Journal of Anxiety Disorders 51 (2017) 14–21

Contents lists available at ScienceDirect

Journal of Anxiety Disorders

journal homepage: www.elsevier.com/locate/janxdis

The 7-factor hybrid model of DSM-5 PTSD symptoms and alcohol consumption and consequences in a national sample of trauma-exposed veterans

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ARTICLE INFO

Keywords:
Alcohol use
Posttraumatic stress disorder
Comorbidity
Confirmatory factor analysis

ABSTRACT

The purpose of the present study was to investigate associations between the 7-factor hybrid model of DSM-5 posttraumatic stress disorder (PTSD) symptoms, which includes intrusions, avoidance, negative affect, anhedonia, externalizing behaviors, anxious arousal, and dysphoric arousal symptoms, and alcohol consumption and consequences. A nationally representative sample of 916 trauma-exposed U.S. military veterans were administered the Trauma History Screen, PTSD Checklist-5, and Alcohol Use Disorders Identification Test. Confirmatory factor analyses were conducted to determine associations between the 7-factor hybrid model of PTSD symptoms, and alcohol consumption and consequences. Results revealed that lifetime dysphoric arousal (r = 0.31), negative affect (r = 0.30), and anhedonia (r = 0.29) symptom clusters were most strongly associated with past-year alcohol consequences. No significant associations were observed for alcohol consumption. While the cross-sectional study design does not allow one to ascertain causative associations between PTSD factors and alcohol consumption and consequences, results generally align with the self-medication hypothesis, as PTSD factors reflecting internalizing were most strongly related to alcohol-related consequences. These results underscore the importance of assessing for alcohol use problems in veterans who score highly on PTSD symptoms reflecting internalizing symptomatology.

1. Introduction

The comorbidity between posttraumatic stress disorder (PTSD) and alcohol use disorder (AUD) is well-documented (Debell et al., 2014; Jacobsen, Southwick, & Kosten, 2001), with The National Epidemiologic Survey on Alcohol and Related Conditions-III showing significant associations between 12-month and lifetime AUD and PTSD (odds ratios range = 1.4–4.4) across all levels of alcohol use (mild to severe; Grant et al., 2015). Rates of co-occurrence of PTSD and AUD are also high among military personnel and veterans (63–73%; Seal et al., 2011). Given the potential etiologic role of PTSD in giving rise to the development of AUD (i.e., self-medication models; Khantzian, 1985), it is important to understand associations between aspects of the multidimensional PTSD phenotype and alcohol-use problems in trauma survivors, particularly veterans.

1.1. Association between PTSD and alcohol-use

There are several theoretical explanations for the relationship between PTSD and alcohol use. One theory, the shared vulnerability hypothesis, posits that trauma, PTSD, and substance use are associated due to a shared vulnerability that contributes to development of both disorders. Support for this theory has been found increasingly in genetic studies (e.g., Sartor et al., 2011; genetic factors that contributed to

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http://dx.doi.org/10.1016/j.janxdis.2017.08.001
Received 9 February 2017; Received in revised form 25 June 2017; Accepted 1 August 2017
Available online 06 August 2017
0887-6185/

PTSD and trauma exposure also accounted for 30% of the variance in alcohol dependence). A study by McLeod et al. (2001) found support for this theory in a twin study of military veterans (both of whom went to war), in that genes influence exposure to combat and subsequent co-occurring alcohol and PTSD symptoms.

Another theory suggests that substance use precedes PTSD, in that individuals with substance use disorders are at risk for trauma and increased stressors due to placing themselves in situations that are dangerous and/or risky in order to continue substance use, which could be due to substances affecting personal traits like decision-making, impulsivity, and risk-taking behaviors (Lijffijt, Hu, & Swann, 2014). This makes individuals vulnerable to trauma and subsequent development of PTSD symptoms (Jacobsen et al., 2001).

