



PTSD symptom severity and impulsivity among firefighters: Associations with alcohol use

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ABSTRACT

Firefighters represent a unique population at high risk for trauma exposure, posttraumatic stress disorder (PTSD), and alcohol use. This study explored the main and interactive effects of PTSD symptom severity and impulsivity with regard to alcohol use severity. We hypothesized that higher levels of PTSD symptom severity and impulsivity would be related to greater alcohol use severity. Covariates included trauma load, depressive symptom severity, and romantic relationship status. The sample was comprised of 654 firefighters (Mage = 38.65, SD = 8.60) who endorsed exposure to potentially traumatic events and lifetime alcohol use. Firefighters completed an online questionnaire battery. A series of hierarchical regressions was conducted. PTSD symptom severity and impulsivity were significantly, incrementally associated with alcohol use severity, and a significant interactive effect was documented; firefighters with heightened PTSD symptom severity and impulsivity had the highest levels of alcohol use severity. This line of inquiry has great potential to inform prevention and intervention efforts for this vulnerable population. Clinical and research implications are discussed.

1. Introduction

Firefighters represent a unique population especially at-risk with regard to alcohol consumption and alcohol use disorder (AUD; Boxer and Wild, 1993; Carey et al., 2011; Haddock et al., 2012; North et al., 2002; Tomaka et al., 2017). Specifically, it is estimated that nearly one-half of firefighters report excessive drinking, defined as consuming three or more drinks of alcohol on one occasion (Haddock et al., 2015), and one-third report heavy episodic drinking, defined as consuming five or more drinks on one occasion (Haddock et al., 2015; Piazza-Gardner et al., 2014). Firefighters also have significantly higher prevalence rates of lifetime AUD (47%) in comparison to the general population (29.1%; Grant et al., 2015). Given the elevated risk for alcohol use and alcohol use problems among this population, further research is needed to obtain a better understanding of the psychological processes associated with alcohol use among firefighters so as to better inform evidence-based prevention and intervention efforts.

Traumatic event exposure (e.g., natural disasters, car accidents) and posttraumatic stress disorder (PTSD) symptomatology are highly prevalent among firefighters (Berger et al., 2011; Corneil et al., 1999; Haslam and Mallon, 2003; McCammon, 1996; Meyer et al., 2012) and both are related to increased risk for alcohol use problems and AUD

(Arbona and Schwartz, 2016; Chiu et al., 2011; Fetzner et al., 2011; Kilpatrick et al., 2013; Martin et al., 2017; Tomaka et al., 2017). Indeed, firefighters experience high levels of trauma exposure, with rates estimated to be approximately 91.5%, and nearly one-third report three or more lifetime traumatic event exposures (Meyer et al., 2012). Given repeated and chronic exposures to trauma, firefighters are at increased risk for the development of PTSD, with prevalence estimates as high as 22.2% (Corneil et al., 1999). PTSD symptomatology has been identified as a major risk and maintenance factor for AUD, which often co-occurs with PTSD among firefighters (Arbona and Schwartz, 2016; Chiu et al., 2011; Smith et al., 2018; Tomaka et al., 2017), veterans (Hoge et al., 2006, 2004; Milliken et al., 2007; Richardson et al., 2010; Walton et al., 2018), and trauma-exposed populations, generally (Kilpatrick et al., 2003; McFarlane, 1998; Mills et al., 2006; Pietrzak et al., 2011). Research providing focused examinations on the direct association between PTSD and alcohol use among firefighters is scarce, but the emerging literature suggests a positive association between PTSD symptomatology and alcohol use problems (Arbona and Schwartz, 2016; Chiu et al., 2011; Martin et al., 2017; Smith et al., 2018; Tomaka et al., 2017). Given the high rates of trauma exposure and PTSD symptomatology among firefighters, it is important to understand psychological processes, targetable via cognitive behavioral

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interventions, that may underlie the association between PTSD symptoms and alcohol use among this particularly vulnerable population.

Impulsivity, broadly defined as a wide range of actions that are poorly conceived, prematurely expressed, unduly risky, or inappropriate to the situation and may result in undesirable outcomes (Evenden, 1999), is one such underlying cognitive-behavioral process with promising relevance to the PTSD-alcohol association. PTSD symptomatology has been associated with greater levels of impulsivity among various populations (e.g., Contractor et al., 2015; Evren et al., 2018; Marshall-Berenz et al., 2011; Miller and Resick, 2007; Weiss et al., 2013), suggesting that impulsivity may function as a risk and/or maintenance factor for PTSD symptoms. Adults with higher levels of PTSD symptomatology may be more likely to act impulsively (Contractor et al., 2015) and to do so when experiencing negative affective states (James et al., 2014). Furthermore, a vast literature has also documented associations between increased impulsivity and greater alcohol use among various populations (e.g., Berey et al., 2017; Granö et al., 2004; Marshall-Berenz et al., 2011; Murphy and MacKillop, 2012; Stamates and Lau-Barraco, 2017; Trull et al., 2016). Specifically, increased impulsivity has been associated with greater alcohol consumption, binge drinking, earlier onset of alcohol problems, more adverse consequences from drinking/alcohol problems, and shorter duration of alcohol abstinence (Granö et al., 2004; Marshall-Berenz et al., 2011; Murphy and MacKillop, 2012).

