanism of great clinical relevance to the associations between posttraumatic stress and alcohol use as well as alcohol use coping motives in firefighters

is sleep disturbance, which refers to both quantitative (e.g., sleep duration, sleep latency, and number of arousals) and qualitative (e.g., depth and restfulness) aspects of sleep (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). In fact, nightmares and insomnia represent two core symptoms of PTSD (APA, 2013), and up to 70% of PTSD populations have reported associated sleep disturbances (Ohayon & Shapiro, 2000). Subclinical PTSD symptoms have also been associated with increased sleep disturbance (McCubbin et al., 2016). Furthermore, increased sleep disturbance among individuals with posttraumatic stress symptoms has been associated with symptoms such as increased latency to sleep onset, disrupted sleep, early morning awakening, sleep paralysis, sleep talking, nightmares, violent or dangerous behaviors during sleep, and hallucinations at sleep onset or awakening (Ohayon & Shapiro, 2000). Research has demonstrated that these types of sleep disturbances act as both risk (e.g., Gehrman et al., 2013; Germain, 2013; Mellman, David, Kulick-Bell, Hebding, & Nolan, 1995; Pace-Schott, Germain, & Milad, 2015) and maintenance factors for PTSD (e.g., Germain, 2013; Pace-Schott et al., 2015). Moreover, a growing body of evidence shows that sleep disturbance may be a core feature, rather than simply a secondary symptom, of PTSD (Germain, 2013; Ross, Ball, Sullivan, & Caroff, 1989; Spoormaker & Montgomery, 2008).

First responders, particularly firefighters, represent a unique population characterized by high levels of work demands requiring frequent sleep disturbances and long shifts (Beaton & Murphy, 1993; Harvey et al., 2016; Haugen, Evces, & Weiss, 2012). Preliminary estimates among firefighters suggest prevalence rates of 51-59% for sleep-related disturbances (Carey et al., 2011; Vargas de Barros, Martins, Saitz, Bastos, & Ronzani, 2013), which are significantly higher than the prevalence rates of 6-33% for

sleep disturbance within the general population (Ohayon, 2002). However, few published studies have examined relations between posttraumatic stress and sleep disturbances in first responders. Internationally, research has shown that among fire service workers in the United Kingdom (N = 31), sleep disturbance is one of the most commonly reported posttraumatic stress symptoms (Haslam & Mallon, 2003). Research among Korean firefighters (N = 515) found that those with an evening chronotype (i.e., propensity to go to bed extremely late) reported increased depression, alcohol use, posttraumatic stress symptoms, stress responsivity, and sleep disturbance than those firefighters with a morning chronotype (i.e., propensity to rise extremely early; Yun, Ahn, Jeong, Joo, & Choi, 2015). In disaster-exposed firefighters and police officers, sleep disturbances have been related to higher cortisol levels (Witteveen et al., 2010) and a case study of a 42-year-old firefighter demonstrated how early-career shift work-related insomnia transformed to severe insomnia with nightmares in the context of later-career posttraumatic stress disorder (Coupland, 2009). Finally, the experience of early (i.e., childhood and adolescent) physical victimization has been found to be associated with increased posttraumatic stress symptom severity and sleep problems (via self-report measure of insomnia) among firefighters and police officers responding to Hurricane Katrina, as compared to first responders who had not experienced early physical victimization (Komarovskaya et al., 2014).

### **Sleep Disturbance and Alcohol Use**

The association between sleep disturbance and alcohol use is bidirectional, with sleep disturbances (particularly insomnia) consistently predictive of alcohol use and AUD (Taylor, Lichstein, & Durrence, 2003; Wong, Brower, Fitzgerald, & Zucker, 2004), and

alcohol use consistently related to increased risk for sleep disturbance (e.g., changes in sleep pattern, poorer sleep quality, daytime sleepiness; Colrain, Nicholas, & Baker, 2014; Mahfoud, Talih, Stroom, & Budur, 2009; Roehrs & Roth, 2001). Indeed, the prevalence of sleep problems has been reported to be high as high as 72% among individuals with AUD (Foster, Marshall, & Peters, 1998). Furthermore, sleep disturbance, measured via polysomnography and subjective measures, has been shown to be predictive of post-treatment relapse to alcohol use among alcohol dependent individuals (Brower, Aldrich, & Hall, 1998). In addition, increased sleep latency is a significant predictor of alcohol relapse among alcohol dependent individuals (Foster et al., 1998). Alcohol problem severity (measured via self-report) has also been shown to explain a significant amount of variance in sleep disturbance, above and beyond demographic, mood, and smoking variables, among self-reported problem drinkers who consumed greater than 48 drinks per month (Hartwell, Bujarski, Glasner-Edwards, & Ray, 2015). Furthermore, the intention to use alcohol in order to mitigate sleep difficulties is commonly cited as a reason that individuals initiate and continue regular alcohol use (Johnson, Roehrs, Roth, & Breslau, 1998). However, alcohol use has been found to actually worsen sleep quality, particularly when consumed in relatively large quantities or over long durations (Colrain et al., 2014). Among firefighters, research has demonstrated positive bivariate correlations between alcohol use and sleep disturbance (Carey et al., 2011; Vargas de Barros et al., 2013; Yun et al., 2015). However, there are no studies to date that have examined relations between sleep disturbance and alcohol use coping motives among firefighters or first responders, in general. This underscores the importance of advancing

research to better understand the associations between sleep disturbance and alcohol use and motives for use among firefighters, specifically, and first responders, more generally.

Finally, greater sleep disturbances (such as poorer sleep quality) have been documented among individuals with comorbid PTSD-AUD, as compared to those with PTSD alone (Saladin, Brady, Dansky, & Kilpatrick, 1995; Wild et al., 2016). Insomnia, specifically, has been suggested to be a transdiagnostic process uniquely associated with symptom severity for individuals with comorbid posttraumatic stress symptoms and alcohol misuse (Fairholme et al., 2013). It is therefore important to better understand how sleep disturbance may be related to the associations between posttraumatic stress symptom severity and alcohol use and coping motives in firefighters.

### **Theoretical Model**

Taken together, firefighters with elevated levels of posttraumatic stress symptom severity and/or sleep disturbance are especially likely to endorse high levels of alcohol use (Arbona et al., 2016; Arbona & Schwartz, 2016; Carey et al., 2011; Paulus et al., 2017; Simpson et al., 2014; Stanley et al., 2017; Vargas de Barros et al., 2013). Extant literature has demonstrated that rates of both alcohol misuse/AUD (Jones, 2017; North, Tivis, McMillen, Pfefferbaum, Spitznagel, et al., 2002) and posttraumatic stress symptoms are high among firefighters (Corneil et al., 1999; Jones, 2017; Lee et al., 2017), and posttraumatic stress symptomatology increases the risk of alcohol use (Harvey et al., 2016; Murphy et al., 1999). Firefighters who experience heightened levels of posttraumatic stress symptomatology or greater sleep disturbance also may be more likely to use alcohol to manage stress or negative emotional states or to facilitate sleep initiation (Bacharach et al., 2008; Carey et al., 2011; North, Tivis, McMillen,



Pfefferbaum, Cox, et al., 2002; Vargas de Barros et al., 2013). Thus, heightened sleep disturbance among firefighters with posttraumatic stress symptomatology is a behavioral factor likely to exacerbate the well-established association between posttraumatic stress symptom severity, alcohol use severity and alcohol use coping motives (see Figure 1 for a graphical representation of this theoretical model). Firefighters struggling with elevated posttraumatic stress symptoms and sleep disturbance are thus most likely to endorse high rates of alcohol use and high levels of coping-related motivations to use alcohol. Sleep disturbance may thus moderate – or exacerbate – the association between posttraumatic stress symptomatology and alcohol use and alcohol use coping motives among firefighters.

### **Limitations of Previous Research**

All things considered, there is a relative paucity of research on mental health among firefighters, generally. The sparse extant literature has been largely limited to basic correlational analyses (e.g., Meyer et al., 2012; Murphy et al., 1999) or has focused upon exploring biological (e.g., Witteveen et al., 2010; Wolkow, Ferguson, Aisbett, & Main, 2015; Yun et al., 2015) and occupational outcomes (e.g., Lusa, Häkkänen, Luukkonen, & Viikari-Juntura, 2002; Vincent et al., 2015; Vincent, Aisbett, Hall, & Ferguson, 2016). A small, yet burgeoning, literature has begun to examine mental health outcomes in this highly vulnerable population. First, across US and international samples, there have been less than twenty studies that have examined associations between posttraumatic stress symptomatology and/or trauma exposure and alcohol use among firefighters. This literature therefore represents a relatively nascent area of study in need of greater empirical focus. Second, only two studies to date has examined posttraumatic

stress symptom severity and motives for alcohol use among firefighters (North, Tivis, McMillen, Pfefferbaum, Cox, et al., 2002; Tomaka et al., 2017). In the study by North and colleagues (2002), analyses were restricted to basic between-group and correlational analyses (i.e., student's t-test, chi-square), preventing consideration of covariates. Further, drinking motives were assessed through a single item, past trauma exposure was not assessed, and the extent to which the constructs of posttraumatic stress symptom severity and motives for alcohol use were related was not examined. While the second study by Tomaka and colleagues (2017) utilized more advanced statistical techniques and improved measurement, this study was limited in that it did not assess past trauma exposure or consider relevant psychological covariates for this population, such as occupational stress. This is unfortunate, as a better understanding of motives for alcohol use has great potential to inform intervention development. Third, only seven published studies have examined associations between posttraumatic stress symptomatology and sleep disturbance in firefighters (Coupland, 2009; Haslam & Mallon, 2003; Hom, Stanley, Spencer-Thomas, & Joiner, 2017; Komarovskaya et al., 2014; Straud, Henderson, Vega, Black, & Van Hasselt, 2018; Witteveen et al., 2010; Yun et al., 2015). These studies have largely been limited to basic correlational analyses. Similarly, there are only four published studies that have explored associations between alcohol use and sleep disturbance among firefighters (Carey et al., 2011; Hom et al., 2017; Vargas de Barros et al., 2013; Yun et al., 2015), and these studies have generally been limited to bivariate associations, as well. Extensions of this work are necessary to better characterize posttraumatic stress symptoms within this vulnerable population and to inform targeted intervention and prevention efforts. Finally, no study to date has

evaluated the associations among posttraumatic stress symptom severity, sleep disturbance, and alcohol use and alcohol use motives among firefighters. Only one published empirical study has examined a similar model, which was evaluated among female rape victims with severe posttraumatic stress symptomatology (Nishith, Resick, & Mueser, 2001). This study examined the influence of posttraumatic stress symptoms and sleep difficulties on alcohol use motives. While no associations were observed between posttraumatic stress symptoms and alcohol use motives, disordered sleep (defined via PSQI Component 5 subscale) was associated with coping-oriented alcohol use. Thus, research examining the moderating effect of sleep disturbance on the association between posttraumatic stress symptomatology and alcohol use and alcohol use coping motives is scant, generally, and has yet to be conducted in first responder populations, such as firefighters. This line of work has significant potential to inform our understanding of the processes related to posttraumatic stress symptomatology and alcohol use in firefighters, a vulnerable and understudied population in need of greater clinical attention and specialized intervention approaches.

### **Present Study Aims and Hypothesis**

The current study aimed to extend the current literature through an examination of associations among posttraumatic stress symptom severity, sleep disturbance, and alcohol use severity and alcohol use motives (i.e., coping, enhancement, conformity, social motives) among a large sample of urban firefighters. It was first hypothesized that posttraumatic stress symptom severity would significantly (positively) predict (1) alcohol use severity and (2) alcohol use coping motives. Second, it was hypothesized that sleep disturbance would significantly (positively) predict both alcohol use severity and alcohol

use coping motives. Finally, it was hypothesized that the interactive effect of posttraumatic stress symptom severity and sleep disturbance would significantly predict the outcomes of both alcohol use severity and alcohol use coping motives. Specifically, it was expected that sleep disturbance would significantly moderate, or exacerbate, the association between posttraumatic stress symptom severity and both alcohol use severity and alcohol use coping motives. It was hypothesized that the effect of posttraumatic stress symptom severity on alcohol use severity and alcohol use coping motives would be greater for those with greater sleep difficulties relative to those with lower sleep difficulties among firefighters. The interactive effect was *not expected* to be significant for other alcohol use motives, including social, enhancement, and conformity motives. All effects were expected above and beyond the theoretically-relevant covariates of years in the fire department and occupational stress severity. These covariates were selected due to statistically significant associations with alcohol use outcomes in past work among first responders (e.g., Meyer et al., 2012; Murphy et al., 1999; Paulus et al., 2017; Piazza-Gardner et al., 2014).

## **Method**

### **Participants**

This study was based upon a subset of data from a larger ongoing project examining stress and health-related behaviors among firefighters. Participants were comprised of 639 firefighters. Participants were current full-time firefighters at the Houston Fire Department (HFD). At the time of the current analyses, the study had a 30% response rate. To be included in the study, participants must have: been 18 years of age or older, been current firefighters in the HFD, and consented to participating to the

completion of all online questionnaires. Furthermore, participants must have reported experiencing at least one traumatic life event, according to DSM-5 PTSD Criterion A [American Psychiatric Association (APA), 2013], and reported drinking alcohol on at least a “monthly or less” basis, which was used as a screener to determine ever alcohol use. Exclusionary criteria were comprised of inability or unwillingness to provide informed consent for the completion of the online questionnaires. See Table 1 for a summary of participant characteristics.

## **Measures**

*Demographic Questionnaire.* Participants reported upon sociodemographic characteristics, health and medical information, and fire department service. In the current study, the demographic questionnaire was used to describe the sample, with years of service in the fire department, assessed within the demographics questionnaire, utilized as an observed covariate in the proposed models.

*Life Events Checklist Version-5 (LEC-5; Weathers et al., 2013).* The LEC-5 is a self-report questionnaire that is used to screen for potentially traumatic events experienced at any time throughout the lifespan. Respondents are presented with 16 categories of traumatic stressors (e.g., combat, sexual assault, transportation accident) as well as an additional item assessing for ‘other’ potentially traumatic events not listed. Previous versions of the LEC have been shown to be reliable and valid in a variety of samples (Gray, Litz, Hsu, & Lombardo, 2004). In the current study, respondents were asked to indicate (via check mark) whether each listed event “happened to me, “witnessed it”, “learned about it”, “part of my job”, or “not sure”. The LEC-5 was scored by summing the traumatic event types endorsed as “happened to me”, “witnessed it”, or

“part of my job”. In the current study, the LEC-5 was used to determine trauma exposure, an inclusion criterion for the study.

*PTSD Checklist-Civilian Version-5* (PCL-5; Blevins, Weathers, Davis, Witte, & Domino, 2015). The PCL-5 is a 20-item self-report questionnaire that measures posttraumatic stress symptom severity over the past month. Each of the 20 items reflects a symptom of PTSD according to the *DSM-5*. Respondents were asked to rate each item on a 5-point scale (0 = *Not at all* to 4 = *Extremely*) in regard to the frequency in which they have been bothered by the symptom in the past month (e.g., “In the past month, how much have you been bothered by repeated, disturbing, and unwanted memories of the stressful experience?”). Total symptom severity scores range from 0-80, with higher scores indicating higher symptom severity. The current literature recommends a PTSD diagnostic cut-off score of 33 (e.g., Bovin et al., 2016). The PCL-5 has demonstrated strong internal consistency ( $\alpha = .94$ ), test-retest reliability ( $r = .82$ ), and convergent ( $r$ 's = .74 to .85) and discriminant ( $r$ 's = .31 to .60) validity. In addition, confirmatory factor analyses indicated adequate fit with the *DSM-5* four-factor model (Blevins et al., 2015). In the current study, the two sleep symptom items (i.e., “Trouble falling or staying asleep” and “Repeated, disturbing dreams of a stressful experience”) were removed from the PCL-5 in order to reduce multicollinearity, as consistent with past research (e.g., Babson et al., 2015; Davidson, Babson, Bonn-Miller, Souter, & Vannoy, 2013; Short, Babson, Boden, & Bonn-Miller, 2014). The internal consistency was excellent ( $\alpha = 0.97$ ) for the PCL-5 without the two sleep items. As specified by the *DSM-5* and assessed by the PCL-5, the symptom clusters of PTSD include: intrusion, avoidance, negative alterations in mood, and arousal and reactivity (APA, 2013). These symptom clusters

were used as indicators of the latent posttraumatic stress symptom severity variable, a predictor in the proposed model.