The theory of PTSD-AUD comorbidity that has received the most support in the literature is the self-medication hypothesis (Khantzian, 1985), which suggests PTSD precedes substance use, in that individuals use substances to relieve symptoms of stress or symptoms of PTSD that develop as a result of a trauma (Hien et al., 2010). Further, individuals with abuse or dependence experiencing withdrawal symptoms are likely to experience heightened arousal symptoms, which can remind the person of the trauma; thereby resulting in increased PTSD symptomatology and substance use (Jacobsen et al., 2001). Longitudinal work has also supported the self-medication hypothesis in a sample of adults (Chilcoat & Breslau, 1998). This hypothesis describes a pathway between PTSD and alcohol use via internalizing symptoms (e.g., depression, anxiety; Kessler, Petukhova, & Zaslavsky, 2011), which can be characterized as pervasive negative emotionality (i.e., negative affectivity; Haller & Chassin, 2013; Miller & Resick, 2007). Thus, PTSD-related increases in negative affect may be a potential pathway between PTSD and alcohol use (Haller & Chassin, 2013). Other potential mechanisms contributing to the link between PTSD and alcohol use are externalizing symptoms (e.g., anger, impulsivity; Haller & Chassin, 2013). Relatedly, there is support in the literature for an externalizing subtype of PTSD (Miller, Kaloupek, Dillon, & Keane, 2004; Miller & Resick, 2007), which includes clinical features such as disinhibition and problematic substance use, while an internalizing subtype of PTSD includes low positive emotionality and features consistent with depression (Miller & Resick, 2007). Although some research has found evidence against the self-medication hypothesis (e.g., PTSD symptoms did not mediate between trauma exposure and binge drinking; Cisler et al., 2011), the results of this study are limited because they did not assess for drinking to cope motives. Therefore, although there are several competing theories that have adequate empirical evidence to merit consideration, there appears to be robust evidence for the self-medication hypothesis and its explanation of the relationship between PTSD and alcohol use.

1.2. Differential associations between PTSD and alcohol use

Studies assessing relations between PTSD symptoms and alcohol use have yielded largely inconsistent findings (e.g., Langdon et al., 2016; McFall, Mackay, & Donovan, 1992; Read, Brown, & Kahler, 2004; Stewart, Conrod, Pihl, & Dongier, 1999). A recent review by Debell et al. (2014) found that the DSM-IV PTSD symptoms of avoidance/numbing and hyperarousal were largely related to alcohol misuse; however, several studies investigating these relations were based on DSM-III-R and DSM-IV diagnostic criteria, and used correlational designs based on observed variables. To date, no known study has investigated associations between contemporary DSM-5 models of PTSD symptom clusters (e.g., Armour et al., 2015) and specific subscales of the AUDIT. Assessment of observed variables may be confounded by measurement error and other variance not related to constructs of interest. One way to overcome these problems is the use of latent constructs or factors in a structural equation model (Kline, 2011). Thus, in the current study, we investigated relations between latent factors of DSM-5 PTSD symptoms, and alcohol consumption and alcohol consequences.

1.3. PTSD factor structure

Continued study of the underlying structure of PTSD symptoms is important because determining the most accurate cluster of PTSD symptoms improves diagnostic accuracy, and allows researchers to determine specific sets of symptoms accounting for comorbidity of PTSD with other disorders (Armour, 2015). In *DSM-5*, there are currently four PTSD symptom clusters of intrusions, avoidance, negative alterations in cognitions and mood, and alterations in arousal and reactivity (AAR) (for review of different PTSD models, see Armour, Mullerova, & Elhai, 2016).

Recently, a 7-factor hybrid model of PTSD was proposed, which incorporates elements of two recent 6-factor models, the Anhedonia model (Liu et al., 2014) and the Externalizing Behavior Model (Tsai et al., 2015). This model proposed seven PTSD factors of intrusions, avoidance, negative affect, anhedonia, externalizing behaviors, anxious arousal, and dysphoric arousal (for thorough review of the hybrid model, see Armour et al., 2015). The hybrid model separates AAR into anxious arousal and dysphoric arousal, and incorporates the negative affect and anhedonia factors from the Anhedonia model (P. Liu et al., 2014), and the externalizing behaviors factor from the Externalizing Behaviors Model (Tsai et al., 2015); thus, it has been termed a “hybrid” model. The 7-factor hybrid model of PTSD has been found to be the best-fitting structural model of DSM-5 PTSD symptoms in veterans (Bovin et al., 2016; Pietrzak et al., 2015; Wortmann et al., 2016), college students (Armour, Contractor, Shea, Elhai, & Pietrzak, 2016), adolescents (Cao, Wang, Cao, Zhang, & Elhai, 2017; Liu, Wang, Cao, Qing, & Armour, 2016; Zhou, Wu, & Zhen, 2017) a trauma-exposed community sample (Seligowski & Orcutt, 2016), and has been found to be invariant across gender (Cao et al., 2017).