An emergent, though relatively scant, literature has been devoted to concurrently examining associations between PTSD symptomatology, impulsivity, and alcohol use. For example, among residential patients diagnosed with comorbid PTSD and substance use disorders, impulsivity was associated with greater levels of alcohol use severity (Schaumberg et al., 2015). Research has also found impulsivity to mediate associations between PTSD and alcohol use and coping motives for use among trauma-exposed community residents (Marshall-Berenz et al., 2011). Among military veterans, heightened impulsivity significantly exacerbated the association between PTSD symptomatology and alcohol use (Black et al., 2018). Thus, both PTSD symptomatology and impulsivity may be factors that interact to confer greater risk for alcohol consumption and alcohol-related problems.

Taken together, several notable gaps have been found in the literature. First, there is exceptionally limited research examining impulsivity, generally, among firefighters. Second, no studies to date have examined impulsivity as it relates to PTSD symptom severity or alcohol use among firefighters. This is unfortunate since research suggests that firefighters experience higher rates of various negative mental health outcomes, including increased alcohol use (Martin et al., 2017; Meyer et al., 2012). Better understanding clinical correlates of alcohol use among firefighters has immense potential for purpose of developing evidence-based prevention and intervention efforts. Third, no studies to date have examined the interplay between PTSD symptom severity and impulsivity with regard to alcohol use among firefighters. Given that emerging research demonstrates that greater levels of impulsivity may play a meaningful role in the association between PTSD symptomatology and alcohol use among trauma-exposed populations (e.g., Black et al., 2018; Schaumberg et al., 2015), it is important to explore these associations among firefighters. Specifically, greater levels of impulsivity among firefighters may amplify the established association between PTSD symptomatology and alcohol use, such that this association may be strongest among firefighters with heightened impulsivity. Theoretically, firefighters with PTSD symptomatology who are more apt to respond impulsively to a variety of emotions and situations may be at increased risk of developing an AUD in an attempt to cope with the demands of their job.

The current study aimed to examine the main and interactive effects of PTSD symptom severity and impulsivity on alcohol use severity. Specifically, we first hypothesized that higher PTSD symptom severity would be positively associated with alcohol use severity. Second, we hypothesized that higher levels of impulsivity would be associated

positively with greater alcohol use severity. Finally, we hypothesized that higher levels of PTSD symptom severity and impulsivity would be associated with greater alcohol use severity. That is, we expected that firefighters with higher levels of PTSD symptomatology who report heightened impulsivity would manifest the highest levels of alcohol use severity. All effects were expected above and beyond theoretically-relevant covariates, including trauma load (i.e., total number of traumatic event types experienced) and depressive symptom severity. Covariates of trauma load and depressive symptom severity were selected based on their associations with alcohol use among firefighters and other trauma-exposed populations (Berninger et al., 2010; Martin et al., 2017; Paulus et al., 2017; Shalev et al., 1998; Suliman et al., 2009). Exploratory *post hoc* analyses were conducted to examine three specific aspects of alcohol use (i.e., hazardous alcohol use, dependence symptoms, and harmful alcohol use) as outcomes in the model proposed above. Similar patterns of associations were expected.

2. Methods

2.1. Participants

This study is a secondary analysis of data from a larger project examining stress and health-related behaviors among firefighters (e.g., Bartlett et al., 2018a, 2018b; Smith et al., 2018). The overall sample included 654 firefighters (Mage = 38.65, SD = 8.60) in a large, urban fire department (see Tables 1). Participants were career firefighters, who perform both Emergency Medical Services (EMS) and fire suppression services. To be included in the parent study, participants must have: been 18 years of age or older, been current firefighters in the department, and consented to completion of all online questionnaires. To be included in this secondary analysis, firefighters were required to have endorsed at least one DSM-5 PTSD Criterion A traumatic life event (American Psychiatric Association, 2013) and lifetime alcohol use (i.e., endorsing a score of ≥ 1 on item 1 [i.e., “How often do you have a drink containing alcohol?”] of the Alcohol Use Disorders Identification Test [AUDIT]). Exclusionary criteria were comprised of inability or unwillingness to provide informed consent for the completion of the online questionnaires. Please see Procedures section for further details.

2.2. Measures

2.2.1. Demographic questionnaire

Participants were asked to self-report demographic information including sociodemographic factors, firefighter service history, and time served in the military.

2.2.2. Life events checklist for DSM-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 potentially traumatic events (e.g., combat, sexual assault, transportation accident) as well as an additional item assessing for ‘other’ potentially traumatic events not listed. In the current study, respondents were asked to select whether each listed event “happened to me”, “witnessed it”, “learned about it”, “part of my job”, or “not sure”. If participants endorsed “happened to me”, “witnessed it”, or “part of my job” for a given item, this was coded as positive exposure to the particular traumatic event type. Total exposure types were then summed to produce a variable indicating the total number of traumatic life event types experienced; and this variable was entered as a covariate in analyses.

2.2.3. PTSD checklist for DSM-5

(PCL-5; Blevins et al., 2015). The PCL-5 is a 20-item self-report questionnaire that measures PTSD symptom severity. Each of the 20 items reflects a symptom of PTSD according to the DSM-5 (APA, 2013).

Table 1
Participant characteristics (N = 654).