*Pittsburgh Sleep Quality Index* (PSQI; Buysse et al.). The PSQI was used to assess sleep quality and disturbances during the previous month. The PSQI is a 19-item self-report measure of sleep quality over the past month. The PSQI subscales include subjective sleep quality (Component 1; rating of sleep quality), sleep latency (Component 2; length in minutes to typically fall asleep), sleep duration (Component 3; hours of actual sleep per night), habitual sleep efficiency (Component 4; number of hours slept divided by number of hours spent in bed, multiplied by 100), sleep disturbance (Component 5; sum of sleep related problems, such as using the bathroom during the night or coughing/snoring loudly), use of sleeping medication (Component 6; frequency of sleep medication use), and daytime dysfunction (Component 7; difficulty staying awake or becoming motivated). Component scores were added together to create a global sleep score that may range from 0 to 21, with higher scores indicating increased sleep disturbance. Factor analyses of the PSQI have demonstrated support for a 3-factor model over and above support for the original single-factor or 2-factor model, which includes sleep efficiency (i.e., using sleep duration and sleep efficiency variables), perceived sleep quality (i.e., using subjective sleep quality, sleep latency, and sleep medication variables), and daily disturbances (i.e., using sleep disturbances and daytime dysfunctions variables) (Casement, Harrington, Miller, & Resick, 2012; Cole et al., 2006; Mariman et al., 2012; Tomfohr, Schweizer, Dimsdale, & Lored, 2013). The 3-factor model obtained the status of perfect fit and demonstrated significant coefficients between each PSQI component and its respective factor (ranging from .43 to .91); correlations between factors ranged

from .42 to .82. PSQI has good internal consistency, with Cronbach's alphas of approximately .70 across nine studies of clinical and non-clinical samples summarized in a recent meta-analysis (Mollayeva et al., 2016). Recent meta-analytic evidence for the PSQI indicates strong test-retest reliability ( $r$ 's = .70 to .86) as well as convergent ( $r$ 's = .72 to .80) and discriminant ( $r$ 's = .31 to .62) validity (Mollayeva et al., 2016). The PSQI has been used to assess sleep disturbance in AUD samples (e.g., Foster & Peters, 1999; Kolla et al., 2014; Wallen et al., 2014) and PTSD samples (e.g., Casement et al., 2012; Lind et al., 2017; Nishith et al., 2001). In the current study, the internal consistency was acceptable ( $\alpha = 0.74$ ). The three component scores, based upon the 3-factor model of the PSQI, were used as indicators of the latent construct of sleep disturbance, a predictor within the proposed model.

*Alcohol Use Disorders Identification Test (AUDIT;* Saunders, Aasland, Babor, de la Fuente, & Grant, 1993). The AUDIT is an extensively validated 10-item, Likert-style screening instrument that was developed by the World Health Organization (WHO) and designed to identify individuals presenting with alcohol problems (Newcombe, Humeniuk, & Ali, 2005; Saunders et al., 1993). Scores range from 0 to 40, and the generally accepted cut-off to identify potentially hazardous alcohol intake is 8. The AUDIT has demonstrated strong internal consistency across domains ( $\alpha$ 's = .75-.83; Garcia Carretero, Novalbos Ruiz, Martinez Delgado, & O'Ferrall Gonzalez, 2016) as well as good test-retest reliability ( $r = .84$ ; Selin, 2003) and convergent ( $r = .87$ ; Garcia Carretero et al., 2016) and discriminant validity (Bohn, Babor, & Kranzler, 1995). The AUDIT has demonstrated acceptable levels of inter-rater reliability for total scores and acceptable to good inter-rater reliabilities for most of the individual items (Hildebrand &



Noteborn, 2015). The AUDIT has demonstrated high sensitivity and specificity for detecting probably alcohol dependence and hazardous or harmful drinking (sensitivity = 32-96%, specificity = 84-96%; Barry & Fleming, 1993; Rubio Valladolid, Bermejo Vicedo, Caballero Sanchez-Serrano, & Santo-Domingo Carrasco, 1998; Saunders et al., 1993; Schmidt, Barry, & Fleming, 1995). A recent systematic review confirmed the validity and efficiency of the AUDIT in the identification of harmful use, abuse, and dependence of alcohol (Meneses-Gaya, Waldo Zuardi, Regina Loureiro, & Crippa, 2009). In the current study, the internal consistency was good ( $\alpha = 0.85$ ). The three subscales of the AUDIT, including hazardous alcohol use, alcohol dependence, and harmful alcohol use, were used as indicators of the latent alcohol use severity variable, an outcome in the proposed model.

*Drinking Motives Questionnaire Revised Short Form (DMQ-R-SF; Kuntsche & Kuntsche, 2009).* Motives for consuming alcohol were assessed using the 12-item DMQ-R-SF, which was derived from the original Drinking Motive Questionnaire Revised (Cooper, 1994). This measure is based on the motivational model of alcohol use (Cox & Klinger, 1988). Each item is rated on a scale ranging from 1 (never) to 3 (almost always). The DMQ-R-SF measures the frequency with which individuals consume alcohol for four distinct reasons: Coping (drinking to cope with negative emotions; e.g., “Because it helps you when you feel depressed or nervous?”), Conformity (drinking to conform or avoid social censure and rejection; e.g., “To fit in with a group you like?”), Enhancement (drinking to enhance positive mood or well-being; e.g., “Because it’s fun?”), and Social (drinking to obtain positive social rewards; e.g., “Because it makes social gatherings more fun?”). Each subscale/motive consists of 3 items and mean scores are typically

computed for each subscale/motive. This instrument has been validated across international samples (Kuntsche & Kuntsche, 2009; Mazzardis, Vieno, Kuntsche, & Santinello, 2010; Nemeth et al., 2011); and internal consistencies between .70 – .83 have been demonstrated across subscales for the DMQ-R-SF (Kuntsche & Kuntsche, 2009). In the current study, the internal consistency was excellent ( $\alpha = 0.90$ ). Latent variables for each of the four motives subscales (i.e., Coping, Enhancement, Conformity, Social) were created for the current study using the three items (per subscale) as indicators. Each subscale was an outcome in the proposed models.

*Sources of Occupational Stress* (SOOS-14; Kimbrel, 2011). Occupational stress severity was measured with the 14-item revised version of the Sources of Occupational Stress Scale (Beaton & Murphy, 1993). Conceptually, occupational stress refers to the harmful physical and emotional responses that occur when the requirements of the job do not match the capabilities, resources, or needs of the worker (Health, 1999). Specifically, the SOOS-14 measures on-the-job stress (e.g., “Discrimination based on gender, ethnicity, or age”, “Financial strain due to inadequate pay”, and “Concerns about serious personal injury/disablement/death due to work”). Items are scored on a 5-point Likert-style scale (1 = “Not at all bothered” to 5 = “Extremely bothered”). The SOOS-14 has exhibited good internal consistency ( $\alpha = .82$ ), good factor structure [ $\chi^2(77) = 115.172, p = .003$ ; RMSEA = .046; SRMR = .055; CFI = .922], and good validity coefficients across independent samples of firefighters ( $r = .94, p = .001$ ;  $r = .96, p = .001$ ; Kimbrel, 2011). The internal consistency was excellent ( $\alpha = 0.90$ ) for the SOOS-14 in the current study. The SOOS-14 was used to index occupational stress severity, an observed covariate in the proposed models.

## **Procedures**

This study was based upon ongoing data collection on stress and health behaviors in firefighters. All firefighters were being recruited for participation in the parent study through the HFD. A department-wide email was sent to all firefighters in the HFD, notifying them of the opportunity to complete an online research survey for one continuing education (CE) credit and a chance to win one of several raffle prizes. Prizes included \$50 - \$100 restaurant gift cards, iPic Theaters movie passes, and Yeti Tumblers. Monthly reminders regarding the survey were sent via the HFD department-wide email notification system for up to 3 months from the onset of the study. All notification emails indicated that the purpose of the survey was to better understand how firefighters cope with stress and how much firefighters engage in health-related behaviors. Firefighters were given access to the informed consent form and survey through an online HFD continuing education portal. Once firefighters accessed the portal, they were provided with a description of the survey and the choice to review the informed consent form, which delineated all aspects of the study. Those who did not wish to participate and consent to the study were given the option to indicate (by clicking 'no') that they did not wish to participate. Participants who indicated that they are interested in participating (by clicking 'yes') were directed to the informed consent form. Once they electronically signed off on the consent form, they were asked to select the time and place for completion of all online survey questionnaires in Qualtrics. The total amount of time required for participation in this study was 45-60 minutes. Firefighters could discontinue participation at any time without penalty. The study was approved by the University of Houston Institutional Review Board and the HFD.

## **Data Analytic Plan**

Descriptive statistics were calculated for all study variables using IBM SPSS version 24.0 (IBM Corporation). Bivariate correlations and main hypotheses were tested using structural equation modeling (SEM) in Mplus version 8.0 (Muthén & Muthén, 1998-2017), utilizing maximum likelihood with robust standard errors estimation method. First, the measurement model with seven latent variables was evaluated using confirmatory factor analysis (CFA): (1) posttraumatic stress symptom severity (PCL-5), (2) sleep disturbance (PSQI), (3) alcohol use severity (AUDIT), (4) alcohol coping motives (DMQ-R-SF), (5) alcohol enhancement motives (DMQ-R-SF), (6) alcohol conformity motives (DMQ-R-SF), and (7) alcohol social motives (DMQ-R-SF). Please see Measures section for information on how latent variables were created (see Figure 2 for a graphical representation of these latent variables). Second, covariates of years in the fire department (demographics questionnaire) and occupational stress severity (SOOS-14) were added to the model to examine the effects of theoretically-relevant covariates on alcohol use severity and alcohol use motives (coping, enhancement, conformity, and social). Third, posttraumatic stress symptom severity and sleep disturbance were added to the model to examine main effects on alcohol use severity and alcohol use motives (coping, enhancement, conformity, and social). Fourth, interactive associations of posttraumatic stress symptom severity and sleep disturbance on alcohol use severity and alcohol use motives (coping, enhancement, conformity, and social) were evaluated. Finally, the main effects and interaction models were evaluated for significant interactions. Interaction results were then graphed in order to evaluate the patterns of interaction for the effect of posttraumatic stress symptom severity on alcohol use

outcomes (alcohol use severity and each of four alcohol use motives) for those with high versus low sleep disturbance (see Figures 3 and 4 for a graphical representation of interactive effects). Structural model standardized parameter estimates predicting alcohol use outcomes are presented in-text (see Results below) and unstandardized parameter estimates predicting alcohol use outcomes are presented in Table 4.

Model fit was assessed using the following indices: root mean square error (RMSEA), Comparative Fit Index (CFI), and Tucker-Lewis Index (TLI). RMSEA should ideally be below  $< .06$  (Browne & Cudeck, 1992). CFI and TLI should be  $> 0.90$  (Marsh & Hau, 2014). Significance of effects were determined using 95% confidence intervals (CI), although  $p$ -values are also provided for each analysis. Finally,  $R^2$  effect-size measures were evaluated to assess variance accounted for in moderation models.

## **Results**

### **Descriptive Statistics and Bivariate Correlations**

Distributions for study variables approximated normality (skewness  $< |2.25|$ ; George & Mallery, 2003) and no missing values were identified for any of the current study variables. Examination of collinearity diagnostics revealed no evidence of excess collinearity among predictors (variance inflation index [VIF]  $< 1.68$ ). VIF values greater than 10.0, indicating problematic collinearity (Mason & Perreault, 1991), were not observed. Bivariate correlations for study and indicator variables are presented in Tables 2 and 3, respectively. Posttraumatic stress symptom severity was positively and significantly associated with occupational stress ( $r = .63, p < .01$ ), sleep disturbance ( $r = .46, p < .01$ ), and all alcohol-related study variables ( $r$ 's = .20-.50,  $p$ 's  $< .01$ ). Sleep disturbance was also positively and significantly associated with occupational stress ( $r =$

.45,  $p < .01$ ), posttraumatic stress symptom severity ( $r = .46, p < .01$ ), and all alcohol-related study variables ( $r$ 's = .21-.41,  $p$ 's  $< .01$ ). Years of service within the fire department, in contrast, was negatively correlated with alcohol use severity ( $r = -.04, p = ns$ ), alcohol coping use motives ( $r = -.03, p = ns$ ), and alcohol conformity use motives ( $r = -.04, p = ns$ ). Further, Years of service within the fire department was negatively and significantly correlated with alcohol enhancement use motives ( $r = -.11, p < .01$ ) and alcohol social use motives ( $r = -.11, p < .01$ ).

### **Measurement Model of Latent Variables**

The measurement model with seven latent variables (Figure 2) demonstrated good fit: [ $\chi^2 (188) = 614.22, p < .001, RMSEA = .06, CFI = .93, TLI = .92$ ]. All indicators had acceptable loadings onto latent variables ( $\lambda$  ranged from .44-.95). All latent variables demonstrated statistically significant and positive correlations: posttraumatic stress symptom severity was correlated with sleep disturbance ( $r = .60, 95\% CI [.51, .69], p < .001$ ), alcohol use severity ( $r = .47, 95\% CI [.36, .58], p < .001$ ), alcohol use coping motives ( $r = .58, 95\% CI [.48,.67], p < .001$ ), alcohol use enhancement motives ( $r = .22, 95\% CI [.11,.32], p < .001$ ), alcohol use conformity motives ( $r = .30, 95\% CI [.21,.40], p < .001$ ), and alcohol use social motives ( $r = .21, 95\% CI [.13,.30], p < .001$ ). Sleep disturbance was also correlated with alcohol use severity ( $r = .43, 95\% CI [.32, .53], p < .001$ ), alcohol use coping motives ( $r = .57, 95\% CI [.49,.66], p < .001$ ), alcohol use enhancement motives ( $r = .30, 95\% CI [0.19,0.40], p < .001$ ), alcohol use conformity motives ( $r = .31, 95\% CI [.20,.41], p < .001$ ), and alcohol use social motives ( $r = .32, 95\% CI [.27,.41], p < .001$ ). Please see Figure 2 for further details on the measurement model.