Studies have begun to investigate the functional significance of the 7-factor hybrid model with other co-morbid psychopathology (e.g., depression, anxiety, suicide ideation, hostility; Pietrzak et al., 2015). All factors of the 7-factor PTSD model have been found to be associated with negative affect (Seligowski & Orcutt, 2016) and anger (Armour, Contractor et al., 2016), with the externalizing behaviors factor having the strongest association with both constructs. Further specific associations have been found between depression and the negative affect, anhedonia, and dysphoric arousal factors of the 7-factor model (Liu et al., 2016), social withdrawal and anhedonia (Cao et al., 2017), all factors except intrusions and avoidance being associated with impulsivity (Armour, Contractor et al., 2016), panic symptoms and dysphoric arousal (Wang et al., 2015), and anxiety and intrusion, avoidance, and anxious arousal (Yang et al., 2017). Further investigation of the 7-factor model’s relationship with other psychopathological constructs is important as it clarifies specific PTSD symptoms’ relationship with other disorders, and can further clarify each of the newly proposed factors of the hybrid model as distinct.

1.4. Alcohol use disorders identification test (AUDIT) factor structure

The AUDIT is used to screen for alcohol use disorders (Babor, Biddle-Higgins, Saunders, & Monteiro, 2001; Saunders, Aasland, Babor, de la Fuente, & Grant, 1993) and has been validated across a variety of populations. The majority of previous research illustrates a two-factor solution (alcohol consumption and alcohol consequences) as the most parsimonious representation of the AUDIT’s factor structure (Doyle, Donovan, & Kivlahan, 2007; Hallinan, McGilloway, Dempster, & Donnelly, 2011; Shevlin & Smith, 2007;), and has been validated across a variety of populations, including trauma-exposed veterans (). Mallett, Varvil-Weld, Turrisi, and Read (2011) highlight that alcohol consumption and consequences are two separate constructs and merit individual investigation in their relations with other disorders. The argument can be made that heavy alcohol consumption does not necessarily mean an individual will experience severe consequences of alcohol use, and severe consequences can be experienced by those individuals that are not as heavy consumers of alcohol (Angkaw et al., 2015;

Ray, Turrisi, Abar, & Peters, 2009). To date, however, it is unclear how contemporary structural models of DSM-5 PTSD symptoms relate to alcohol consumption and alcohol consequences.

1.5. AUDIT and PTSD associations

In a sample of Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) veterans, Angkaw et al. (2015) found significant correlations between PTSD symptoms and alcohol consequences as measured by the AUDIT, and no significant relation between PTSD symptoms and alcohol consumption in a sample of OEF/OIF veterans; however, that study analyzed PTSD symptoms, and alcohol consumption and consequences as observed total scores.

1.6. Aims and hypotheses

To the best of our knowledge, the current study is the first to evaluate the relations between the 7-factor DSM-5 PTSD model and 2-factor AUDIT model using latent factors. Past studies have examined an externalizing subtype of PTSD, with clinical features such as problematic substance use, similar to the AUDIT's alcohol consumption factor; additionally, hyperarousal has been found to be strongly related to alcohol consumption (McFall et al., 1992; Stewart et al., 1999). Due to their high correlation with alcohol consumption, we hypothesized that the externalizing behaviors factor and the anxious arousal factor would relate similarly to alcohol consumption on the AUDIT. Considering the self-medication hypothesis' description of a pathway between PTSD and alcohol use via internalizing symptoms, we examined relations between the internalizing factors of the 7-factor model (anhedonia, negative affect, and dysphoric arousal) and the consequences factor of the AUDIT based on prior research (Angkaw et al., 2015). Therefore, we hypothesized the following: Hypothesis 1: PTSD's externalizing behavior and anxious arousal symptoms would be most strongly related to the AUDIT alcohol consumption factor than other PTSD factors; and Hypothesis 2: negative affect, anhedonia, and dysphoric arousal would be most strongly related to alcohol consequences.