Variable	M/n (SD/%)
Gender ^a	
Male	610 (93.3)
Female	39 (6.0)
Transgender	5 (0.8)
Race/ethnicity ^a	
White	509 (77.8)
Hispanic/Latino	169 (25.8)
Black/African American	71 (10.9)
'Other'	50 (7.6)
Asian	11 (1.7)
Native Hawaiian/Pacific Islander	1 (0.2)
American Indian/Alaskan Native	12 (1.8)
Age ^a	38.7 (8.6)
Education ^a	
8th Grade	3 (0.5)
GED (or equivalent)	1 (0.2)
High school	53 (8.1)
Some college	304 (46.5)
Bachelor's degree	293 (44.8)
Years of service in department ^a	13.4 (8.8)
Romantic Relationship status ^a	
Married	443 (67.7)
Divorced	50 (7.6)
Living with partner	36 (5.5)
Single	123 (18.8)
Widowed	2 (0.3)
PTSD diagnostic criteria ^b	63 (9.6)
Risky/hazardous alcohol use ^c	150 (22.9%)
Trauma exposure (happened to me, witnessed it, and/or part of my job) ^d	
Natural disaster	620 (94.8)
Fire or explosion	629 (96.2)
Transportation accident	637 (97.4)
Serious accident	565 (86.4)
Exposure to toxic substance	522 (79.8)
Physical assault	537 (82.1)
Assault with a weapon	487 (74.5)
Sexual assault	385 (58.9)
Other unwanted or uncomfortable sexual experience	282 (43.1)
Combat or exposure to a war-zone	118 (18.0)
Captivity	95 (14.5)
Life-threatening illness or injury	444 (67.9)
Severe human suffering	451 (69.0)
Sudden violent death	547 (83.6)
Sudden accidental death	539 (82.4)
Serious injury you caused to someone else	230 (35.2)
Any other stressful event or experience	483 (73.9)

^a Demographics questionnaire

^b PTSD Checklist for DSM-5 (PCL-5; diagnostic cut-off of 33)

^c Alcohol Use Disorders Identification Test (AUDIT; total score ≥ 8)

^d Life Events Checklist for DSM-5 (LEC-5)

Respondents were asked to keep their worst traumatic event in mind as they rated each item on a 5-point scale (0 = *Not at all* to 4 = *Extremely*) regarding the frequency with which they have been bothered by each 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 to 80, with higher scores indicating higher symptom severity. The PCL-5 has demonstrated good psychometric properties (Blevins et al., 2015). Internal consistency of the total PTSD symptom severity (PCL-5 total score) in the current sample was excellent ($\alpha = 0.97$). Total PTSD symptom severity (PCL-5 total score) was a predictor in the current analyses.

2.2.4. Barratt impulsiveness scale

(BIS-11; Patton et al., 1995). The BIS-11 is a well-established, 30-item self-report questionnaire of impulsivity-related personality traits. It is the most widely cited instrument to assess impulsiveness (Stanford et al., 2009). Respondents are asked to indicate the extent to

which they behave impulsively (e.g., "I act on the spur of the moment") on a 4-point Likert-type scale (1 = *rarely/never* to 4 = *almost always/always*). Scores range from 30 to 120, with higher scores indicating greater impulsivity. The BIS-11 assesses three main dimensions of impulsive behavior: attentional (i.e., lack of focus on the ongoing task), motor (i.e., acting without thinking), and non-planning impulsivity (i.e., orientation to the present rather than to the future). The BIS-11 has demonstrated good psychometric properties (Stanford et al., 2009). In the current sample, the total impulsivity score (BIS-11 total score) demonstrated acceptable ($\alpha = 0.79$) internal consistency and was utilized in the current analyses.

2.2.5. Alcohol use disorders identification test

(AUDIT; Saunders et al., 1993). The AUDIT is a well-established, 10-item screening instrument developed by the World Health Organization (WHO) to identify individuals presenting with alcohol problems (Newcombe et al., 2005; Saunders et al., 1993). Respondents are asked to rate items 1–8 on a 4-point Likert-style scale, and items 9 and 10 on a 0, 2, or 4-point scale to indicate the frequency with which they engage in various alcohol-related behaviors. Total scores range from 0 to 40, and the generally accepted cut-off to identify potentially hazardous alcohol intake is 8. The AUDIT contains three subscales: hazardous alcohol use ("How often do you have a drink containing alcohol?"; scores range from 0 to 12), dependence symptoms ("How often during the last year have you found that you were not able to stop drinking once you had started?"; scores range from 0 to 12), and harmful alcohol use ("Have you or someone else been injured as a result of your drinking?" scores range from 0 to 16). The AUDIT has demonstrated good test-retest reliability (Selin, 2003) and convergent (García Carretero et al., 2016) and discriminant validity (Bohn et al., 1995). The AUDIT has demonstrated high sensitivity and specificity for detecting probable alcohol dependence and hazardous or harmful drinking (sensitivity = 32–96%, specificity = 84–96%; Barry and Fleming, 1993; Saunders et al., 1993; Schmidt et al., 1995). In the current sample, internal consistency for alcohol use severity was good (AUDIT total score; $\alpha = 0.85$), and this variable was included as an outcome in main analyses. Post-hoc analyses utilized all three AUDIT subscale scores as outcome variables: hazardous alcohol use ($\alpha = 0.73$), dependence symptoms ($\alpha = 0.86$), and harmful alcohol use ($\alpha = 0.68$).