### **Base Associations of Covariates with Alcohol Use Outcomes**

Covariates (years in the fire department and occupational stress severity) were examined as predictors of alcohol use severity and alcohol use motive outcomes. The years in the fire service variable was significantly and negatively associated with enhancement use motives ( $\beta = -.17$ , 95% CI [-.25, -.08],  $p < .001$ ) and social use motives ( $\beta = -.13$ , 95% CI [-.20, -.05],  $p = .001$ ). The years in the fire service variable was not associated with alcohol use severity, coping use motives, and conformity use motives. This model demonstrated good fit: [ $\chi^2$  (100) = 446.203,  $p < .001$ , RMSEA = .07, CFI = .91, TLI = .88]. Occupational stress severity was significantly and positively associated with alcohol use severity ( $\beta = .30$ , 95% CI [.20, .39],  $p < .001$ ), coping alcohol use motives ( $\beta = .39$ , 95% CI [0.30, 0.48],  $p < .001$ ), enhancement use motives ( $\beta = .25$ , 95% CI [.16, .34],  $p < .001$ ), conformity use motives ( $\beta = .21$ , 95% CI [.11, .30],  $p < .001$ ), and social use motives ( $\beta = .24$ , 95% CI [.16, .32],  $p < .001$ ).

### **Main Effects of Posttraumatic Stress Symptom Severity and Sleep Disturbance on Alcohol Use Outcomes**

The main effects of posttraumatic stress symptom severity and sleep disturbance latent variables were examined as predictors of alcohol use severity and alcohol use motive latent variable outcomes. This model demonstrated good fit: [ $\chi^2$  (218) = 680.62,  $p < .001$ , RMSEA = .06, CFI = .93, TLI = .91]. Posttraumatic stress symptom severity ( $\beta = .38$ , 95% CI [.23, .53],  $p < .001$ ) and sleep disturbance ( $\beta = .25$ , 95% CI [.10, .41],  $p < .001$ ) were statistically significant predictors of alcohol use severity. Posttraumatic stress symptom severity ( $\beta = .40$ , 95% CI [.27, .54],  $p < .001$ ) and sleep disturbance ( $\beta = .39$ , 95% CI [.25, .53],  $p < .001$ ) were also both statistically significant predictors of alcohol

use coping motives. Posttraumatic stress symptom severity ( $\beta = .01$ , 95% CI [-.12, .14],  $p = .88$ ) was not a statistically significant predictor of alcohol use enhancement motives, but sleep disturbance ( $\beta = .24$ , 95% CI [.09, .39],  $p < .01$ ) was a statistically significant predictor. Posttraumatic stress symptom severity ( $\beta = .21$ , 95% CI [.08, .35],  $p < .01$ ) and sleep disturbance ( $\beta = .21$ , 95% CI [.03, .40],  $p < .05$ ) were both statistically significant predictors of alcohol use conformity motives. Finally, posttraumatic stress symptom severity ( $\beta = .00$ , 95% CI [-.11, .12],  $p = .99$ ) was not a statistically significant predictor of alcohol use social motives, but sleep disturbance ( $\beta = .28$ , 95% CI [.15, .42],  $p < .001$ ) was a statistically significant predictor.

### **Interactive Effect of Posttraumatic Stress Symptom Severity and Sleep Disturbance on Alcohol Use Outcomes**

Please see Figure 5 for further details on the interactive path analysis model utilizing the standardized effects. The final model included the interactive effect of posttraumatic stress symptom severity and sleep disturbance on the alcohol use outcome variables. After accounting for covariates and main effects, the interaction of posttraumatic stress symptom severity and sleep disturbance was a significant predictor of alcohol use severity ( $\beta = .22$ , 95% CI [.01, .44],  $p < .05$ ) and alcohol use coping motives ( $\beta = .17$ , 95% CI [.05, .30],  $p < .01$ ). The interaction model accounted for 23.7% of variance in alcohol use severity and 38.0% of the variance in alcohol use coping motives. Furthermore, as predicted, the interaction of posttraumatic stress symptom severity and sleep disturbance was not a significant predictor of alcohol use enhancement motives ( $\beta = .02$ , 95% CI [-.07, .11],  $p = .66$ ), alcohol use conformity motives ( $\beta = -.04$ , 95% CI [-.15, .07],  $p = .46$ ), or alcohol use social motives ( $\beta = .02$ , 95% CI [-.06, .09],  $p =$



.63). The interaction model accounted for 13.4%, 14.0%, and 12.6% of variance for alcohol use enhancement, conformity, and social motives, respectfully. Of note, the variance accounted for by the latent variables between the main effects and interaction model remained the same. Given the significant interactive effects noted within the interaction model, the main effects model was determined to be mis-specified as it did not include the interaction term. Thus, the main effects results derived from the interaction, rather than the main effects model, are also reported in the discussion (below) (Muthén, 2018). For a comparison of these models in table format, please see Table 4.

### **Discussion**

The current study examined the main and interactive effects of posttraumatic stress symptom severity and sleep disturbance with regard to alcohol use severity and alcohol use motives. Hypotheses were largely supported by the data, and sleep disturbance significantly moderated the association between posttraumatic stress severity and alcohol use severity and alcohol use coping motives. Overall, the model fit well and the interactive effects accounted for 23.7% of variance in alcohol use severity and 38.0% of the variance in alcohol use coping motives. While these findings should be interpreted in light of the study limitations (outlined below), the findings are informative given the relative dearth of information regarding psychological underpinnings of alcohol use within this vulnerable population.

#### **Posttraumatic Stress – Alcohol Use and Motives: Main Effects**

In the main effects model, posttraumatic stress symptom severity significantly and positively predicted alcohol use severity ( $p < .001$ ). Alcohol use severity increased by .38 standard deviations for each standard deviation increase in posttraumatic stress severity,

which represented a medium effect. Thus, firefighters with elevated posttraumatic stress symptomatology may be more likely to consume alcohol (Haddock et al., 2012). However, this effect became non-significant ( $p = .52$ ) when the interactive term of posttraumatic stress severity and sleep disturbance was added into the model. The combined effect of posttraumatic stress severity and sleep disturbance therefore accounted for the variance in alcohol use severity better than posttraumatic stress severity alone.

Posttraumatic stress symptom severity was also a significant predictor of alcohol use coping motives ( $p < .001$ ) in the main effects model. Alcohol use coping motives increased by .40 standard deviations for each standard deviation increase in posttraumatic stress severity, which also represented a medium effect. This finding is consistent with literature that has demonstrated that individuals with increased posttraumatic stress symptomatology are more likely to use alcohol to cope with symptoms of posttraumatic stress (Simpson et al., 2014; Waldrop et al., 2007) and extant literature demonstrating that coping-oriented alcohol use partially mediates the relationship between posttraumatic stress symptoms and increased alcohol use (O'Hare & Sherrer, 2011; Tomaka et al., 2017; Yeater et al., 2010). This effect also became non-significant ( $p = .93$ ) when the interactive term of posttraumatic stress severity and sleep disturbance was added into the model. The combined effect of posttraumatic stress severity and sleep disturbance therefore accounted for the variance in alcohol use coping motives better than posttraumatic stress severity alone. Posttraumatic stress symptom severity was also a significant predictor of alcohol use conformity motives ( $p < .01$ ), increasing by .21 standard deviations for each standard deviation increase in posttraumatic stress severity,

which represented a small effect. In the model with the interaction term, the effect of posttraumatic stress severity alone remained a significant predictor of alcohol use conformity motives ( $p < .05$ ). In contrast, the effects of posttraumatic stress severity on alcohol use enhancement ( $p = .88$ ) and social motives ( $p = .99$ ) were not statistically significant in the main effects model, a finding that was consistent when the interactive term of posttraumatic stress severity and sleep disturbance was added into the model. Thus, posttraumatic stress severity did not account for a significant amount of variance in these motives. These findings are also consistent with past literature examining alcohol use motives, which has shown that posttraumatic stress robustly predicts alcohol use coping motives, with little or no association with enhancement and social motives (e.g., Dixon, Leen-Feldner, Ham, Feldner, & Lewis, 2009; McDevitt-Murphy, Fields, Monahan, & Bracken, 2015; Stappenbeck, Bedard-Gilligan, Lee, & Kaysen, 2013; Stewart, Mitchell, Wright, & Loba, 2004).

### **Sleep Disturbance – Alcohol Use and Motives: Main Effects**

This is the first study to examine the relationship of sleep disturbance with both alcohol use severity and alcohol use motives among firefighters. Consistent with the hypothesis, sleep disturbance significantly and positively predicted alcohol use severity in the main effects model ( $p = .001$ ). Alcohol use severity increased by .25 standard deviations for each standard deviation increase in sleep disturbance, which represented a small effect. Thus, firefighters reporting greater sleep disturbance are more likely to use alcohol to a greater extent. This finding is consistent with past work that has linked sleep disturbance with alcohol use and AUD (Taylor et al., 2003; Wong et al., 2004), generally. It is also consistent with emerging work among firefighters, specifically, that has

demonstrated positive bivariate correlations between sleep disturbance and alcohol use severity, as measure by the Timeline Follow-Back (Carey et al., 2011; Sobell & Sobell, 1992) and the AUDIT (Vargas de Barros et al., 2013; Yun et al., 2015). However, this effect became non-significant ( $p = .96$ ) when the interactive term of posttraumatic stress severity and sleep disturbance was added into the model. The combined effect of posttraumatic stress severity and sleep disturbance therefore accounted for the variance in alcohol use severity better than sleep disturbance alone.

Further, sleep disturbance significantly and positively predicted alcohol use coping ( $p < .001$ ), enhancement ( $p < .01$ ), conformity ( $p < .05$ ), and social motives ( $p < .001$ ) in the main effects model. Alcohol use coping motives increased by .39 standard deviations for each standard deviation increase in sleep disturbance, which represented a medium effect. Alcohol use enhancement, conformity, and social motives increased by .24, .21, and .28 standard deviations, respectively, for each standard deviation increase in sleep disturbance, which all represented small effects. These findings are consistent with past work that has shown that poor sleep quality is associated with coping, conformity, enhancement, and social motives for alcohol use (Kenney, Lac, Labrie, Hummer, & Pham, 2013; Kenney, Paves, Grimaldi, & LaBrie, 2014). Importantly, this line of work also demonstrated that coping motives moderated the relationship between sleep quality and consequences such that participants reporting poor sleep and high coping motives may experience heightened levels of consequences (Kenney et al., 2014). This finding is consistent with further work that has shown disordered sleep is associated with coping-oriented alcohol use among rape victims with severe PTSD (Nishith et al., 2001). These significant main effects of sleep disturbance on enhancement ( $p < .05$ ), conformity ( $p <$

.05), and social alcohol use motives ( $p < .001$ ) remained significant when the interactive term of posttraumatic stress severity and sleep disturbance was added into the model. Thus, in the model with the interaction term, the effect of sleep disturbance alone remained a significant predictor of these alcohol use motives. However, the effect of sleep disturbance on coping alcohol use motives became non-significant ( $p = .09$ ) when the interactive term of posttraumatic stress severity and sleep disturbance was added into the model. The combined effect of posttraumatic stress severity and sleep disturbance therefore accounted for the variance in alcohol use coping motives better than sleep disturbance alone.

### **Interactive Effects**

The overall interactive effect of posttraumatic stress symptom severity and sleep disturbance significantly predicted alcohol use severity and accounted for 23.7% of variance in alcohol use severity. In particular, for each standard deviation increase in sleep disturbance, the relationship between posttraumatic stress severity and alcohol use severity increased by 0.22 standard deviations. While this effect size is small, these findings indicate that posttraumatic stress symptom severity is related to increased alcohol use severity, and this association is markedly stronger when firefighters' levels of sleep disturbance are heightened. In other words, firefighters in the current sample with higher levels of posttraumatic stress symptomatology and higher levels of sleep disturbance are more likely to exhibit increased alcohol use severity. Please see Figure 3 for the plotted interaction of posttraumatic stress symptom severity with sleep disturbance in predicting alcohol use severity.

The interactive effect of posttraumatic stress symptom severity and sleep disturbance also significantly predicted alcohol use coping motives and accounted for 38.0% of the variance in alcohol use coping motives. In particular, for each standard deviation increase in sleep disturbance, the relationship between posttraumatic stress severity and alcohol use coping motives increased by .17 standard deviations. This effect size may also be characterized as low, but the overall model accounted for more variance in alcohol use coping motives when compared to alcohol use severity (38.0% versus 23.7%, respectively). This indicates that firefighters in the current sample with higher levels of posttraumatic stress symptomatology and higher levels of sleep disturbance are more likely to use alcohol to cope with negative emotions. Thus, posttraumatic stress symptom severity is related to increased alcohol coping motives, and this association is markedly stronger when firefighters' levels of sleep disturbance are heightened. Please see Figure 4 for the plotted interaction of posttraumatic stress symptom severity with sleep disturbance in predicting alcohol use coping motives. As hypothesized, the interactive effect of posttraumatic stress symptom severity and sleep disturbance was not a significant predictor of alcohol use enhancement, conformity, or social motives. Specifically, effect sizes for these statistically non-significant outcomes were very weak (-.04 – .02), with the interaction model accounting for only 13.4% of the variance in enhancement alcohol use motives, 14.0% of the variance in conformity alcohol use motives, and 12.6% of the variance in social alcohol use motives.

This is the first study to date that has evaluated these associations among posttraumatic stress symptom severity, sleep disturbance, and alcohol use and alcohol use motives among firefighters. These findings are consistent with research examining

marijuana use, which has demonstrated a significant interaction between sleep problems and posttraumatic stress symptom severity in relation to coping-motivated marijuana use among adults in the general population (Bonn-Miller, Babson, Vujanovic, & Feldner, 2010). However, these findings are inconsistent with a study by Nishith and colleagues (2001) that examined the influence of posttraumatic stress symptoms and sleep difficulties on alcohol use motives among female rape victims with severe posttraumatic stress and did not document an interactive effect between posttraumatic stress and disordered sleep in terms of alcohol use motives. Specifically, while this study found that disordered sleep (defined via PSQI Component 5 subscale) was associated with coping-oriented alcohol use, no associations were observed between posttraumatic stress symptoms and alcohol use motives. Given that substance use is frequently used as a means of coping with symptoms related to both posttraumatic stress and sleep disturbance (Vandrey, Babson, Herrmann, & Bonn-Miller, 2014), firefighters with elevated posttraumatic stress symptomatology may be more likely to exhibit increased alcohol use severity and alcohol use coping motives at high levels of sleep disturbance. Further, given the high rates of posttraumatic stress symptomatology (e.g., Corneil et al., 1999; Jones, 2017), sleep disturbance by (e.g., Beaton & Murphy, 1993; Harvey et al., 2016; Haugen et al., 2012), and alcohol use among firefighters (e.g., Carey et al., 2011; Haddock et al., 2015; Piazza-Gardner et al., 2014), this work underscores the importance of further examination of the role of sleep in the PTSD-AUD association and alcohol use motives among this highly vulnerable population.

## **Bivariate Associations**

The bivariate associations demonstrated in the current study also are noteworthy. First, years in the fire service, a covariate in the current study, was negatively and significantly correlated with enhancement, conformity, and social motives for alcohol use. This may indicate that the more years in the fire service, the less likely firefighters are to consume alcohol for enhancement (i.e., drinking to enhance positive mood or wellbeing), conformity (i.e., drinking to avoid social censure or rejection), and social (i.e., drinking to obtain social rewards) motivations. While longitudinal designs have not examined patterns in alcohol use motives over time among firefighters, extant literature demonstrates evidence for developmental changes in alcohol use motives, suggesting that individuals who continue to use alcohol to escape from problems are less likely to decrease alcohol binge drinking behavior over time (Patrick & Schulenberg, 2011). Future research may examine the temporal changes in alcohol use motives over time. Furthermore, there was no correlation between years in the fire service and alcohol use severity or coping alcohol use motives, indicating that these variables are not related to the number of years that a firefighter has been in the service.