2. Method

2.1. Procedures and participants

Data utilized in this study were drawn from a larger dataset from the National Health and Resilience in Veterans Study (NHRVS), which surveyed a contemporary, nationally representative sample of 1484 U.S. military veterans. Data collection for this study occurred between September-October 2013. All participants provided informed consent and completed a 60-minute, anonymous survey consisting of a variety of questionnaires. Post-stratification weights were applied based on basic demographic distributions from the most recent Current Population Survey (U.S. Census Bureau, 2010) for generalizability and more representativeness of all U.S. veterans. In total, 1602 U.S. veterans answered "Yes" to a screening question confirming status as a veteran. This resulted in 1484 individuals indicating they would participate in the NHRVS (92% response rate). For this study, we analyzed data from a subsample of veterans that endorsed a 'worst' traumatic event on the Trauma History Screen (n = 913). The NHRVS was approved by the Human Subjects Subcommittee of the VA Connecticut Healthcare System and VA Office of Research & Development.

Among the 913 trauma-exposed veterans (weighted sample size = 873), there were 830 men (90.7%). Participants had a weighted mean age of 59.7 (SD = 15.2; range of 20–94), a majority had a household income of $59,999 or less (unweighted n = 416; weighted 50.1%), a majority were married (unweighted n = 632; weighted 64%) and had a college or higher education (unweighted n = 799; weighted 72.6%). Most identified their race as White (unweighted n = 745; weighted 74.6%), Black (unweighted n = 68; weighted 9.7%), and Hispanic (unweighted n = 60; weighted 10.1%).

2.2. Assessments

The following demographic characteristics were collected: age, gender, years of education, race, marital status, employment status, and household income.

The *Trauma History Screen* (THS; Carlson et al., 2011) is a 14-item self-report measure assessing endorsement of 14 traumatic events in an individual's lifetime. The response scale included two options ("yes" and "no"). An additional potentially traumatic event, life-threatening illness or injury, was added to the THS for use in the NHRVS. At the end of the questionnaire, participants were asked which trauma was the 'worst' for them and to keep this trauma in mind while answering questions on the PTSD Checklist for DSM-5. The THS has shown good test-retest reliability (0.73-0.95) and convergent validity (Carlson et al., 2011).

The *PTSD Checklist for DSM-5* (PCL-5; Weathers et al., 2013) is a 20-item self-report questionnaire that assesses for PTSD symptoms based on *DSM-5* criteria. PTSD symptoms were rated based on the worst traumatic event reported by the participant on the THQ, and symptom severity is rated on a 5-point Likert scale ranging from 0 ("not at all") to 4 ("Extremely"). Past research has shown a cutoff score of 33 on the PCL-5 to be efficient for detecting a probable PTSD diagnosis in veterans (Bovin et al., 2016; Wortmann et al., 2016). The PCL-5 has shown strong internal consistency (α = 0.95), and convergent and discriminant validity (r = 0.68 to 0.87; r = 0.12 to 0.64) in treatment-seeking veterans (Wortmann et al., 2016). The internal consistency of the seven lifetime PTSD symptom clusters in this study ranged from 0.72 for PTSD-DA to 0.90 for PTSD-INT. Internal consistency for lifetime PTSD symptoms was excellent (weighted α = 0.95).

The *Alcohol Use Disorders Identification Test* (AUDIT; Saunders et al., 1993) is a 10-item self-report questionnaire that assesses alcohol consumption and consequences (Doyle et al., 2007; Hallinan et al., 2011; Shevlin & Smith, 2007; Wade et al., 2012). Items are measured on a 5-point Likert scale (0–4) and can total up to 40 points. The AUDIT has demonstrated test-retest reliabilities across studies (0.64–0.92), and adequate median internal consistency (in the 0.80s; Reinert & Allen, 2002). In the sample for this study, internal consistency for the AUDIT total score and the consumption and consequences total scores were good-to-acceptable (AUDIT-total: weighted α = 0.80; consumption, AUDIT-C: weighted α = 0.74; consequences AUDIT-CQ: weighted α = 0.77). In order to cover the time frame for the AUDIT (the past 12 months), we asked Veterans about lifetime PTSD symptoms. Assessment of current PTSD symptoms asks about symptoms experienced in the past month, and would therefore have not allowed examination of the entire time span covered by the AUDIT.