2.2.6. Center for epidemiological studies depression scale

(CES-D; Radloff, 1977). The CES-D is a 20-item self-report measure used to assess depressive symptom severity. Items are scored on a 4-point scale ranging from 0 ("rarely or none of the time / less than 1 day") to 3 ("most or all of the time / 5 to 7 days") with regard to the frequency of which individuals have been bothered by specific symptoms in the past week. Total symptom severity scores range from 0 to 60, with higher scores indicating higher depressive symptom severity. The CES-D has demonstrated high internal consistency, moderate test-retest reliability, and good convergent and discriminant validity (Myers and Weissman, 1980; Naughton and Wiklund, 1993). In the current sample, internal consistency of the total depression symptom severity score (CES-D total score) was good ($\alpha = 0.86$). This variable was entered as a covariate in analyses.

2.3. Procedures

All of the approximately 4000 firefighters in one urban department in the southern United States were recruited for participation in the parent study via an email sent through the fire department. Firefighters were notified 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 (e.g., movie tickets, restaurant gift certificates) via a department-wide e-mail. Notification e-mails 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 fire department CE portal. Those who did not wish to participate or consent to the study were given the option to indicate as such (by clicking ‘no’). Participants interested in participating were directed to the informed consent form (by clicking ‘yes’). The total amount of time required for participation in this study was estimated at 45–60 min, and firefighters were allowed to discontinue participation at any time without penalty. Of the approximately 4000 firefighters that received the department-wide e-mail, 2060 accessed the informed consent form through the online CE portal. Of the 2060 that accessed the portal, 1239 firefighters consented to participating in the study, and a total of 1162 firefighters completed the entire survey. All procedures performed in the study were in accordance with the institutional review board for each respective institution. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

2.4. Data analytic plan

All analyses were conducted in IBM SPSS Statistics version 24.0. First, frequency distributions were examined among all variables to ensure normality of the distribution and examine the data for missingness. Less than 5% of the data across all variables were missing. Missing data were handled via list-wise deletion. Second, descriptive statistics and bivariate correlations were calculated for all study variables (see Tables 1 and 2). Lastly, a series of hierarchical linear and regression analyses was conducted. For main analyses, one hierarchical regression analysis was conducted, which included alcohol use severity (AUDIT total score) as the outcome variable. For exploratory analyses, three additional hierarchical regressions were conducted, and outcome variables included: (1) hazardous alcohol use (AUDIT subscale items 1–3); (2) dependence symptoms (AUDIT subscale items 4–6); and (3) harmful alcohol use (AUDIT subscale items 7–10). Predictor variables for main and exploratory analyses included PTSD symptom severity (PCL-5 total score) and impulsivity (BIS-11 total score). Regressions for main and exploratory analyses contained three steps. Covariates were

entered at step one of each regression model and final covariates included trauma load (LEC-5 total score), depressive symptom severity (CES-D total score), and romantic relationship status. While trauma load and depressive symptom severity were conceptualized *a priori* as theoretically relevant covariates, various sociodemographic variables (see Table 2) were evaluated for inclusion in the models based on significant correlations with alcohol use severity. PTSD symptom severity and impulsivity were entered at step two of each regression model to examine their direct effects on all four outcomes. Finally, step three consisted of entering the interaction of PTSD symptom severity by impulsivity into the regression model. A Bonferroni correction was applied to control for Type I error across the three planned exploratory comparisons ($\alpha = 0.05/3 = 0.017$)

3. Results

3.1. Descriptive statistics

Distributions for all study variables approximated normality (skewness < |2.25|; George and Mallery, 2003), except for dependence symptoms (AUDIT subscale; skewness = 3.25) and harmful alcohol use (AUDIT subscale; skewness = 2.78). As previously mentioned, less than 5% of the data were identified as missing across all study variables and was handled with list-wise deletion. Examination of collinearity diagnostics did not reveal evidence of excess collinearity among study predictors (variance inflation index [VIF] < 1.78) as VIF values did not exceed 10.0 (Mason and Perreault, 1991). See Tables 1 and 2 for descriptive statistics and bivariate associations for all variables of interest. Approximately 9.6% ($n = 63$) of the sample met diagnostic criteria for PTSD as indexed by a PCL-5 total score ≥ 33 , and approximately 22.9% ($n = 150$) endorsed risky or hazardous alcohol use, as indexed by an AUDIT total score ≥ 8 .