In contrast, the other covariate in the study, occupational stress, was significantly and positively correlated with all study variables, with the exception of years in the fire service. Thus, as occupational stress increases, the severity of posttraumatic stress, sleep disturbance, and all alcohol use motive variables also increase (and vice versa). This is consistent with past research, which indicates that occupational stress is associated with posttraumatic stress symptomatology in police officers (Maguen et al., 2009), and



increased sleep disturbance (Lusa et al., 2002) and increased alcohol use in firefighters (e.g., Murphy et al., 1999).

### **Additional Findings**

Although not primary aims of the study, there were additional findings worthy of mention. First, approximately 9.9% of the sample in the current investigation met clinical cut-off levels for probable PTSD (PCL-5  $\geq$  33). The prevalence of firefighters who met self-reported diagnostic criteria for PTSD in this sample was within a similar range to other samples of firefighters (3.9-22.0%; Jones, 2017), but higher than the general population (3.5%; Kessler, et al., 2005). Next, approximately 60.3% of the sample in the current investigation met clinical cut-off levels for probable sleep disturbance (PSQI  $\geq$  5). Of note, the prevalence of firefighters who met probable sleep disturbance in this sample was higher in comparison to other samples of firefighters (51.2-59.0%; Carey et al., 2011; de Barros et al., 2013) and significantly higher than the prevalence rates of 6-33% for sleep disturbance within the general population (Ohayon, 2002). Finally, approximately 23.3% of the sample in the current study met clinical cut-off levels for hazardous alcohol use (AUDIT  $\geq$  8). This finding is similar to past year probably alcohol abuse prevalence in other samples of firefighters (22.5%; Meyer et al., 2012), but higher than the rates of alcohol abuse (3.1%) and alcohol dependence (1.3%) in the general population (Kessler et al., 2005). Altogether, these results underscore this important line of inquiry for future research for the purposes of better understanding relationships between posttraumatic stress, sleep disturbances, and alcohol use and alcohol use motives among firefighters.

## **Limitations**

While the present study had many strengths, several limitations are worthy of note while interpreting the findings of the current study. First, the study relied exclusively on self-report, and therefore, the effects of method variance and reporting bias cannot be ruled out. Although a self-report methodology facilitated the screening of a large sample of firefighters, it is important for future work to integrate interview-based and experimental measures, such as actigraphy, polysomnography, or ecological momentary assessment, in order to advance our understanding beyond self-report measurement and to combat potential under-reporting trends for sensitive topics. Related, brief alcohol use-oriented intervention studies targeting these mental health (i.e., posttraumatic stress) and behavioral mechanisms (i.e., sleep disturbance) could provide key knowledge regarding the effective, evidence-based, specialized intervention programs for firefighters. Second, the study utilized a sample of primarily male (93.6%;  $n = 598$ ) firefighters from a single, all-career fire department that serves an urban locale. Thus, findings might not generalize to firefighters at large. Future research is needed to advance our understanding of the unique experiences and needs of diverse subgroups of firefighters (e.g., women, racial/ethnic groups, LGBTQ, transgender) from various areas (e.g., urban, rural) (e.g., Jahnke et al., 2012; Ward & Winstanley, 2006; Yoder & Aniakudo, 1996). Further, as firefighters in this study were all career (compared to volunteer) firefighters, certain psychiatric symptoms (e.g., posttraumatic stress, alcohol use) may have been underreported due to fears of job-related repercussions (Hom, Stanley, Ringer, & Joiner, 2016; Stanley et al., 2017). Third, this study employed a cross-sectional design, and therefore, no inferences about causality among variables can be made. Replication of

study findings, ideally using diverse methodologies, will be important to strengthen conclusions about the generalizability of our findings. For example, it would be helpful to trace firefighters' posttraumatic stress symptomatology, sleep patterns, and alcohol use with longitudinal designs in order to better understand the temporal relations among pertinent variables. Related, these types of methodologies will allow for characterizing normative and problematic patterns of alcohol use among firefighters over time and considering relations with relevant clinical correlates (e.g., posttraumatic stress, sleep disturbance). The current investigation makes it clear that more research is needed, utilizing more rigorous methodologies and study designs, to better understand associations of these variables among firefighters, a population in need of greater attention and understanding, particularly given the invaluable service they provide to our communities.

### **Empirical Contributions**

Despite these limitations, the current study had several noteworthy strengths. First, the current study examined a unique, understudied, and highly vulnerable population. Second, the present study utilized a large sample of firefighters, a relatively understudied population with regard to mental health (e.g., posttraumatic stress), behavioral mechanisms (e.g., sleep disturbance), and substance use behaviors (e.g., alcohol use). Finally, this study utilized structural equation modeling, which better accounted for measurement error and improved the statistical power of this behavioral research (Tomarken & Waller, 2005). Overall, the current results underscore the importance of considering mental health concerns, such as posttraumatic stress, and

behavioral factors, such as sleep disturbance, in order to better understand alcohol use and alcohol use motives among members of the fire service.

### **Conclusions**

Among a large sample of firefighters, the present study found that greater posttraumatic stress severity is associated with elevated levels of alcohol use severity as well alcohol use coping motives. Moreover, these associations were exacerbated at heightened levels of self-reported sleep disturbance. Given that sleep disturbance is amenable to therapeutic intervention, should these results be replicated among other firefighter samples, alcohol use prevention and intervention efforts within the fire service might benefit from the inclusion of skills to improve sleep quality and address posttraumatic stress.

## References

- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*. Washington, DC: Author.
- Arbona, C., Fan, W., & Noor, N. (2016). Factor structure and external correlates of posttraumatic stress disorder symptoms among African American firefighters. *Psychology Research and Behaviour Management, 9*, 201-209.  
doi:10.2147/prbm.s113615
- Arbona, C., & Schwartz, J. P. (2016). Posttraumatic stress disorder symptom clusters, depression, alcohol abuse, and general stress among hispanic male firefighters. *Hispanic Journal of Behavioral Sciences, 38*(4), 507-522. doi:  
10.1177/0739986316661328
- Babson, K. A., Heinz, A. J., Ramirez, G., Puckett, M., Irons, J. G., Bonn-Miller, M. O., & Woodward, S. H. (2015). The interactive role of exercise and sleep on veteran recovery from symptoms of PTSD. *Mental health and Physical Activity, 8*, 15-20.  
doi:10.1016/j.mhpa.2014.12.002
- Bacharach, S. B., Bamberger, P. A., & Doveh, E. (2008). Firefighters, critical incidents, and drinking to cope: The adequacy of unit-level performance resources as a source of vulnerability and protection. *Journal of Applied Psychology, 93*(1), 155-169. doi:10.1037/0021-9010.93.1.155
- Barry, K. L., & Fleming, M. F. (1993). The Alcohol Use Disorders Identification Test (AUDIT) and the SMAST-13: Predictive validity in a rural primary care sample. *Alcohol and Alcoholism, 28*(1), 33-42. doi:10.1093/oxfordjournals.alcalc.a045346
- Beaton, R. D., & Murphy, S. A. (1993). Sources of occupational stress among firefighter/EMTs and firefighter/paramedics and correlations with job-related

outcomes. *Prehospital Disaster Medicine*, 8(2), 140-150. doi:  
10.1017/S1049023X00040218

Bergman, H. E., Przeworski, A., & Feeny, N. C. (2016). Rates of Subthreshold PTSD Among U.S. Military Veterans and Service Members: A Literature Review. *Military Psychology*. doi:10.1037/mil0000154

Beseler, C. L., Aharonovich, E., Keyes, K. M., & Hasin, D. S. (2008). Adult transition from at-risk drinking to alcohol dependence: the relationship of family history and drinking motives. *Alcoholism: Clinical and Experimental Research*, 32(4), 607-616. doi:10.1111/j.1530-0277.2008.00619.x

Blevins, C. A., Weathers, F. W., Davis, M. T., Witte, T. K., & Domino, J. L. (2015). The Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5): Development and Initial Psychometric Evaluation. *Journal of Traumatic Stress*, 28(6), 489-498. doi:10.1002/jts.22059

Bohn, M. J., Babor, T. F., & Kranzler, H. R. (1995). The Alcohol Use Disorders Identification Test (AUDIT): validation of a screening instrument for use in medical settings. *Journal of Studies on Alcohol*, 56(4), 423-432. doi:10.15288/jsa.1995.56.423

Bonn-Miller, M. O., Babson, K. A., Vujanovic, A. A., & Feldner, M. (2010). Sleep Problems and PTSD Symptoms Interact to Predict Marijuana Use Coping Motives: A Preliminary Investigation. *Journal of Dual Diagnosis*, 6(2), 111-112. doi:10.1080/15504261003751887

Bovin, M. J., Marx, B. P., Weathers, F. W., Gallagher, M. W., Rodriguez, P., Schnurr, P. P., & Keane, T. M. (2016). Psychometric properties of the PTSD Checklist for

- Diagnostic and Statistical Manual of Mental Disorders-Fifth Edition (PCL-5) in veterans. *Psychological Assessment*, 28(11), 1379-1391. doi:10.1037/pas0000254
- Boxer, P. A., & Wild, D. (1993). Psychological distress and alcohol use among fire fighters. *Scandinavian Journal of Work, Environment & Health*, 19(2), 121-125. doi:10.5271/sjweh.1497
- Bremner, J. D., Southwick, S. M., Darnell, A., & Charney, D. S. (1996). Chronic PTSD in Vietnam combat veterans: course of illness and substance abuse. *American Journal of Psychiatry*, 153(3), 369-375. doi:10.1176/ajp.153.3.369
- Breslau, N., Davis, G. C., Andreski, P., & Peterson, E. (1991). Traumatic events and posttraumatic stress disorder in an urban population of young adults. *Archives of General Psychiatry*, 48(3), 216-222. doi:10.1001/archpsyc.1991.01810270028003
- Brower, K. J., Aldrich, M. S., & Hall, J. M. (1998). Polysomnographic and subjective sleep predictors of alcoholic relapse. *Alcoholism: Clinical and Experimental Research*, 22(8), 1864-1871. doi: 10.1111/j.1530-0277.1998.tb03995.x
- Browne, M. W., & Cudeck, R. (1992). Alternative Ways of Assessing Model Fit. *Sociological Methods & Research*, 21(2), 230 - 258. doi:https://doi.org/10.1177/0049124192021002005
- Burke, R. J. (1993). Work-family stress, conflict, coping, and burnout in police officers. *Stress Medicine*, 9, 171-180. doi: 10.1002/smi.2460090308
- Buysse, D. J., Reynolds, C. F., 3rd, Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research*, 28(2), 193-213. doi:doi.org/10.1016/0165-1781(89)90047-4

- Carey, M. G., Al-Zaiti, S. S., Dean, G. E., Sessanna, L., & Finnell, D. S. (2011). Sleep problems, depression, substance use, social bonding, and quality of life in professional firefighters. *Journal of Occupational and Environmental Medicine*, 53(8), 928-933. doi:10.1097/JOM.0b013e318225898f
- Casement, M. D., Harrington, K. M., Miller, M. W., & Resick, P. A. (2012). Associations between Pittsburgh Sleep Quality Index factors and health outcomes in women with posttraumatic stress disorder. *Sleep Medicine*, 13(6), 752-758. doi:10.1016/j.sleep.2012.02.014
- Cole, J. C., Motivala, S. J., Buysse, D. J., Oxman, M. N., Levin, M. J., & Irwin, M. R. (2006). Validation of a 3-factor scoring model for the Pittsburgh sleep quality index in older adults. *Sleep*, 29(1), 112-116. doi: 10.1093/sleep/29.1.112
- Colrain, I. M., Nicholas, C. L., & Baker, F. C. (2014). Alcohol and the sleeping brain. *Handbook of Clinical Neurology*, 125, 415-431. doi:10.1016/b978-0-444-62619-6.00024-0
- Cooper, M. L. (1994). Motivations for alcohol use among adolescents: Development and validation of a four-factor-model. *Psychological Assessment*, 6, 117-128. doi: 10.1037/1040-3590.6.2.117
- Cooper, M. L., Krull, J. L., Agocha, V. B., Flanagan, M. E., Orcutt, H. K., Grabe, S., . . . Jackson, M. (2008). Motivational pathways to alcohol use and abuse among Black and White adolescents. *Journal of Abnormal Psychology*, 117(3), 485-501. doi:10.1037/a0012592
- Cooper, M. L., Kuntsche, E., Levitt, A., Barbar, L. L., & Wolf, S. (2016). Motivational Models of Substance Use: A Review of Theory and Research on Motives for



- Using Alcohol, Marijuana, and Tobacco. In K. J. Sher (Ed.), *The Oxford Handbook of Substance Use and Substance Use Disorders: Volume 2 (Oxford Library of Psychology)* (Vol. 1). New York: Oxford University Press.
- Cooper, M. L., Russel, M., Skinner, J. B., Windel, M. (1992). Development and validation of a three-dimensional measure of drinking motives. *Psychological Assessment, 42*, 123-132. doi: 10.1037/1040-3590.4.2.123
- Corneil, W., Beaton, R., Murphy, S., Johnson, C., & Pike, K. (1999). Exposure to traumatic incidents and prevalence of posttraumatic stress symptomatology in urban firefighters in two countries. *Journal of Occupational Health Psychology, 4*(2), 131-141. doi: 10.1037/1076-8998.4.2.131
- Coupland, N. J. (2009). Treatment of insomnia in post--traumatic stress disorder. *Journal of Psychiatry and Neuroscience, 34*(5), E5-6.
- Cox, W. M., & Klinger, E. (1988). A motivational model of alcohol use. *Journal of Abnormal Psychology, 97*(2), 168-180. doi: 10.1037/0021-843X.97.2.168
- Crutzen, R., & Kuntsche, E. (2013). Validation of the four-dimensional structure of drinking motives among adults. *Eur Addict Res, 19*(4), 222-226.  
doi:10.1159/000345457
- Cutter, H. S., & O'Farrell, T. J. (1984). Relationship between reasons for drinking and customary drinking behavior. *Journal of Studies on Alcohol and Drugs, 45*(4), 321-325. doi: 10.15288/jsa.1984.45.321
- Davidson, C. L., Babson, K. A., Bonn-Miller, M. O., Souter, T., & Vannoy, S. (2013). The impact of exercise on suicide risk: Examining pathways through depression,

PTSD, and sleep in an inpatient sample of veterans. *Suicide and Life-Threatening Behavior*, 43(3), 279-289. doi: 10.1111/sltb.12014

de Barros, V., Martins, L. F., Saitz, R., Bastos, R. R., & Ronzani, T. M. (2013). Mental health conditions, individual and job characteristics and sleep disturbances among firefighters. *Journal of Health Psychology*, 18(3), 350-358.  
doi:10.1177/1359105312443402

Dietrich, J. F., & Smith, J. (1986). The nonmedical use of drugs including alcohol among police personnel: A critical literature review. *Journal of Police Science & Administration*, 14(4), 300-306.

Dixon, L. J., Leen-Feldner, E. W., Ham, L. S., Feldner, M. T., & Lewis, S. F. (2009). Alcohol use motives among traumatic event-exposed, treatment-seeking adolescents: associations with posttraumatic stress. *Addictive Behaviors*, 34(12), 1065-1068. doi:10.1016/j.addbeh.2009.06.008

Dvorak, R. D., Pearson, M. R., & Day, A. M. (2014). Ecological momentary assessment of acute alcohol use disorder symptoms: associations with mood, motives, and use on planned drinking days. *Experimental and Clinical Psychopharmacology*, 22(4), 285-297. doi:10.1037/a0037157

Fairholme, C. P., Nosen, E. L., Nillni, Y. I., Schumacher, J. A., Tull, M. T., & Coffey, S. F. (2013). Sleep disturbance and emotion dysregulation as transdiagnostic processes in a comorbid sample. *Behavior Research and Therapy*, 51(9), 540-546.  
doi:10.1016/j.brat.2013.05.014

Foster, J. H., Marshall, E. J., & Peters, T. J. (1998). Predictors of relapse to heavy drinking in alcohol dependent subjects following alcohol detoxification-the role

of quality of life measures, ethnicity, social class, cigarette and drug use.