The *Patient Health Questionnaire – 4* (PHQ-4; Kroenke, Spitzer, Williams, & Löwe, 2009) is a 4-item brief measure of depression and anxiety symptoms, and has demonstrated to be a valid and reliable measure. Internal consistency of this measure in the current sample was excellent (weighted α = 0.91)

2.3. Exclusions and missing data

Of the total sample (n = 1484), 1256 (unweighted) participants endorsed a worst trauma and rated lifetime PTSD symptoms based on this trauma. Participants missing more than 50% of data on the PCL, PHQ-4, and the AUDIT were excluded from analyses (n = 343; due to survey skip-out rules, meaning if the individual did not endorse any of the first three items on the AUDIT, the survey skipped to the next questionnaire). This resulted in a final sample of 913 trauma-exposed participants. Data were found to be Missing Completely at Random for all measures (all Little's chi-square test values were $p > 0.05$). CFA analyses were conducted with Mplus 7.3 software (Muthén & Muthén, 2013). Missing values were estimated using maximum likelihood procedures with a pairwise present approach.

2.4. Analytic approach

Three CFAs were conducted to examine the following models: the 7-factor hybrid PTSD model, the two-factor AUDIT model, and a combined 7-factor PTSD and two-factor AUDIT model. Error covariance was fixed to zero, and factor variance was fixed to 1 to standardize factors in each model. Goodness of fit indices (Kline, 2011) that are reported below are the following: comparative fit index (CFI), Tucker Lewis Index (TLI), and root mean square error of approximation (RMSEA). According to Hu and Bentler (1999), models with excellent fit (adequate fit statistics are in parentheses) have the following fit statistics: CFI and TLI ≥ 0.95 (0.90–0.94) and RMSEA ≤ 0.06 (0.07–0.08).

The first CFA conducted was the 7-factor hybrid model of PTSD, with items loaded on the following factors: items 1–5 on the Intrusions (INT) factor, items 6–7 on the Avoidance (AV) factor, items 8–11 on the Negative Affect (NA factor), items 12–14 on the Anhedonia (AN) factor, items 15–16 on the Externalizing Behaviors (EB) factor, items 17–18 on the Anxious Arousal (AA) factor, and items 19–20 on the Dysphoric Arousal (DA) factor. We then conducted a CFA with the AUDIT items to construct the two-factor model, with items 1–3 on the Consumption (AUDIT-C) factor, and items 4–10 on the Consequences factor (AUDIT-CQ) factor. Last, we examined the combined 7-factor PTSD hybrid model and 2-factor AUDIT model, allowing all factors to correlate. For CFAs, items were treated as ordinal and we used weighted least squares with a mean- and variance-adjusted (WLSMV) chi-square for CFA, which is the preferred estimator for ordinal/categorical items (Flora & Curran, 2004; Wirth & Edwards, 2007).

We tested the null hypothesis that the difference between two correlations would be zero by using Wald chi-square tests of parameter constraints. We examined correlations between the AUDIT-CQ and AUDIT-C factors, and PTSD's NA, AN, DA, EB, and AA factors. To control for Type 1 error, we used a false discovery rate adjustment (Benjamini & Hochberg, 2000). Depression was controlled across all analyses to account for variance in internalizing symptoms that could be due to comorbid depression. Due to the PHQ-4's poor CFA fit, we utilized the depression subscale as an observed score.

3. Results

The most commonly endorsed worst traumas were sudden death of a family member or friend (unweighted: n = 277; weighted 31.2%), experiencing a life-threatening illness or injury (unweighted: n = 147; weighted: 14.1%), and seeing something horrible or being scared during military service (unweighted: n = 67; weighted: 7.7%). PCL-5 total scores ranged from 0 to 70 (weighted M = 14.74, SD = 14.64). Approximately (weighted) 9.16% (unweighted n = 77; weighted 90% CI [8.35, 9.98]) of the sample met criteria for a probable PTSD diagnosis by scoring at or above a clinical cutoff of 33 on the PCL-5 (Wortmann et al., 2016). AUDIT total scores ranged from 1 to 32 (weighted M = 4.92, SD = 4.71). Approximately (weighted) 18.4% (unweighted n = 132; weighted 90% CI [4.66, 5.18]) met criteria for problematic alcohol use by scoring at or above an 8 on the AUDIT (Conigrave, Hall, & Saunders, 1995). The PHQ-4's total scores ranged from 0 to 12 (weighted M = 1.28, SD = 2.39). Approximately (weighted) 7.8% (unweighted n = 61; weighted 90% CI [7.73, 7.87]) met criteria for clinically significant depression by scoring at or above a 3 on the depression subscale, while (weighted) 7.3% (unweighted n = 67; weighted 90% CI [7.23, 7.37]) met criteria for clinically significant anxiety by scoring at or above a 3 on the anxiety subscale (Kerper et al., 2014).