With regard to bivariate correlations, PTSD symptom severity (PCL-5 total score) was significantly, positively correlated with impulsivity (BIS-11 total score), alcohol use severity (AUDIT total score), the three AUDIT subscales, depressive symptom severity (CES-D total score),

Table 2
Bivariate associations and descriptive statistics for study variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Mean	SD
1. PCL-5 Total	–	0.39**	0.40**	0.22**	0.42**	0.38**	0.12**	0.66**	–0.08	–0.05	0.01	0.02	0.00	0.00	0.00	10.42	14.11
2. BIS-11 Total		–	0.33**	0.25**	0.32**	0.26**	0.13**	0.39**	–0.07	–0.05	–0.11**	–0.09*	0.11**	0.04	0.01	59.20	10.67
3. AUDIT Total			–	0.81**	0.84**	0.87**	0.10*	0.31**	–0.07	–0.09*	–0.06	–0.03	0.07	0.00	–0.02	6.54	5.03
4. AUDIT: Hazardous Alcohol Use				–	0.45**	0.49**	0.09*	0.13**	–0.04	–0.08*	–0.04	–0.01	0.10**	0.06	0.01	4.96	2.36
5. AUDIT: Dependence Symptoms					–	0.76**	0.07	0.38**	–0.06	–0.09*	–0.06	–0.05	0.01	–0.06	–0.04	0.69	1.71
6. AUDIT: Harmful Alcohol Use						–	0.09*	0.31**	–0.08*	–0.07	–0.04	–0.03	0.03	–0.03	–0.03	0.90	1.93
7. LEC-5 Total							–	0.05	–0.03	0.06	0.02	0.04	0.10*	0.01	0.03	11.58	3.78
8. CES-D Total								–	–0.06	–0.06	0.00	0.02	0.00	–0.02	–0.03	10.32	8.07
9. Gender									–	0.07	–0.03	0.02	0.02	0.04	0.07	0.93	0.25
10. Romantic Relationship Status										–	0.22**	0.21**	0.04	0.08*	0.03	0.73	0.44
11. Age											–	0.87**	–0.04	0.12**	0.03	38.75	8.58
12. Years in Fire Department												–	0.03	0.15**	0.08*	13.41	8.81
13. Race													–	–0.25**	0.07	4.73	0.94
14. Ethnicity														–	–0.09*	1.74	0.44
15. Years of Education															–	3.84	1.12

Note. PCL-5 Total = Posttraumatic Stress Disorder Checklist for DSM-5 total scale score; BIS-11 Total = Barratt Impulsiveness Scale total scale score; AUDIT Total = alcohol use disorders identification test (AUDIT) total score; AUDIT: Hazardous alcohol use = AUDIT hazardous drinking total subscale score; AUDIT: dependence symptoms = AUDIT dependence symptoms total subscale score; AUDIT: Harmful alcohol use = AUDIT harmful alcohol use total subscale score; LEC-5 Total = Life Events Checklist for the DSM-5 total score; CES-D Total = Center for Epidemiological Studies Depression Scale total scale score; Gender = Obtained from demographic questionnaire (1 = male, 0 = female or transgender); Romantic relationship status = Demographic questionnaire (1 = married or living with partner, 0 = single, divorced, or widowed); Age = Demographic questionnaire (continuous); Years in Fire Department = Demographic questionnaire (continuous); Race = Demographic questionnaire (1 = American Indian or Alaskan Native, 2 = Asian, 3 = Black or African American, 4 = Native Hawaiian or Other Pacific Islander, 5 = White, 6 = Other), Ethnicity = Demographic questionnaire (1 = Hispanic or Latino, 2 = Not Hispanic or Latino), Years of Education = Demographic questionnaire (1 = 8th grade, 2 = High school graduate, 3 = College graduate, 4 = Partial completion of high school or GED equivalent, 5 = Partial completion of college).

* $p < 0.05$

** $p < 0.01$

Table 3
Hierarchical regression results.

Main Outcome: AUDIT Total Score					
	ΔR^2	β	SE	sr^2	p
Level 1	0.11				0.000
Trauma Load ¹		0.09	0.05	0.01	0.021
Depressive Symptoms ²		0.30	0.02	0.09	0.000
Romantic Relationship Status ³		−0.08	0.42	0.08	0.032
Level 2	0.09				0.000
PTSD Symptoms ⁴		0.29	0.24	0.05	0.000
Impulsivity ⁵		0.19	0.20	0.04	0.000
Level 3	0.01				0.001
Interaction ⁶		0.14	0.17	0.02	0.001
Post Hoc Outcome: AUDIT Hazardous Alcohol Use					
	ΔR^2	B	SE	sr^2	P
Level 1	0.03				0.000
Trauma Load		0.09	0.02	0.01	0.026
Depressive Symptoms		0.12	0.01	0.01	0.003
Romantic Relationship Status		−0.08	0.21	0.01	0.044
Level 2	0.06				0.000
PTSD Symptoms		0.19	0.12	0.02	0.000
Impulsivity		0.20	0.10	0.03	0.000
Level 3	0.00				0.752
Interaction		0.01	0.09	0.00	0.752
Post Hoc Outcome: AUDIT Dependence Symptoms					
	ΔR^2	B	SE	sr^2	P
Level 1	0.15				0.000
Trauma Load		0.05	0.02	0.00	0.169
Depressive Symptoms		0.37	0.01	0.14	0.000
Romantic Relationship Status		−0.07	0.14	0.01	0.059
Level 2	0.07				0.000
PTSD Symptoms		0.27	0.08	0.05	0.000
Impulsivity		0.16	0.07	0.03	0.000
Level 3	0.04				0.000
Interaction		0.22	0.06	0.05	0.000
Post Hoc Outcome: AUDIT Harmful Alcohol Use					
	ΔR^2	B	SE	sr^2	P
Level 1	0.10				0.000
Trauma Load		0.08	0.02	0.01	0.045
Depressive Symptoms		0.30	0.01	0.09	0.000
Romantic Relationship Status		−0.05	0.16	0.00	0.159
Level 2	0.07				0.000
PTSD Symptoms		0.28	0.09	0.05	0.000
Impulsivity		0.12	0.08	0.01	0.003
Level 3	0.02				0.000
Interaction		0.15	0.07	0.02	0.000