*Addiction Biology*, 3(3), 333-343. doi:10.1080/13556219872146

Foster, J. H., & Peters, T. J. (1999). Impaired sleep in alcohol misusers and dependent alcoholics and the impact upon outcome. *Alcoholism: Clinical and Experimental Research*, 23(6), 1044-1051. doi: 10.1097/00000374-199906000-00012

Fuehrlein, B. S., Mota, N., Arias, A. J., Trevisan, L. A., Kachadourian, L. K., Krystal, J. H., . . . Pietrzak, R. H. (2016). The burden of alcohol use disorders in US military veterans: results from the National Health and Resilience in Veterans Study. *Addiction*, 111(10), 1786-1794. doi:10.1111/add.13423

Garcia Carretero, M. A., Novalbos Ruiz, J. P., Martinez Delgado, J. M., & O'Ferrall Gonzalez, C. (2016). Validation of the Alcohol Use Disorders Identification Test in university students: AUDIT and AUDIT-C. *Adicciones*, 28(4), 194-204. doi:10.20882/adicciones.775

Gehrman, P., Seelig, A. D., Jacobson, I. G., Boyko, E. J., Hooper, T. I., Gackstetter, G. D., . . . Smith, T. C. (2013). Predeployment Sleep Duration and Insomnia Symptoms as Risk Factors for New-Onset Mental Health Disorders Following Military Deployment. *Sleep*, 36(7), 1009-1018. doi:10.5665/sleep.2798

Germain, A. (2013). Sleep disturbances as the hallmark of PTSD: where are we now? *American Journal of Psychiatry*, 170(4), 372-382. doi:10.1176/appi.ajp.2012.12040432

Grant, B. F., Goldstein, R. B., Saha, T. D., Chou, S. P., Jung, J., Zhang, H., . . . Hasin, D. S. (2015). Epidemiology of DSM-5 Alcohol Use Disorder: Results From the

- National Epidemiologic Survey on Alcohol and Related Conditions III. *JAMA Psychiatry*, 72(8), 757-766. doi:10.1001/jamapsychiatry.2015.0584
- Gray, M. J., Litz, B. T., Hsu, J. L., & Lombardo, T. W. (2004). Psychometric properties of the life events checklist. *Assessment*, 11(4), 330-341.  
doi:10.1177/1073191104269954
- Haddock, C. K., Day, R. S., Poston, W. S., Jahnke, S. A., & Jitnarin, N. (2015). Alcohol use and caloric intake from alcohol in a national cohort of U.S. career firefighters. *Journal of Studies on Alcohol and Drugs*, 76(3), 360-366. doi: 10.1037/t14973-000
- Haddock, C. K., Jahnke, S. A., Poston, W. S., Jitnarin, N., Kaipust, C. M., Tuley, B., & Hyder, M. L. (2012). Alcohol use among firefighters in the Central United States. *Occupational Medicine*, 62(8), 661-664. doi:10.1093/occmed/kqs162
- Hartwell, E. E., Bujarski, S., Glasner-Edwards, S., & Ray, L. A. (2015). The Association of Alcohol Severity and Sleep Quality in Problem Drinkers. *Alcohol and Alcoholism*, 50(5), 536-541. doi:10.1093/alcalc/agt046
- Harvey, S. B., Milligan-Saville, J. S., Paterson, H. M., Harkness, E. L., Marsh, A. M., Dobson, M., . . . Bryant, R. A. (2016). The mental health of fire-fighters: An examination of the impact of repeated trauma exposure. *The Australian and New Zealand Journal of Psychiatry*, 50(7), 649-658. doi:10.1177/0004867415615217
- Haslam, C., & Mallon, K. (2003). A preliminary investigation of post-traumatic stress symptoms among firefighters. *Work & Stress: An International Journal of Work, Health, & Organizations*, 17(3), 277-285. doi:10.1080/02678370310001625649

- Haugen, P. T., Evces, M., & Weiss, D. S. (2012). Treating posttraumatic stress disorder in first responders: A systematic review. *Clinical Psychology Review, 32*(5), 370-380. doi:10.1016/j.cpr.2012.04.001
- The National Institute for Occupational Safety and Health. (1999). Stress at work (DHHS, NIOSH Publication No. 99-101). Retrieved from <https://www.cdc.gov/niosh/docs/99-101/>
- Hildebrand, M., & Noteborn, M. G. (2015). Exploration of the (Interrater) Reliability and Latent Factor Structure of the Alcohol Use Disorders Identification Test (AUDIT) and the Drug Use Disorders Identification Test (DUDIT) in a Sample of Dutch Probationers. *Substance Use and Misuse, 50*(10), 1294-1306. doi:10.3109/10826084.2014.998238
- Holahan, C. J., Moos, R. H., Holahan, C. K., Cronkite, R. C., & Randall, P. K. (2001). Drinking to cope, emotional distress and alcohol use and abuse: a ten-year model. *Journal of Studies on Alcohol, 62*(2), 190-198. doi: 10.15288/jsa.2001.62.190
- Hom, M. A., Stanley, I. H., Ringer, F. B., & Joiner, T. E. (2016). Mental health service use among firefighters with suicidal thoughts and behaviors. *Psychiatric Services, 67*(6), 688-691. doi:10.1176/appi.ps.201500177
- Hom, M. A., Stanley, I. H., Spencer-Thomas, S., & Joiner, T. E. (2017). Women Firefighters and Workplace Harassment: Associated Suicidality and Mental Health Sequelae. *Journal of Nervous and Mental Disease, 205*(12), 910-917. doi:10.1097/nmd.0000000000000759
- IBM Corporation. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.

- Jahnke, S. A., Poston, W. S., Haddock, C. K., Jitnarin, N., Hyder, M. L., & Horvath, C. (2012). The health of women in the US fire service. *BMC Womens Health, 12*, 39. doi:10.1186/1472-6874-12-39
- Johnson, E. O., Roehrs, T., Roth, T., & Breslau, N. (1998). Epidemiology of alcohol and medication as aids to sleep in early adulthood. *Sleep, 21*(2), 178-186. doi: 10.1093/sleep/21.2.178
- Jones, S. (2017). Describing the Mental Health Profile of First Responders: A Systematic Review. *Journal of the American Psychiatric Nurses Association, 23*(3), 200-214. doi:10.1177/1078390317695266
- Kenney, S. R., Lac, A., Labrie, J. W., Hummer, J. F., & Pham, A. (2013). Mental health, sleep quality, drinking motives, and alcohol-related consequences: A path-analytic model. *Journal of Studies on Alcohol and Drugs, 74*(6), 841-851. doi: 10.15288/jsad.2013.74.841
- Kenney, S. R., Paves, A. P., Grimaldi, E. M., & LaBrie, J. W. (2014). Sleep quality and alcohol risk in college students: Examining the moderating effects of drinking motives. *Journal of American College Health, 62*(5), 301-308. doi:10.1080/07448481.2014.897953
- Kessler, R. C., Chiu, W. T., Demler, O., & Walters, E. E. (2005). Prevalence, Severity, and Comorbidity of Twelve-month DSM-IV Disorders in the National Comorbidity Survey Replication (NCS-R). *Archives of General Psychiatry, 62*(6), 617–627. doi:http://doi.org/10.1001/archpsyc.62.6.617
- Kessler, R. C., Sonnega, A., Bromet, E., Hughes, M., & Nelson, C. B. (1995). Posttraumatic stress disorder in the National Comorbidity Survey. *Archives of*

*General Psychiatry*, 52(12), 1048-1060.

doi:10.1001/archpsyc.1995.03950240066012

Khantzian, E. J. (1999). *Treating addiction as a human process*. Northvale, NJ: Jason Aronson.

Kimbrel, N. A., Steffen, L.E., Meyer, E.C., Kruse, M. I., Knight, J. A., Zimering, R. T., Gulliver, S. B. (2011). A revised measure of occupational stress for fire fighters: Psychometric properties and relationship to PTSD, depression, and substance abuse. *Psychological Services*, 8(4), 294-306. doi:10.1037/a0025845

Kolla, B. P., Schneekloth, T., Biernacka, J., Mansukhani, M., Geske, J., Karpyak, V., . . . Frye, M. A. (2014). The course of sleep disturbances in early alcohol recovery: An observational cohort study. *American Journal on Addictions*, 23(1), 21-26. doi:10.1111/j.1521-0391.2013.12056.x

Komarovskaya, I., Brown, A., Galatzer-Levy, I. R., Madan, A., Henn-Haase, C., Teater, J., . . . Chemtob, C. M. (2014). Early physical victimization is a risk factor for posttraumatic stress disorder symptoms among Mississippi police and firefighter first responders to Hurricane Katrina. *Psychological Trauma: Theory, Research, Practice, and Policy*, 6(1), 92-96. doi: 10.1037/a0031600

Kuntsche, E., Knibbe, R., Engels, R., Gmel, G. (2010). Being drunk to have fun or to forget problems? Identifying enhancement and coping drinkers among risky drinking adolescents. *European Journal of Psychological Assessment*, 26(1), 46-54. doi: 10.1027/1015-5759/a000007

Kuntsche, E., & Kuntsche, S. (2009). Development and validation of the Drinking Motive Questionnaire Revised Short Form (DMQ-R SF). *Journal of Clinical*

*Child and Adolescent Psychology*, 38(6), 899-908.

doi:10.1080/15374410903258967

Lee, J. H., Lee, D., Kim, J., Jeon, K., & Sim, M. (2017). Duty-Related Trauma Exposure and Posttraumatic Stress Symptoms in Professional Firefighters. *Journal of Traumatic Stress*, 30(2), 133-141. doi:10.1002/jts.22180

Lind, M. J., Brown, E., Farrell-Carnahan, L., Brown, R. C., Hawn, S., Berenz, E., . . . Amstadter, A. B. (2017). Sleep disturbances in OEF/OIF/OND veterans: Associations with PTSD, personality, and coping. *Journal of Clinical Sleep Medicine*, 13(2), 291-299. doi:10.5664/jcsm.6466

Lusa, S., Häkkänen, M., Luukkonen, R., & Viikari-Juntura, E. (2002). Perceived physical work capacity, stress, sleep disturbance and occupational accidents among firefighters working during a strike. *Work & Stress: An International Journal of Work, Health, & Organizations*, 16(3), 264-275.

doi:10.1080/02678370210163301

Maguen, S., Metzler, T. J., McCaslin, S. E., Inslicht, S. S., Henn-Haase, C., Neylan, T. C., & Marmar, C. R. (2009). Routine work environment stress and PTSD symptoms in police officers. *Journal of Nervous and Mental Disease*, 197(10), 754-760. doi:10.1097/NMD.0b013e3181b975f8

Mahfoud, Y., Talih, F., Strem, D., & Budur, K. (2009). Sleep disorders in substance abusers: How common are they? *Psychiatry (Edgmont)*, 6(9), 38-42.

Mariman, A., Vogelaers, D., Hanouille, I., Delesie, L., Tobback, E., & Pevernagie, D. (2012). Validation of the three-factor model of the PSQI in a large sample of



- chronic fatigue syndrome (CFS) patients. *Journal of Psychosomatic Research*, 72(2), 111-113. doi:10.1016/j.jpsychores.2011.11.004
- Marsh, H. W., & Hau, K. T. (2014). Assessing goodness of fit: Is parsimony always desirable? *The Journal of Experimental Education*, 64(4), 364-390.  
doi:<https://doi.org/10.1080/00220973.1996.10806604>
- Mazzardis, S., Vieno, A., Kuntsche, E., & Santinello, M. (2010). Italian validation of the drinking motives questionnaire revised short form (DMQ-R SF). *Addictive Behaviors*, 35(10), 905-908. doi:10.1016/j.addbeh.2010.05.002
- McCauley, J. L., Killeen, T., Gros, D. F., Brady, K. T., & Back, S. E. (2012).  
Posttraumatic stress disorder and co-occurring substance use disorders: Advances in assessment and treatment. *Clinical Psychology*, 19(3). doi:10.1111/cpsp.12006
- McCubbin, J. A., Zinzow, H. M., Hibdon, M. A., Nathan, A. W., Morrison, A. V., Hayden, G. W., . . . Switzer, F. S. (2016). Subclinical posttraumatic stress disorder symptoms: Relationships with blood pressure, hostility, and sleep. *Cardiovascular Psychiatry and Neurology*, 2016, 4720941.  
doi:10.1155/2016/4720941
- McDevitt-Murphy, M. E., Fields, J. A., Monahan, C. J., & Bracken, K. L. (2015).  
Drinking motives among heavy-drinking veterans with and without posttraumatic stress disorder. *Addiction Research & Theory*, 23(2), 148-155.  
doi:10.3109/16066359.2014.949696
- McFarlane, A. C., & Papay, P. (1992). Multiple diagnoses in posttraumatic stress disorder in the victims of a natural disaster. *Journal of Nervous and Mental Disease*, 180(8), 1992. doi: 10.1097/00005053-199208000-00004

- Mellman, T. A., David, D., Kulick-Bell, R., Hebding, J., & Nolan, B. (1995). Sleep disturbance and its relationship to psychiatric morbidity after Hurricane Andrew. *American Journal of Psychiatry*, *152*(11), 1659-1663.  
doi:10.1176/ajp.152.11.1659
- Meneses-Gaya, C., Waldo Zuardi, A., Regina Loureiro, S., & Crippa, J. A. S. (2009). Alcohol Use Disorders Identification Test (AUDIT): An updated systematic review of psychometric properties. *Psychology and Neuroscience*, *2*(1), 83-97.  
doi:10.3922/j.psns.2009.1.12
- Meyer, E. C., Zimering, R., Daly, E., Knight, J., Kamholz, B. W., & Gulliver, S. B. (2012). Predictors of posttraumatic stress disorder and other psychological symptoms in trauma-exposed firefighters. *Psychological Services*, *9*(1), 1-15.  
doi:10.1037/a0026414
- Milliken, C. S., Auchterlonie, J. L., & Hoge, C. W. (2007). Longitudinal assessment of mental health problems among active and reserve component soldiers returning from the Iraq war. *Journal of the American Medical Association*, *298*(18), 2141-2148. doi:10.1001/jama.298.18.2141
- Mollayeva, T., Thurairajah, P., Burton, K., Mollayeva, S., Shapiro, C. M., & Colantonio, A. (2016). The Pittsburgh sleep quality index as a screening tool for sleep dysfunction in clinical and non-clinical samples: A systematic review and meta-analysis. *Sleep Medicine Review*, *25*, 52-73. doi:10.1016/j.smr.2015.01.009
- Murphy, S. A., Beaton, R. D., Pike, K. C., & Johnson, L. C. (1999). Occupational stressors, stress responses, and alcohol consumption among professional