All analyses are weighted and goodness of fit indices for each CFA model can be found in Table 1. CFA results indicated an excellent-fitting 7-factor hybrid model of PTSD (see Table 1; see Table 2 for the 7-factor hybrid model of PTSD factor loadings and factor correlations), an excellent fit for the 2-factor AUDIT model (see Table 1; see Table 3 for the 2-factor AUDIT model factor loadings and factor correlations), and excellent fit for the combined CFA model of the 7-factor hybrid model of PTSD and two-factor AUDIT model (see Table 1; see Table 4 for factor correlations between the 7-factor PTSD hybrid model and the 2-factor AUDIT model).

Table 1
Goodness of fit indices for all CFA Models (N = 916).

Model	df	robust χ^2	p	CFI	TLI	RMSEA
7-factor hybrid PTSD	149	300.15	0.001	0.99	0.99	0.03
2-factor AUDIT	34	57.85	0.01	0.99	0.99	0.03
Combined PTSD and AUDIT model	369	517.10	0.001	0.99	0.99	0.02

Table 2
Standardized factor loadings and correlations for the 7-factor PTSD hybrid model.

Items	INT	AV	NA	AN	EB	AA	DA
1. Intrusive thoughts	0.84						
2. Nightmares	0.82						
3. Flashbacks	0.85						
4. Emotional cue reactivity	0.89						
5. Physiological cue reactivity	0.89						
6. Avoidance of thoughts		0.86					
7. Avoidance of reminders		0.92					
8. Trauma-related amnesia			0.59				
9. Negative beliefs			0.88				
10. Blame of self or others			0.74				
11. Negative trauma-related emotions			0.89				
12. Loss of interest				0.76			
13. Detachment				0.90			
14. Restricted Affect				0.91			
15. Irritability/anger					0.88		
16. Self-destructive/reckless behavior					0.78		
17. Hypervigilance						0.81	
18. Exaggerated startle response						0.90	
19. Difficulty concentrating							0.87
20. Sleep disturbance							0.75

Factor Correlation	INT	AV	NA	AN	EB	AA	DA
Intrusions	1						
Avoidance	0.88	1					
Negative Affect	0.79	0.75	1				
Anhedonia	0.76	0.77	0.86	1			
Externalizing Behaviors	0.73	0.72	0.86	0.83	1		
Anxious Arousal	0.85	0.77	0.78	0.78	0.83	1	
Dysphoria Arousal	0.78	0.65	0.75	0.87	0.80	0.80	1

Note. All factor loadings and correlations are significant at $p < 0.001$ level. (INT = Intrusions, AV = Avoidance, NA = Negative Affect, AN = Anhedonia, EB = Externalizing Behavior, AA = Anxious Arousal, DA = Dysphoric Arousal).

Controlling for depressive symptoms, we conducted Wald chi-square tests of parameter constraints to examine differential relations between the selected PTSD factors and the two AUDIT factors (see Table 5 for factor correlations, Wald test values, and alpha adjustment levels). To control for Type 1 error, we adjusted alpha by using the false discovery rate adjustment (Benjamini & Hochberg, 2000). This method involves starting with the least restrictive alpha value (in this study, p = 0.88 for alcohol consequences, and 0.52 for alcohol consumption), and comparing it to p = 0.05. If the highest alpha value is not significant, the next highest alpha value is compared to 0.05/2, the next highest to 0.05/3, and so on until all alpha values have been corrected. Using this adjustment, results yielded the following significant findings for the AUDIT-CQ factor: AA (r = 0.04), was less strongly related to AUDIT-CQ than NA (r = 0.30), Wald $\chi^2(1, N = 913) = 12.792$, p = 0.0003, AN (r = 0.29), Wald $\chi^2(1, N = 913) = 13.029$, p = 0.0003 and DA (r = 0.31), Wald $\chi^2(1, N = 913) = 15.803$,

Table 3
Standardized factor loadings and correlations for the 2-factor AUDIT model.