Note. β = Standardized beta weight

¹ Trauma load = Life Events Checklist for the DSM-5 total score (LEC-5 total score; Weathers et al., 2013)

² Depression Center for Epidemiological Studies Depression Scale total scale score (CES-D total score; Radloff, 1997)

³ Romantic Relationship Status = Demographic questionnaire (1 = married or living with partner, 0 = single, divorced, or widowed)

⁴ PTSD Symptoms = Posttraumatic stress disorder checklist for DSM-5 total scale score (PCL-5 total score; Blevins et al., 2015)

⁵ Impulsivity = Barratt Impulsiveness Scale total scale score (BIS-11 total score; Patton, Stanford, & Barratt, 1995)

⁶ Interactive effect of PCL-5 total score and BIS-11 total score; 8AUDIT = Alcohol Use Disorder Identifications Test total score, AUDIT Hazardous alcohol use subscale, AUDIT dependence symptoms subscale, AUDIT harmful alcohol use subscale (Saunders et al., 1993).

trauma load (LEC-5 total score), and romantic relationship status. Impulsivity was also significantly, positively correlated with alcohol use severity and the three AUDIT subscales, depressive symptom severity, trauma load, romantic relationship status, age, years in the fire department, and race. There was no significant association between depressive symptom severity and trauma load. Romantic relationship status was included as an additional covariate in regression models because it demonstrated a significant bivariate correlation with alcohol use severity (see Table 2).

3.2. Main outcome analyses

A hierarchical regression analysis was conducted. Please see Table 3

for a summary of results. Notably, the pattern of results remained consistent with and without the inclusion of covariates. At step one, the covariates of trauma load, depressive symptom severity, and romantic relationship status were significantly associated with alcohol use severity. At step two, PTSD symptom severity and impulsivity were significantly associated with alcohol use severity, after accounting for covariates. At step three, the interaction of PTSD symptom severity and impulsivity was significantly associated with alcohol use, contributing 1% of variance above and beyond the 20% of variance accounted for by variables in steps one and two of the model (see Fig. 1).

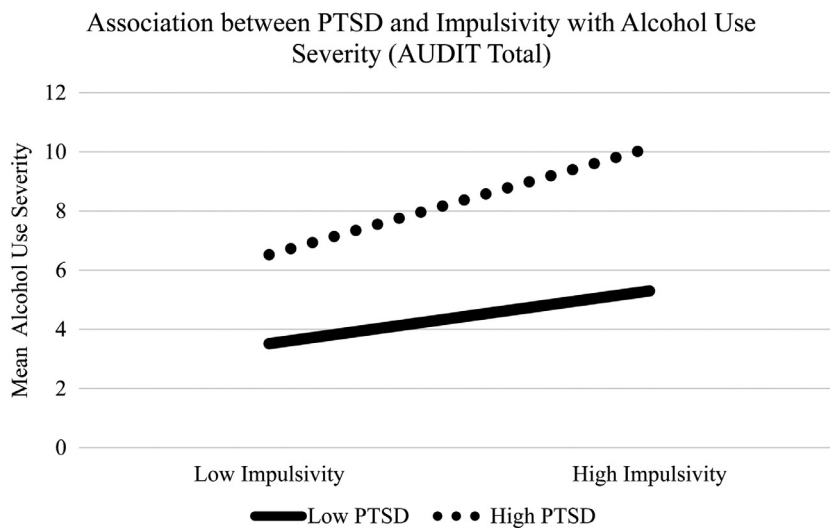


Fig. 1. Association between PTSD symptom severity and impulsivity with regard to alcohol use severity. Low PTSD represents 0.5 standard deviation below the mean of PTSD symptom severity. High PTSD represents 0.5 standard deviation above the mean of PTSD symptom severity. Low Impulsivity represents 0.5 standard deviation below the mean of impulsivity. High Impulsivity represents 0.5 standard deviation above the mean of impulsivity.

3.3. Post-Hoc exploratory analyses

Please see Table 3 for a summary of results. Notably, the pattern of results remained consistent with and without the inclusion of covariates. First, hazardous alcohol use (AUDIT- hazardous alcohol use subscale) was examined as an outcome. At step 1, the covariates of trauma load, depressive symptom severity, and romantic relationship status were significantly associated with hazardous alcohol use. At step 2, PTSD symptom severity and impulsivity were significantly associated with hazardous alcohol use, after accounting for covariates. At step 3, the interaction of PTSD symptom severity and impulsivity was not significantly associated with hazardous alcohol use.

Next, alcohol dependence symptoms (AUDIT- dependence symptoms subscale) were examined as an outcome. At step 1, only the covariate of depressive symptom severity was significantly associated with alcohol dependence symptoms. At step 2, PTSD symptom severity and impulsivity were significantly associated with dependence symptoms, after accounting for covariates. At step 3, the interaction of PTSD symptom severity and impulsivity was significantly associated with dependence symptoms, contributing 4% of variance above and beyond the 22% of variance accounted for in steps 1 and 2.