- firefighters: A prospective, longitudinal analysis. *International Journal of Stress Management*, 6(3), 179-196. doi:10.1023/A:1021934725246
- Muthén, B. O. (2018, February 19, 2018). [Latent Interaction R-Squared].
- Muthén, L. K., & Muthén, B. O. (1998-2017). *Mplus User's Guide* (Eighth Edition ed.). Los Angeles, CA: Muthén & Muthén.
- Nemeth, Z., Urban, R., Kuntsche, E., San Pedro, E. M., Roales Nieto, J. G., Farkas, J., . . . Demetrovics, Z. (2011). Drinking motives among Spanish and Hungarian young adults: a cross-national study. *Alcohol and Alcoholism*, 46(3), 261-269. doi:10.1093/alcalc/agr019
- Newcombe, D. A., Humeniuk, R. E., & Ali, R. (2005). Validation of the World Health Organization Alcohol, Smoking and Substance Involvement Screening Test (ASSIST): report of results from the Australian site. *Drug and Alcohol Review*, 24(3), 217-226. doi:10.1080/09595230500170266
- Nishith, P., Resick, P. A., & Mueser, K. T. (2001). Sleep difficulties and alcohol use motives in female rape victims with posttraumatic stress disorder. *Journal of Traumatic Stress*, 14(3), 469-479. doi:10.1023/a:1011152405048
- North, C. S., Tivis, L., McMillen, J. C., Pfefferbaum, B., Cox, J., Spitznagel, E. L., . . . Smith, E. M. (2002). Coping, functioning, and adjustment of rescue workers after the Oklahoma City bombing. *Journal of Traumatic Stress*, 15(3), 171-175. doi:10.1023/a:1015286909111
- North, C. S., Tivis, L., McMillen, J. C., Pfefferbaum, B., Spitznagel, E. L., Cox, J., . . . Smith, E. M. (2002). Psychiatric disorders in rescue workers after the Oklahoma

City bombing. *American Journal of Psychiatry*, 159(5), 857-859.

doi:10.1176/appi.ajp.159.5.857

- O'Hare, T., & Sherrer, M. (2011). Drinking motives as mediators between PTSD symptom severity and alcohol consumption in persons with severe mental illnesses. *Addictive Behaviors*, 36(5), 465-469. doi:10.1016/j.addbeh.2011.01.006
- Ohayon, M. M. (2002). Epidemiology of insomnia: What we know and what we still need to learn. *Sleep Medicine Review*, 6(2), 97-111. doi: 10.1053/smr.2002.0186
- Ohayon, M. M., & Shapiro, C. M. (2000). Sleep disturbances and psychiatric disorders associated with posttraumatic stress disorder in the general population. *Comprehensive Psychiatry*, 41(6), 469-478. doi:10.1053/comp.2000.16568
- Pace-Schott, E. F., Germain, A., & Milad, M. R. (2015). Sleep and REM sleep disturbance in the pathophysiology of PTSD: the role of extinction memory. *Biology of Mood and Anxiety Disorders*, 5, 3. doi:10.1186/s13587-015-0018-9
- Patrick, M. E., & Schulenberg, J. E. (2011). How trajectories of reasons for alcohol use relate to trajectories of binge drinking: National panel data spanning late adolescence to early adulthood. *Developmental Psychology*, 47(2), 311-317. doi:10.1037/a0021939
- Paulus, D. J., Vujanovic, A. A., Schuhmann, B. B., Smith, L. J., & Tran, J. (2017). Main and interactive effects of depression and posttraumatic stress in relation to alcohol dependence among urban male firefighters. *Psychiatry Research*, 251, 69-75. doi:10.1016/j.psychres.2017.02.011

- Piazza-Gardner, A. K., Barry, A. E., Chaney, E., Dodd, V., Weiler, R., & Delisle, A. (2014). Covariates of alcohol consumption among career firefighters. *Occupational Medicine*, 64(8), 580-582. doi:10.1093/occmed/kqu124
- Pietrzak, R. H., Goldstein, R. B., Southwick, S. M., & Grant, B. F. (2011a). Medical comorbidity of full and partial posttraumatic stress disorder in US adults: results from Wave 2 of the National Epidemiologic Survey on Alcohol and Related Conditions. *Psychosomatic Medicine*, 73(8), 697-707. doi:10.1097/PSY.0b013e3182303775
- Pietrzak, R. H., Goldstein, R. B., Southwick, S. M., & Grant, B. F. (2011b). Prevalence and Axis I comorbidity of full and partial posttraumatic stress disorder in the United States: results from Wave 2 of the National Epidemiologic Survey on Alcohol and Related Conditions. *Journal of Anxiety Disorders*, 25(3), 456-465. doi:10.1016/j.janxdis.2010.11.010
- Richman, J. A., Flaherty, J. A., & Pyskoty, C. (1992). Shifts in problem drinking during a life transition: Adaptation to medical school training. *Journal of Studies on Alcohol*, 53(1), 17-24. doi: 10.15288/jsa.1992.53.17
- Roehrs, T., & Roth, T. (2001). Sleep, sleepiness, sleep disorders and alcohol use and abuse. *Sleep Medicine Review*, 5(4), 287-297. doi:10.1053/smr.2001.0162
- Ross, R. J., Ball, W. A., Sullivan, K. A., & Caroff, S. N. (1989). Sleep disturbance as the hallmark of posttraumatic stress disorder. *American Journal of Psychiatry*, 146(6), 697-707. doi:10.1176/ajp.146.6.697
- Rubio Valladolid, G., Bermejo Vicedo, J., Caballero Sanchez-Serrano, M. C., & Santo-Domingo Carrasco, J. (1998). Validation of the Alcohol Use Disorders

- Identification Test (AUDIT) in primary care. *Revista Clínica Española*, 198(1), 11-14.
- Saladin, M. E., Brady, K. T., Dansky, B. S., & Kilpatrick, D. G. (1995). Understanding comorbidity between PTSD and substance use disorders: Two preliminary investigations. *Addictive Behaviors*, 20(5), 643-655. doi:10.1016/0306-4603(95)00024-7
- Saunders, J. B., Aasland, O. G., Babor, T. F., de la Fuente, J. R., & Grant, M. (1993). Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption--II. *Addiction*, 88(6), 791-804. doi:10.1111/j.1360-0443.1993.tb02093.x
- Schmidt, A., Barry, K. L., & Fleming, M. F. (1995). Detection of problem drinkers: The Alcohol Use Disorders Identification Test (AUDIT). *Southern Medical Journal*, 88(1), 52-59. doi:10.1097/00007611-199501000-00007
- Selin, K. H. (2003). Test-retest reliability of the alcohol use disorder identification test in a general population sample. *Alcoholism: Clinical and Experimental Research*, 27(9), 1428-1435. doi:10.1097/01.alc.0000085633.23230.4a
- Short, N. A., Babson, K. A., Boden, M. T., & Bonn-Miller, M. O. (2014). Sleep quality, problematic cannabis use and posttraumatic stress symptoms among medical cannabis users. *Addiction Research & Theory*, 23(3), 246-252. doi:10.3109/16066359.2014.981259
- Simpson, T. L., Stappenbeck, C. A., Luterek, J. A., Lehavot, K., & Kaysen, D. L. (2014). Drinking motives moderate daily relationships between PTSD symptoms and

alcohol use. *Journal of Abnormal Psychology*, 123(1), 237-247.

doi:10.1037/a0035193

Smith, D. R., Devine, S., Leggat, P. A., & Ishitake, T. (2005). Alcohol and tobacco consumption among police officers. *The Kurume Medical Journal*, 52(1-2), 63-65. doi: 10.2739/kurumemedj.52.63

Sobell, L. C., & Sobell, M. B. (1992). *Timeline Follow-back: A technique for assessing self-reported alcohol consumption*. Towota, NJ: Humana Press.

Spoormaker, V. I., & Montgomery, P. (2008). Disturbed sleep in post-traumatic stress disorder: secondary symptom or core feature? *Sleep Medicine Reviews*, 12(3), 169-184. doi:10.1016/j.smr.2007.08.008

Stanley, I. H., Boffa, J. W., Hom, M. A., Kimbrel, N. A., & Joiner, T. E. (2017). Differences in psychiatric symptoms and barriers to mental health care between volunteer and career firefighters. *Psychiatry Research*, 247, 236-242. doi:10.1016/j.psychres.2016.11.037

Stappenbeck, C. A., Bedard-Gilligan, M., Lee, C. M., & Kaysen, D. (2013). Drinking motives for self and others predict alcohol use and consequences among college women: the moderating effects of PTSD. *Addictive Behaviors*, 38(3), 1831-1839. doi:10.1016/j.addbeh.2012.10.012

Sterud, T., Hem, E., Ekeberg, O., & Lau, B. (2007). Occupational stress and alcohol use: A study of two nationwide samples of operational police and ambulance, personnel in Norway. *Journal of Studies on Alcohol and Drugs*, 68(6), 896-904. doi: 10.15288/jsad.2007.68.896

- Stewart, S. H., Mitchell, T. L., Wright, K. D., & Loba, P. (2004). The relations of PTSD symptoms to alcohol use and coping drinking in volunteers who responded to the Swissair Flight 111 airline disaster. *Journal of Anxiety Disorders, 18*(1), 51-68. doi: 10.1016/j.janxdis.2003.07.006
- Stewart, S. H., Pihl, R. O., Conrod, P. J., & Dongier, M. (1998). Functional associations among trauma, PTSD, and substance-related disorders. *Addictive Behaviors, 23*(6), 797-812. doi: 10.1016/S0306-4603(98)00070-7
- Straud, C., Henderson, S. N., Vega, L., Black, R., & Van Hasselt, V. (2018). Resiliency and posttraumatic stress symptoms in firefighter paramedics: The mediating role of depression, anxiety, and sleep. *Traumatology*. Advanced online publication. doi:10.1037/trm0000142
- Taylor, D. J., Lichstein, K. L., & Durrence, H. H. (2003). Insomnia as a health risk factor. *Behavioral Sleep Medicine, 1*(4), 227-247. doi:10.1207/s15402010bsm0104\_5
- Todd, M., Armeli, S., Tennen, H., Carney, M. A., Ball, S. A., Kranzler, H. R., & Affleck, G. (2005). Drinking to cope: A comparison of questionnaire and electronic diary reports. *Journal of Studies on Alcohol, 66*, 121-129. doi: 10.15288/jsa.2005.66.121
- Tomaka, J., Magoc, D., Morales-Monks, S. M., & Reyes, A. C. (2017). Posttraumatic stress symptoms and alcohol-related outcomes among municipal firefighters. *Journal of Traumatic Stress, 30*(4), 416-424. doi:10.1002/jts.22203
- Tomarken, A. J., & Waller, N. G. (2005). Structural equation modeling: Strengths, limitations, and misconceptions. *Annual Review of Clinical Psychology, 1*, 31-65. doi:10.1146/annurev.clinpsy.1.102803.144239



- Tomfohr, L. M., Schweizer, C. A., Dimsdale, J. E., & Loreda, J. S. (2013). Psychometric characteristics of the Pittsburgh Sleep Quality Index in English speaking non-Hispanic whites and English and Spanish speaking Hispanics of Mexican descent. *Journal of Clinical Sleep Medicine*, 9(1), 61-66. doi:10.5664/jcsm.2342
- Vandrey, R., Babson, K. A., Herrmann, E. S., & Bonn-Miller, M. O. (2014). Interactions between disordered sleep, post-traumatic stress disorder, and substance use disorders. *International Review of Psychiatry*, 26(2), 237-247. doi:10.3109/09540261.2014.901300
- Vincent, G., Ferguson, S. A., Tran, J., Larsen, B., Wolkow, A., & Aisbett, B. (2015). Sleep restriction during simulated wildfire suppression: effect on physical task performance. *PLoS One*, 10(1), e0115329. doi:10.1371/journal.pone.0115329
- Vincent, G. E., Aisbett, B., Hall, S. J., & Ferguson, S. A. (2016). Fighting fire and fatigue: sleep quantity and quality during multi-day wildfire suppression. *Ergonomics*, 59(7), 932-940. doi:10.1080/00140139.2015.1105389
- Violanti, J. M., Marshall, J. R., & Howe, B. (1985). Stress, coping, and alcohol use: The police connection. *Journal of Police Science & Administration*, 13(2), 106-110.
- Waldrop, A. E., Back, S. E., Verduin, M. L., & Brady, K. T. (2007). Triggers for cocaine and alcohol use in the presence and absence of posttraumatic stress disorder. *Addictive Behaviors*, 32(3), 634-639. doi:10.1016/j.addbeh.2006.06.001
- Wallen, G. R., Brooks, A. T., Whiting, B., Clark, R., Krumlauf, M. C., Yang, L., . . . Ramchandani, V. A. (2014). The prevalence of sleep disturbance in alcoholics admitted for treatment: a target for chronic disease management. *Family & Community Health*, 37(4), 288-297. doi:10.1097/fch.0000000000000040

- Ward, J., & Winstanley, D. (2006). Watching the watch: The UK fire service and its impact on sexual minorities in the workplace. *Gender, Work, and Organization*, 13(2), 193-219. doi: 10.1111/j.1468-0432.2006.00304.x
- Weathers, F. W., Blake, D. D., Schnurr, P. P., Kaloupek, D. G., Marx, B. P., & Keane, T. M. (2013). The Life Events Checklist for DSM-5 (LEC-5). *Instrument available from the National Center for PTSD at www.ptsd.va.gov.*
- Wild, J., Smith, K. V., Thompson, E., Bear, F., Lommen, M. J., & Ehlers, A. (2016). A prospective study of pre-trauma risk factors for post-traumatic stress disorder and depression. *Psychological Medicine*, 46(12), 2571-2582.  
doi:10.1017/s0033291716000532
- Witteveen, A. B., Huizink, A. C., Slottje, P., Bramsen, I., Smid, T., & van der Ploeg, H. M. (2010). Associations of cortisol with posttraumatic stress symptoms and negative life events: a study of police officers and firefighters. *Psychoneuroendocrinology*, 35(7), 1113-1118.  
doi:10.1016/j.psyneuen.2009.12.013
- Wolkow, A., Ferguson, S., Aisbett, B., & Main, L. (2015). Effects of work-related sleep restriction on acute physiological and psychological stress responses and their interactions: A review among emergency service personnel. *International Journal of Occupational Medicine Environmental Health*, 28(2), 183-208.  
doi:10.13075/ijomeh.1896.00227
- Wong, M. M., Brower, K. J., Fitzgerald, H. E., & Zucker, R. A. (2004). Sleep problems in early childhood and early onset of alcohol and other drug use in adolescence.