Items	AUDIT-Consume	AUDIT-Consequences
1. How often did you have a drink containing alcohol in the past year?	0.58	
2. How many drinks did you have on a typical day when you were drinking in the past year?	0.86	
3. How often did you have 6 or more drinks on one occasion in the past year?	0.97	
4. How often during the last year have you found that you were not able to stop drinking once you had started?		0.87
5. How often during the last year have you failed to do what was normally expected from you because of drinking?		0.84
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?		0.83
7. How often during the last year have you had a feeling of guilt or remorse after drinking?		0.84
8. How often during the last year have you been unable to remember what happened the night before because you had been drinking?		0.91
9. Have you or someone else been injured as a result of your drinking?		0.53
10. Has a relative, friend, or doctor/healthcare professional been concerned about your drinking or suggested you cut down?		0.80

Factor Correlation	AUDIT-Consume	AUDIT-Consequences
AUDIT-Consume	1	
AUDIT-Consequences	0.74	1

Note. All factor loadings and correlations are significant at $p < 0.001$ level.

Table 4
Factor correlations for the combined 7-factor PTSD hybrid model and 2-Factor AUDIT model.

Factor Correlation	AUDIT-Consumption	AUDIT-Consequences
INT	0.26	0.40
AV	0.24	0.38
NA	0.16	0.49
AN	0.23	0.52
EB	0.28	0.46
AA	0.22	0.33
DA	0.23	0.50

Note. All factor correlations are significant at $p < 0.001$ level. (INT = Intrusions, AV = Avoidance, NA = Negative Affect, AN = Anhedonia, EB = Externalizing Behavior, AA = Anxious Arousal, DA = Dysphoric Arousal).

$p = 0.0001$. There were no significant associations observed for alcohol consumption scores.

In a secondary analysis, we examined relations between the AUDIT-CQ and AUDIT-C factors, and PTSD's NA, AN, DA, EB, and AA factors utilizing lifetime Major Depressive Disorder (MDD) as a categorical covariate (instead of the PHQ-4 depression subscale). Lifetime MDD diagnosis was assessed using a self-report version of the MDD module from the MINI Neuropsychiatric Interview. This did not change the pattern of observed results (results not shown, available from first author).

Last, we modeled AUDIT scores as observed variables (i.e., sum of consumption and sum of consequences items) and compared them to PTSD latent factors while controlling for depression using the PHQ-4's depression subscale. Associations that were significant in the original latent variable analyses remained significant at the $p < 0.05$ level (all p's = 0.03–0.04), but not at the threshold required after the false discovery adjustment rate for multiple comparisons ($p = 0.05$/number of comparisons).

4. Discussion

The factors of the 7-factor model of PTSD appear to be differentially related to consequences of alcohol use, which is notable when considering the specific content of the PTSD factors. Past research has observed associations between heightened depressive symptoms and maladaptive drinking behaviors (Kenney, Jones, & Barnett, 2015;

Table 5
Significant Correlations between the 7-Factor PTSD Hybrid Model and 2-Factor AUDIT Model, and the Corresponding Wald Test Values.