Finally, harmful alcohol use severity (AUDIT- harmful alcohol use subscale) was examined as an outcome. At step 1, the covariates of trauma load and depressive symptom severity were significantly associated with harmful alcohol use. At step 2, PTSD symptom severity and impulsivity were significantly associated with harmful alcohol use, after accounting for covariates. At step 3, the interaction of PTSD symptom severity and impulsivity was significantly associated with harmful alcohol use, contributing 2% of variance above and beyond the 17% of variance accounted for in steps 1 and 2.

4. Discussion

The current study examined the main and interactive effects of PTSD symptom severity and impulsivity with regard to alcohol use severity among firefighters. Hypotheses were largely supported by the data. First, greater PTSD symptom severity was significantly, incrementally related to higher levels of alcohol use severity. Furthermore, post hoc analyses revealed that greater PTSD symptom severity was significantly associated with all three AUDIT subscales, including hazardous alcohol use, dependence symptoms, and harmful alcohol use. The dependence symptoms and harmful alcohol use subscales (β 's = 0.27 and 0.29, respectively) demonstrated stronger relationships with PTSD symptom severity in comparison to the hazardous alcohol use subscale (β = 0.18). These results are broadly

consistent with a growing body of research documenting that PTSD symptom severity is significantly associated with alcohol use problems and AUD among firefighters (Arbona and Schwartz, 2016; Chiu et al., 2011; Martin et al., 2017; Smith et al., 2018; Tomaka et al., 2017). This work underscores the importance of additional examination of the PTSD-alcohol use association among this particularly vulnerable population.

Second, a significant main effect was found with regard to impulsivity and alcohol use severity. This is consistent with extant literature demonstrating positive associations between impulsivity and alcohol use among a variety of populations, including college students, psychiatric outpatients, and trauma-exposed adults (Berey et al., 2017; Granö et al., 2004; Marshall-Berenz et al., 2011; Murphy and MacKillop, 2012; Stamates and Lau-Barraco, 2017; Trull et al., 2016). Post hoc analyses indicated that greater impulsivity was associated with all three AUDIT subscales, including hazardous alcohol use, dependence symptoms, and harmful alcohol use. These findings are also consistent with the literature, which suggests that greater levels of impulsivity are related to greater alcohol-related problems (e.g., greater alcohol consumption, binge drinking, earlier onset of alcohol problems, more adverse consequences from drinking/alcohol problems, and shorter duration of alcohol abstinence; Granö et al., 2004; Marshall-Berenz et al., 2011; Murphy and MacKillop, 2012). This is the first study to date to examine impulsivity in relation to alcohol use among firefighters. Therefore, more research is needed to better understand associations between impulsivity and (a) alcohol use severity and (b) alcohol-related problems in order to inform effective intervention efforts.

Third, there was a significant interactive effect of PTSD symptom severity and impulsivity in relation to alcohol use severity. As hypothesized, the association between PTSD symptom severity and alcohol use severity is markedly stronger among firefighters with high levels of impulsivity. However, it is important to note that the interactive effect of PTSD symptom severity and impulsivity, while significant, contributed only 2% of unique variance to the model. Thus, further research using mixed methods is needed to confirm these findings. These findings are consistent with previous research that demonstrated significant associations between PTSD symptomatology and impulsivity in relation to alcohol use among military veterans (Black et al., 2018). Notably, research has demonstrated a potential mediating role of impulsivity in the association between PTSD symptom severity and alcohol use coping motives (Marshall-Berenz et al., 2011). Taken together, the few relevant studies to date suggest that impulsivity may exacerbate the association between PTSD and alcohol use. Moreover, impulsivity may also account for – or mediate – associations

between PTSD and coping-oriented motives for alcohol use (i.e., drinking alcohol to cope with negative emotional states). More work is needed among firefighters to elucidate the role of impulsivity in regard to the association between PTSD and alcohol use as well as motives for use. Furthermore, post hoc analyses revealed significant interactive effects of PTSD symptom severity and impulsivity in relation to alcohol dependence symptoms and harmful alcohol use, but not hazardous alcohol use. Thus, although PTSD symptomatology and impulsivity both had significant direct effects in relation to hazardous alcohol use (i.e., frequency/quantity of drinking), impulsivity may be especially relevant to alcohol-related consequences (i.e., morning drinking; guilt after drinking; blackouts; alcohol-related injuries) over time, as opposed solely to the quantity and frequency of drinking.

Taken together, the strain placed on firefighters via the nature of the profession (e.g., occupational stressors; chronic exposure to traumatic events) may put them at an increased risk for the development of PTSD symptomatology, which may then confer risk for increased alcohol use severity as a means to cope with the stress of the job. Moreover, firefighters who have a greater tendency to react impulsively to job-related stress by consuming alcohol may increase their potential for exposure to potentially harmful and dangerous trauma-related personal events, which may increase PTSD-related symptomatology. Notably, it also is possible that PTSD emerges in the aftermath of AUD among firefighters who act impulsively while consuming alcohol, thus putting themselves at heightened risk of experiencing potentially traumatic life events (e.g., McCauley et al., 2012). Furthermore, it is possible that PTSD and AUD develop concurrently in the aftermath of trauma among firefighters (McCauley et al., 2012). Longitudinal research is needed to better understand the etiology of PTSD and AUD comorbidity among firefighter populations, specifically.