*Alcoholism: Clinical and Experimental Research*, 28(4), 578-587. doi:  
10.1097/01.ALC.0000121651.75952.39

Yeater, E. A., Austin, J. L., Green, M. J., & Smith, E. J. (2010). Coping mediates the relationship between posttraumatic stress disorder (PTSD) symptoms and alcohol use in homeless, ethnically diverse women: A preliminary study. *Psychological Trauma: Theory, Research, Practice, and Policy*, 2(4), 307-310.  
doi:10.1037/a0021779

Yoder, J. D., & Aniakudo, P. (1996). When pranks become harassment: The case of African American women firefighters. *Sex Roles*, 35(5-6), 253-270. doi:  
10.1007/BF01664768

Yun, J. A., Ahn, Y. S., Jeong, K. S., Joo, E. J., & Choi, K. S. (2015). The Relationship between Chronotype and Sleep Quality in Korean Firefighters. *Clinical Psychopharmacology and Neuroscience*, 13(2), 201-208.  
doi:10.9758/cpn.2015.13.2.201

Zlotnick, C., Franklin, C. L., & Zimmerman, M. (2002). Does "subthreshold" posttraumatic stress disorder have any clinical relevance? *Comprehensive Psychiatry*, 43(6), 413-419. doi:10.1053/comp.2002.35900

Table 1.  
*Participant Characteristics*

	Participants (n=639)
<b>Age (years)</b>	38.5 (8.6)
<b>Sex</b>	
Male	93.6% (598)
Female	5.6% (36)
Transgender	0.8% (5)
<b>Race</b>	
White	77.9% (498)
Hispanic/Latino	26.1% (167)
African American	10.8% (69)
Asian	1.6% (10)
American Indian or Alaskan Native	1.9% (12)
Other	7.7% (49)
<b>Education</b>	
GED/equivalent	0.3% (2)
High School Graduate	8.0% (51)
Some College	46.5% (297)
College Graduate	44.9% (287)
<b>Relationship Status</b>	
Married	68.1% (435)
Living with a Partner	5.2% (33)
Single	19.1% (122)
Divorced	7.4% (47)
Widowed	0.3% (2)
<b>Fire Department Tenure</b>	13.1 (8.8)
<b>Posttraumatic Stress Severity<sup>a</sup></b>	
Traumatic Event Exposures	12.6 (4.01)
PTSD Diagnosis (PCL-5 Total $\geq$ 33)	9.9% (63)
<b>Alcohol Use<sup>b</sup></b>	
Drinks Monthly or less	27.7% (177)
Drinks 2-4 times a month	31.0% (198)
Drinks 2-3 times a week	28.2% (180)
Drinks 4 or more times a week	13.1% (84)
Hazardous Alcohol Use (AUDIT $\geq$ 8)	23.3% (149)
<b>Sleep Disturbance<sup>c</sup></b>	
Disturbed Sleep (PSQI Total $\geq$ 5)	60.3% (385)

*Note.* Values are Mean (Standard Deviation) or N (%), as appropriate.

<sup>a</sup> Information on Posttraumatic stress severity obtained from the PTSD Checklist for DSM-5 (PCL-5; Blevins et al., 2015).

<sup>b</sup> Information on alcohol use obtained from the Alcohol Use Disorders Identification Test (AUDIT; Saunders et al., 1993) questionnaire.

<sup>c</sup> Information on disturbed sleep obtained from the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989).

<sup>d</sup> Information on occupational stress obtained from the Sources of Occupational Stress Scale -14 (SOOS-14; Kimbrel, 2011).

Table 2.

*Descriptive statistics and correlations for study variables (n=639)*

	1	2	3	4	5	6	7	8	9	Mean	SD
1. Years of Fire Service	-	-	-	-	-	-	-	-	-	13.14	8.78
2. Occupational Stress	.06	-	-	-	-	-	-	-	-	25.49	9.95
3. Posttraumatic Stress Severity	.01	.63**	-	-	-	-	-	-	-	9.20	12.77
4. Sleep Disturbance	.01	.45**	.46**	-	-	-	-	-	-	6.12	3.72
5. Alcohol Use Severity	-.04	.27**	.40**	.30**	-	-	-	-	-	5.59	5.05
6. Alcohol Use Coping Motives	-.03	.36**	.50**	.41**	.54**	-	-	-	-	3.79	1.39
7. Alcohol Use Enhancement Motives	-.11**	.23**	.23**	.21**	.52**	.54**	-	-	-	4.57	1.46
8. Alcohol Use Conformity Motives	-.04	.21**	.30**	.25**	.36**	.50**	.36**	-	-	3.40	0.98
9. Alcohol Use Social Motives	-.11**	.22**	.20**	.23**	.43**	.45**	.73**	.38**	-	4.95	1.81

*Note.* \*\* $p < .01$ ; Years in the service = demographic measures; Occupational Stress = SOOS-14 total score (Kimbrel, 2011); Posttraumatic Stress Severity = PCL-5 total score (Blevins et al., 2015); Sleep Disturbance = PSQI total score (Buysse et al., 1989); Alcohol Use Severity = AUDIT total score (Saunders et al., 1993); Coping Motives = DMQ-R-SF coping motives subscale (Kuntsche & Kuntsche, 2009); Enhancement Motives = DMQ-R-SF enhancement motives subscale (Kuntsche & Kuntsche, 2009); Social Motives = DMQ-R-SF social motives subscale (Kuntsche & Kuntsche, 2009); Conformity Motives = DMQ-R-SF conformity motives subscale (Kuntsche & Kuntsche, 2009).

Table 3.

*Descriptive statistics and correlations for indicator variables (n=639)*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Mean	SD
1. Posttraumatic Stress Intrusion	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.13	3.10
2. Posttraumatic Stress Avoidance	.81**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.21	1.86
3. Posttraumatic Stress Negative Cognitions/Mood	.84**	.79**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.18	4.98
4. Posttraumatic Stress Arousal	.75**	.71**	.84**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.67	3.85
5. Sleep Efficiency	.23**	.23**	.25**	.22**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.90	1.54
6. Perceived Sleep Quality	.32**	.30**	.34**	.34**	.41**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.64	1.94
7. Daily Sleep Disturbances	.45**	.46**	.48**	.47**	.30**	.56**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.58	1.21
8. Hazardous Alcohol Use	.21**	.19**	.19**	.21**	.05	.19**	.20**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.99	2.36
9. Alcohol Dependence	.38**	.37**	.43**	.42**	.16**	.23**	.25**	.45**	-	-	-	-	-	-	-	-	-	-	-	-	-	0.70	1.73
10. Harmful Alcohol Use	.32**	.32**	.37**	.39**	.18**	.28**	.33**	.50**	.77**	-	-	-	-	-	-	-	-	-	-	-	-	0.90	1.92
11. Alcohol Use Coping Motives 1	.44**	.45**	.47**	.42**	.16**	.30**	.38**	.38**	.43**	.41**	-	-	-	-	-	-	-	-	-	-	-	1.25	0.52
12. Alcohol Use Coping Motives 2	.46**	.46**	.48**	.43**	.21**	.33**	.42**	.34**	.46**	.46**	.68**	-	-	-	-	-	-	-	-	-	-	1.21	0.49
13. Alcohol Use Coping Motives 3	.36**	.35**	.34**	.32**	.17**	.31**	.37**	.43**	.35**	.39**	.64**	.66**	-	-	-	-	-	-	-	-	-	1.33	0.58
14. Alcohol Use Enhancement Motives 1	.20**	.23**	.17**	.17**	.03	.20**	.20**	.47**	.26**	.32**	.42**	.36**	.45**	-	-	-	-	-	-	-	-	1.70	0.70
15. Alcohol Use Enhancement Motives 2	.26**	.27**	.27**	.30**	.10	.14**	.23**	.35**	.39**	.39**	.39**	.38**	.44**	.38**	-	-	-	-	-	-	-	1.15	0.43
16. Alcohol Use Enhancement Motives 3	.12**	.15**	.09**	.09**	.04	.15**	.17**	.45**	.22**	.26**	.28**	.30**	.40**	.59**	.35**	-	-	-	-	-	-	1.71	0.68
17. Alcohol Use Conformity Motives 1	.27**	.29**	.29**	.27**	.15**	.20**	.30**	.22**	.35**	.33**	.38**	.46**	.37**	.24**	.33**	.31**	-	-	-	-	-	1.19	0.43
18. Alcohol Use Conformity Motives 2	.18**	.18**	.22**	.23**	.12**	.15**	.17**	.16**	.33**	.32**	.32**	.45**	.33**	.15**	.38**	.20**	.56**	-	-	-	-	1.09	0.32
19. Alcohol Use Conformity Motives 3	.24**	.23**	.25**	.24**	.14**	.18**	.22**	.16**	.29**	.26**	.37**	.49**	.35**	.18**	.36**	.23**	.69**	.76**	-	-	-	1.12	0.36
20. Alcohol Use Social Motives 1	.18**	.21**	.17**	.16**	.06	.17**	.21**	.42**	.26**	.29**	.33**	.36**	.45**	.52**	.38**	.64**	.40**	.22**	.30**	-	-	1.61	0.63
21. Alcohol Use Social Motives 2	.18**	.22**	.16**	.17**	.08	.20**	.24**	.40**	.24**	.30**	.29**	.34**	.43**	.50**	.33**	.70**	.39**	.23**	.29**	.74**	-	1.72	0.66
22. Alcohol Use Social Motives 3	.19**	.21**	.16**	.17**	.08	.21**	.26**	.43**	.24**	.32**	.30**	.33**	.47**	.52**	.38**	.74**	.39**	.23**	.29**	.76**	.86**	1.62	0.66

*Note.* \*\* $p < .01$ , \* $p < .05$ ; Posttraumatic stress intrusion, posttraumatic stress avoidance, posttraumatic stress negative cognitions/mood, and posttraumatic stress arousal subscales are derived from the PCL-5 (Blevins et al., 2015); Sleep efficiency, perceived sleep quality, and daily sleep disturbances subscales (e.g., Casement et al., 2012; Cole et al., 2006; Mariman et al., 2012; Tomfohr et al., 2013) are derived from the PSQI (Buysse et al., 1989); Hazardous alcohol use, alcohol dependence, and harmful alcohol use are derived from the AUDIT (Saunders et al., 1993); Coping alcohol motive items derived from the DMQ-R-SF coping motives subscale (Kuntsche & Kuntsche, 2009); Enhancement alcohol motive items derived from the DMQ-R-SF enhancement motives subscale (Kuntsche & Kuntsche, 2009); Social alcohol motive items derived from the DMQ-R-SF social motives subscale (Kuntsche & Kuntsche, 2009); Conformity alcohol motive items derived from the DMQ-R-SF conformity motives subscale (Kuntsche & Kuntsche, 2009).

Table 4.

*Structural model unstandardized parameter estimates predicting alcohol use outcomes*

Alcohol Use Severity	Main Effects Model				Interaction Effect Model			
	<i>B</i>	SE	Lower CI	Upper CI	<i>B</i>	SE	Lower CI	Upper CI
Posttraumatic Stress Severity	0.18	0.04	0.10	0.27	-0.08	0.11	-0.30	0.15
Sleep Disturbance	0.53	0.17	0.20	0.85	0.01	0.21	-0.40	0.43
Interaction	-	-	-	-	0.15	0.07	0.02	0.28
Years of Fire Service	-0.01	0.01	-0.02	0.00	-0.01	0.01	-0.02	0.41
Occupational Stress	-0.01	0.01	-0.03	0.00	-0.02	0.01	-0.02	0.03

Alcohol Use Coping Motives	Main Effects Model				Interaction Effect Model			
	<i>B</i>	SE	Lower CI	Upper CI	<i>B</i>	SE	Lower CI	Upper CI
Posttraumatic Stress Severity	0.06	0.01	0.04	0.08	-0.01	0.02	-0.04	0.04
Sleep Disturbance	0.25	0.05	0.15	0.35	0.11	0.07	-0.02	0.23
Interaction	-	-	-	-	0.04	0.01	0.10	0.06
Years of Fire Service	0.00	0.00	-0.01	0.00	-0.01	0.01	-0.01	0.00
Occupational Stress	0.00	0.00	-0.01	0.00	-0.01	0.01	-0.01	0.00

Alcohol Use Enhancement Motives	Main Effects Model				Interaction Effect Model			
	<i>B</i>	SE	Lower CI	Upper CI	<i>B</i>	SE	Lower CI	Upper CI
Posttraumatic Stress Severity	0.00	0.01	-0.02	0.03	-0.01	0.02	-0.06	0.04
Sleep Disturbance	0.18	0.06	0.06	0.30	0.20	0.09	0.03	0.37
Interaction	-	-	-	-	0.01	0.01	-0.02	0.03
Years of Fire Service	-0.01	0.00	-0.01	-0.01	-0.01	0.01	-0.01	-0.01
Occupational Stress	0.01	0.00	-0.01	0.01	0.01	0.01	-0.01	0.01

Alcohol Use Conformity Motives	Main Effects Model				Interaction Effect Model			
	<i>B</i>	SE	Lower CI	Upper CI	<i>B</i>	SE	Lower CI	Upper CI
Posttraumatic Stress Severity	0.03	0.01	0.01	0.04	0.04	0.02	0.00	0.07
Sleep Disturbance	0.11	0.05	0.01	0.20	0.14	0.06	0.02	0.25
Interaction	-	-	-	-	-0.01	0.01	-0.03	0.01
Years of Fire Service	0.00	0.00	-0.01	0.00	-0.01	0.01	-0.01	0.00
Occupational Stress	0.00	0.00	-0.01	0.00	-0.01	0.01	-0.01	0.00

Alcohol Use Social Motives	Main Effects Model				Interaction Effect Model			
	<i>B</i>	SE	Lower CI	Upper CI	<i>B</i>	SE	Lower CI	Upper CI
Posttraumatic Stress Severity	0.00	0.01	-0.02	0.21	-0.01	0.02	-0.05	0.03
Sleep Disturbance	0.22	0.06	0.01	0.35	0.23	0.09	0.06	0.41
Interaction	-	-	-	-	0.01	0.01	-0.02	0.03
Years of Fire Service	-0.01	0.00	-0.01	-0.01	-0.01	0.01	-0.01	-0.01
Occupational Stress	0.00	0.00	-0.01	0.01	0.01	0.01	-0.01	0.01

*Note.* Alcohol use severity latent variable derived from AUDIT (Saunders et al., 1993); Alcohol use motive latent variables derived from the DMQ-R-SF (Kuntsche & Kuntsche, 2009); Posttraumatic stress severity latent variable derived from the PCL-5 (Blevins et al., 2015); Sleep disturbance latent variable derived from the PSQI (Buysse et al., 1989); Interaction latent variable is a product of posttraumatic stress severity with sleep disturbance; Years in the service variable is derived from the demographic measures; Occupational Stress variable derived from the SOOS-14 (Kimbrel, 2011).



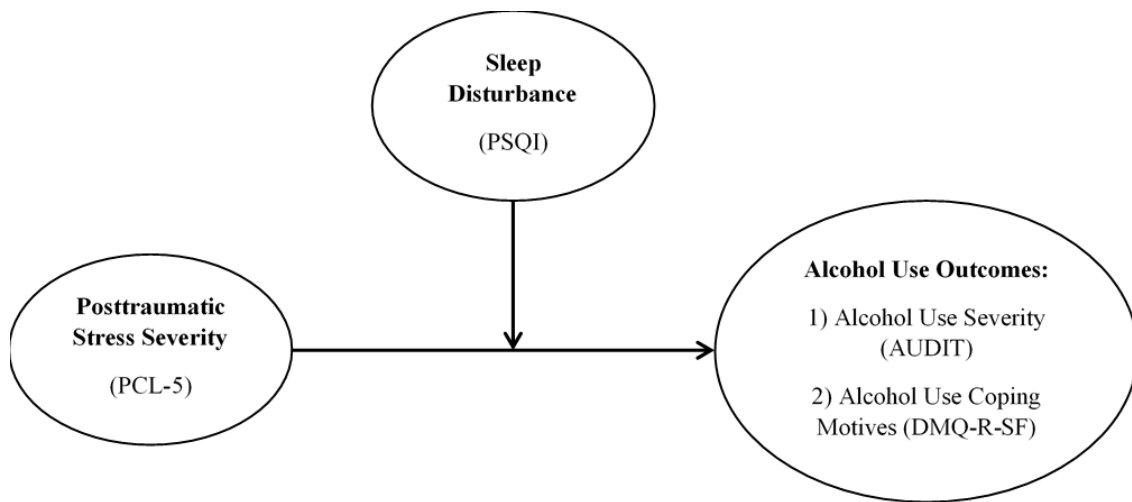


Figure 1. This figure provides a depiction of the theoretical model, whereby higher levels of sleep disturbance moderate the association between posttraumatic stress symptom severity and alcohol use outcomes, including alcohol use severity and alcohol use coping motives. Covariates included years in the fire department, derived from the demographics questionnaire, and occupational stress severity, derived from the SOOS-14 (Occupational Stress Scale Total Score; Kimbrel, 2011). PCL-5: PTSD Checklist – Civilian Version for DSM-5 Total Score (Blevins et al., 2015); PSQI: Pittsburgh Sleep Quality Index Total Score (Buysse et al., 1989); AUDIT: Alcohol Use Disorders Identification Test Total Score (Saunders et al., 1993); DMQ-R-SF: Drinking Motives Questionnaire Revised Short Form - Coping Motives Subscale (Kuntsche & Kuntsche, 2009).