Overall, our findings have clinically-relevant implications in that treatment-seeking firefighters who present with higher levels of PTSD symptomatology and/or elevated alcohol consumption may benefit from receiving treatment that incorporates skills for managing impulsivity and adaptively engaging with difficult emotions. Such treatments can be employed adjunctively or independently for the treatment of PTSD and may serve as a preventative measure for increased alcohol use given that they have been associated with improvements in PTSD symptoms (Becker and Zayfert, 2001; Cloitre et al., 2002; Ford et al., 2012). This line of inquiry has the potential to increase awareness regarding firefighters' risk of developing adverse mental health outcomes, such as PTSD and AUD, by increasing the fire department service-wide implementation of relevant intervention and prevention programs. To date, this is the first study to examine the associations between PTSD symptom severity and impulsivity in relation to alcohol use severity and alcohol-related problems among firefighters. It is imperative that future work examine PTSD symptomatology and related cognitive mechanisms so as to decrease the risk for AUD among firefighters via effective intervention and prevention programs.

Although not primary aims of the study, there were additional findings worthy of mention. First, both trauma load and depressive symptom severity were significantly related to alcohol use severity, with depressive symptom severity providing a significantly higher magnitude of effect ($r = 0.31$, $\beta = 0.30$) as compared to trauma load ($r = 0.10$, $\beta = 0.08$). Greater trauma load and depressive symptom severity have been found to be associated with alcohol use severity among trauma-exposed civilian, veteran, and firefighter populations (e.g., Berninger et al., 2010; Martin et al., 2017; Paulus et al., 2017; Smith et al., 2017; Suliman et al., 2009). Second, romantic relationship status was significantly, negatively related to alcohol use severity ($r = -0.09$, $\beta = -0.08$), although the association was of small magnitude. Among firefighters, being in a romantic relationship (i.e., married or living with a partner) is related to lower levels of alcohol use severity (e.g., Martin et al., 2017). More work is necessary to understand the potential protective role of relationship status with regard to alcohol use among firefighters. Third, approximately 9.6% of firefighters met

clinical cut-off levels for probable PTSD. Of note, the prevalence of firefighters who met diagnostic criteria for PTSD in this sample was equivalent in comparison to other samples of firefighters (e.g., 9.8%; Berninger et al., 2010) and higher in comparison to the general population (e.g., 8.3%; Kilpatrick et al., 2013). With regard to alcohol, a relatively smaller percentage of our sample (22.9%) met criteria for risky or hazardous alcohol use, defined as a total score of 8 or greater on the AUDIT (Babor et al., 1992), in comparison to nationally representative samples of U.S. adults (29.1%; Grant et al., 2015). It is possible that firefighters in the current sample may have underreported general rates of alcohol use due to potential stigma associated with negative health behaviors and mental health concerns in the fire service and/or due to fears of negative job ramifications (Haugen et al., 2017; Henderson et al., 2016).

There are additional caveats to take into consideration, in addition to the study limitations already noted. First, this study relied exclusively on self-report and therefore, effects of method variance and reporting bias cannot be ruled out. It is crucial that future research incorporate interview-based and experimental measures addressing cognitive-behavioral mechanisms, PTSD, and alcohol use to advance our understanding of these associations as well as reduce under-reporting trends that result from fear of reporting sensitive topics (e.g., Haugen et al., 2017; Henderson et al., 2016). Future studies employing multimodal measures (i.e., self-report and behavioral indices) of impulsivity are imperative to better understand relations between impulsivity, a broad and multifaceted construct, with regard to alcohol use. Second, this study utilized a cross-sectional design, and therefore, no inferences about causality among variables can be inferred. Prospective, longitudinal studies among firefighters are necessary to understand temporal associations between stress and health over time. Third, these data were based on a sample of mostly white/Caucasian male firefighters. It is imperative that future research be conducted among women firefighters and those of diverse sexual orientations and racial and ethnic backgrounds so as to improve our understanding of their unique experiences and needs. Moreover, our sample of firefighters work in a large, urban fire department, potentially limiting generalizability to firefighters who work in more rural areas. This underscores the need for future work to replicate findings among nationally representative samples of firefighters. Lastly, all firefighters surveyed were active duty at the time of the survey and therefore may have underreported psychiatric symptoms due to the aforementioned fears of breaches in confidentiality and negative job ramifications.

The current study also had several strengths worth mentioning, including its focus on a large sample of firefighters, a population that is relatively understudied especially in regard to PTSD symptomatology and related psychological correlates. Moreover, this was the first study to provide a focused examination on impulsivity and its association between PTSD symptomatology and alcohol use among firefighters. Indeed, results underscore the importance of considering symptoms of PTSD and underlying cognitive mechanisms, such as impulsivity, in better understanding alcohol use and alcohol-related problems among firefighters. Future research should build upon this preliminary work by providing a focused investigation of associations between impulsivity and different facets of alcohol use and related problems (e.g., dependence, blackouts, fighting while intoxicated). This line of work may shed light on our understanding of risk and resilience factors among populations exposed to chronic stress and trauma, such as firefighters, who are in immense need of more attention and understanding given their essential services to our communities.

Declarations of interest

None.

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