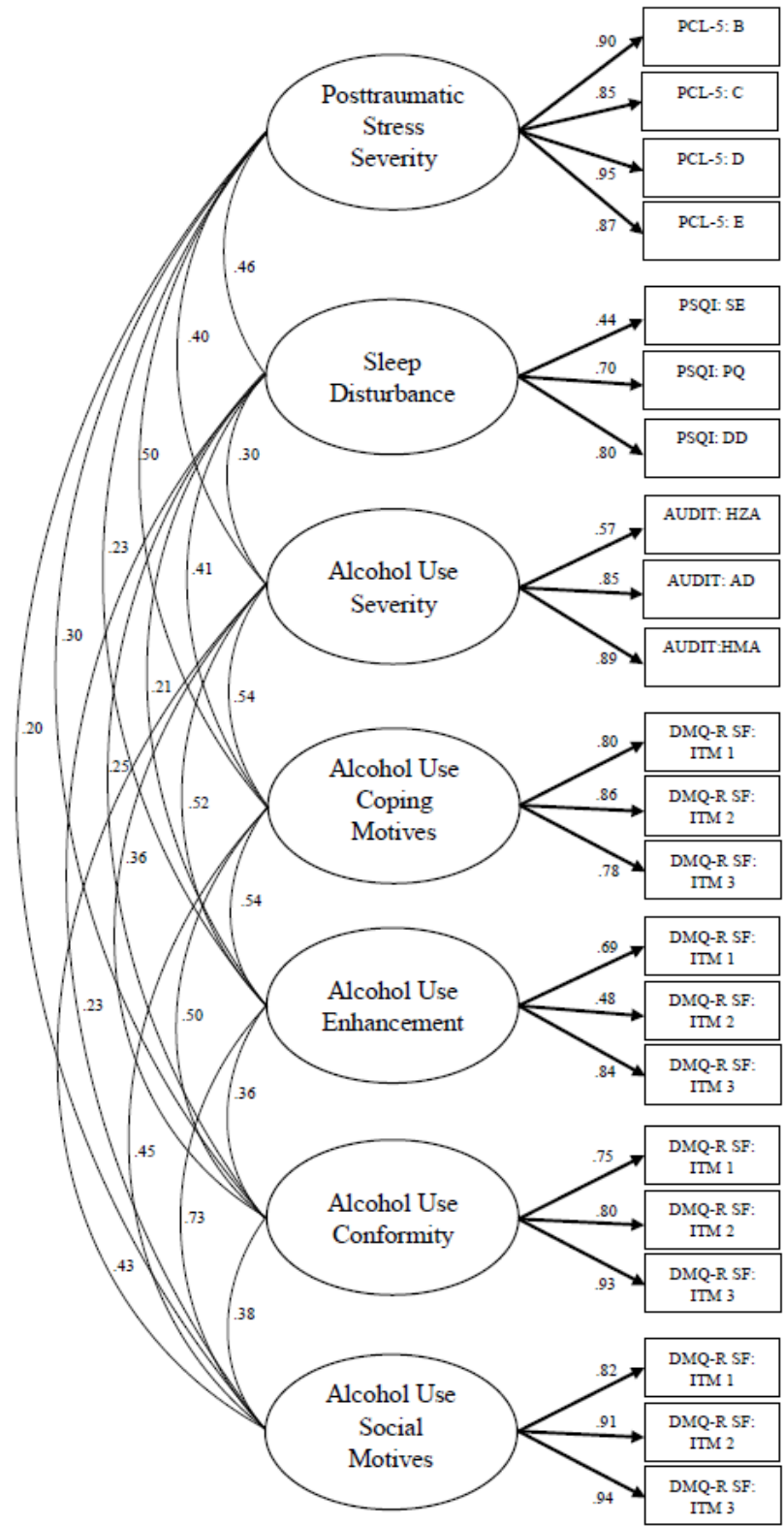


Figure 2. This figure provides a depiction of the measurement model with standardized factor loadings. For the latent construct of posttraumatic stress severity derived from the PCL-5 (Blevins et al., 2015), B = intrusion symptom cluster; C = avoidance symptom

cluster; D = negative alterations in mood symptom cluster; E = arousal and reactivity symptom cluster. For the latent construct of sleep disturbance derived from the PSQI (Buysse et al., 1989), SE = sleep efficiency factor; PQ = perceived sleep quality factor; DD = daily disturbances factor. For the latent construct of alcohol use severity derived from the AUDIT (Saunders et al., 1993), HZA = hazardous alcohol use subscale; AD = alcohol dependence subscale; HMA = harmful alcohol use subscale. For the latent variables of alcohol use coping motives derived from the DMQ-R-SF (Kuntsche & Kuntsche, 2009), ITM1 = “because it helps you when you feel depressed or nervous”; ITM2 = “to cheer up when you’re in a bad mood”; ITM3 = “to forget about your problems”. For the latent variables of alcohol use enhancement motives derived from the DMQ-R-SF (Kuntsche & Kuntsche, 2009), ITM1 = “because you like the feeling”; ITM2 = “to get high”; ITM3 = “because it’s fun”. For the latent variables of alcohol use conformity motives derived from the DMQ-R-SF (Kuntsche & Kuntsche, 2009), ITM1 = “to fit in with a group you like”; ITM2 = “to be liked”; ITM3 = “so you won’t feel left out”. For the latent variables of alcohol use social motives derived from the DMQ-R-SF (Kuntsche & Kuntsche, 2009), ITM1 = “because it helps you enjoy a party”; ITM2 = “because it makes social gatherings more fun”; ITM3 = “because it improves parties and celebrations”. Unstandardized factor loadings and parameter estimates available upon request. For further information on study correlations, please see Tables 2 and 3.

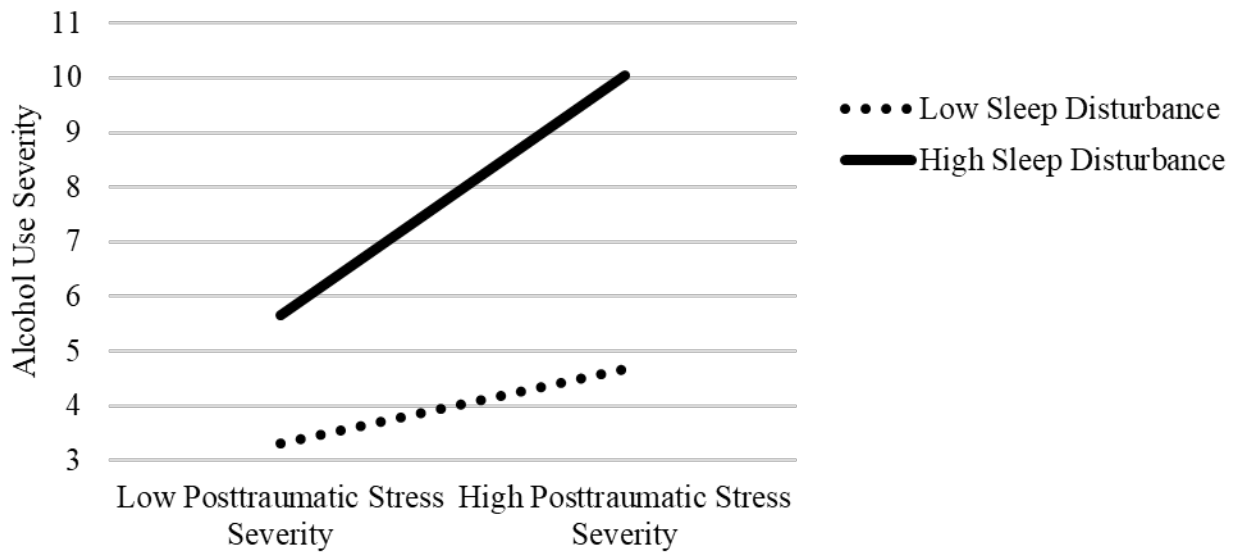


Figure 3. Interaction of posttraumatic stress symptom severity with sleep disturbance in predicting alcohol use severity. Low posttraumatic stress symptom severity represents .5 standard deviation below the mean of posttraumatic stress symptom severity. High posttraumatic stress symptom severity represents 1 standard deviation above the mean of posttraumatic stress symptom severity.

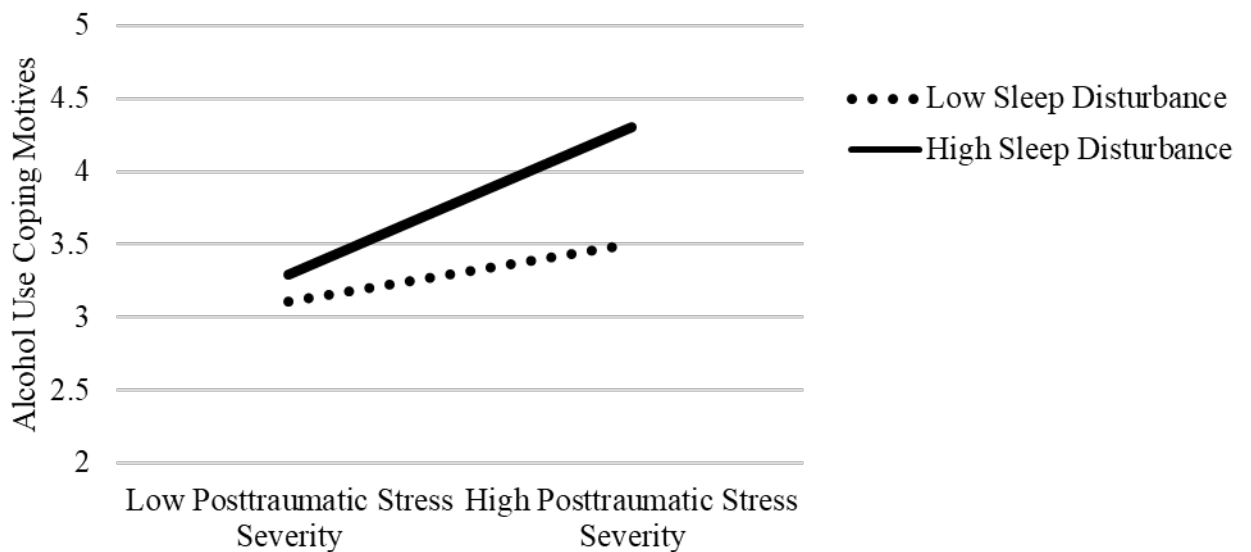


Figure 4. Interaction of posttraumatic stress symptom severity with sleep disturbance in predicting alcohol use coping motives. Low posttraumatic stress symptom severity represents .5 standard deviation below the mean of posttraumatic stress symptom severity. High posttraumatic stress symptom severity represents 1 standard deviation above the mean of posttraumatic stress symptom severity.

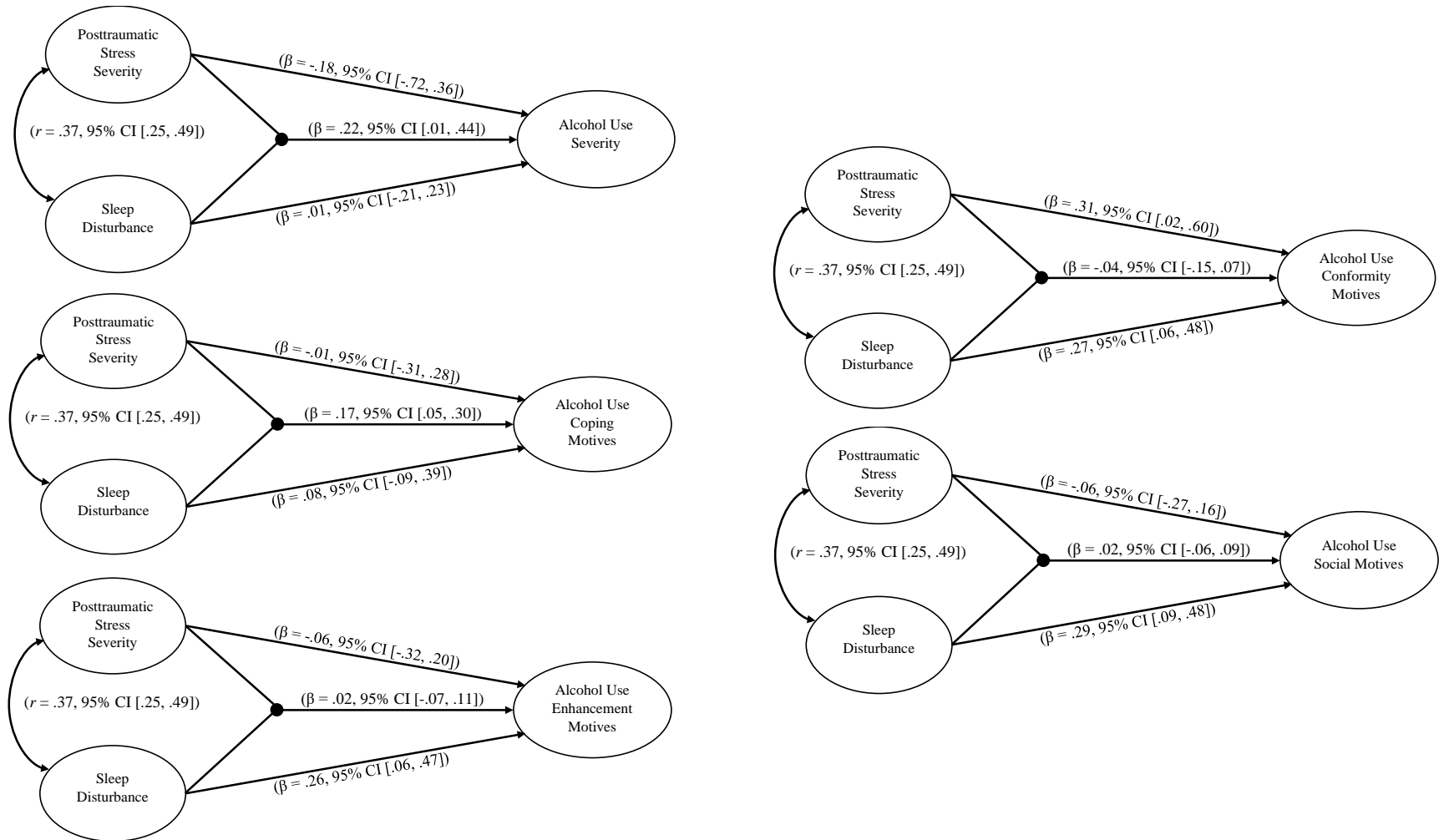


Figure 5. Interactive path analysis model utilizing the standardized effects. Posttraumatic stress symptom severity latent variable derived from the PCL-5 (Blevins et al., 2015); Sleep disturbance latent variable derived from the PSQI (Buysse et al., 1989); Alcohol use severity latent variable derived from AUDIT (Saunders et al., 1993); Alcohol use motive latent variables derived from the DMQ-R-SF (Kuntsche & Kuntsche, 2009). Unstandardized factor loadings and parameter estimates available in Table 4.