Path	*r* (p-value)	Path	*r* (p-value)	*Wald* $\chi 2$ (p-value)	Alpha Adjustment
NA with CQ	0.297 (0.000)	AN with CQ	0.288 (0.000)	0.021 (0.884)	0.025
NA with CQ	0.297 (0.000)	EB with CQ	0.309 (0.000)	0.051 (0.821)	0.013
NA with CQ	**0.297 (0.000)**	**AA with CQ**	**0.041 (0.571)**	**12.792 (0.0003)***	**0.007**
NA with CQ	0.297 (0.000)	DA with CQ	0.309 (0.000)	0.036 (0.849)	0.017
AN with CQ	0.288 (0.000)	EB with CQ	0.309 (0.000)	0.084 (0.772)	0.010
AN with CQ	**0.288 (0.000)**	**AA with CQ**	**0.041 (0.571)**	**13.029 (0.0003)***	**0.006**
AN with CQ	0.288 (0.000)	DA with CQ	0.309 (0.000)	0.125 (0.723)	0.008
DA with CQ	0.309 (0.000)	EB with CQ	0.309 (0.000)	0.000 (0.999)	0.050
DA with CQ	**0.309 (0.000)**	**AA with CQ**	**0.041 (0.571)**	**15.803 (0.0001)***	**0.006**
NA with CS	0.060 (0.315)	AN with CS	0.101 (0.076)	0.406 (0.524)	0.013
NA with CS	0.060 (0.315)	EB with CS	0.205 (0.001)	4.762 (0.458)	0.010
NA with CS	0.060 (0.315)	AA with CS	0.110 (0.095)	0.551 (0.394)	0.008
NA with CS	0.060 (0.315)	DA with CS	0.138 (0.031)	1.132 (0.287)	0.006
AN with CS	0.101 (0.076)	EB with CS	0.205 (0.001)	2.089 (0.148)	0.006
AN with CS	0.101 (0.076)	AA with CS	0.110 (0.095)	0.018 (0.893)	0.050
AN with CS	0.101 (0.076)	DA with CS	0.138 (0.031)	0.332 (0.564)	0.017
DA with CS	0.138 (0.031)	EB with CS	0.205 (0.001)	0.901 (0.342)	0.007
DA with CS	0.138 (0.031)	AA with CS	0.110 (0.095)	0.144 (0.704)	0.025

Note. *Compared alpha values to the false discovery rate adjustment and significant findings also marked in bold; (INT = Intrusion, AV = Avoidance, NA = Negative Affect, AN = Anhedonia, EB = Externalizing Behavior, AA = Anxious Arousal, DA = Dysphoric Arousal; CS = AUDIT-Consumption, CQ = AUDIT-Consequences); All results are adjusted for PHQ-2 depression scores.

Mushquash et al., 2013), and anxiety and alcohol consequences (Goldsmith, Thompson, Black, Tran, & Smith, 2012; Nitka & O'Connor, 2017), and negative affect, anhedonia, and dysphoric arousal all have internalizing symptoms that load onto them (see Table 2). The fact that these internalizing factors are related to the AUDIT-CQ (Doyle et al., 2007; see Table 3) is unsurprising (Fuehrlein et al., 2016) when interpreted in the context of the self-medication hypothesis, which posits that trauma-exposed individuals experiencing negative affect (PTSD's internalizing symptoms) engage in problematic drinking (Khantzian, 1997). Our findings are also consistent with prior research that has found significant bivariate correlations between PTSD symptoms and alcohol consequences as measured by the AUDIT, and no significant relation between PTSD symptoms and alcohol consumption in a sample of OEF/OIF veterans (Angkaw et al., 2015), but extends this work by examining relations at the factor level. Angkaw et al. (2015) suggested that, while alcohol consequences and alcohol consumption are generally correlated, and individuals that engaged in heavy drinking were at higher risk of experiencing alcohol-related consequences, it does not necessitate that they will; additionally, individuals with lighter episodic drinking do not necessarily avoid alcohol-related consequences (Ray et al., 2009). This merits consideration of the mechanisms that can account for the relationship between the dimensions of the disorders.

Past research has found that internalizing symptoms of PTSD and internalizing symptoms in general (e.g., depression, anxiety; Wright, Foran, Wood, Eckford, & McGurk, 2012) mediate the relationship between combat exposure experienced by military service members, and problematic behaviors such as alcohol use. These findings are consistent with the self-medication hypothesis in that alcohol use was used to cope with internal distress. One reason that the internalizing symptoms and alcohol use consequences are more related could be that, while alcohol consumption can serve as a coping mechanism for PTSD symptoms, it is the adverse consequences of alcohol use (e.g., tolerance, being unable to fulfill responsibilities, blackouts) that trump effects of alcohol consumption, which further exacerbate PTSD symptoms. Individuals experiencing increased internalizing symptoms might be more vulnerable in general to experiencing alcohol consequences, regardless of level of alcohol consumption; however, to date, no studies have examined this specific research question.

There could be further mechanisms not measured in this study that explain the relations between internalizing PTSD symptom factors and consequences of alcohol use. For example, Mallett et al. (2011) found that alcohol consequences can be predicted by variables such as a person's willingness to accept consequences of alcohol use, after controlling for alcohol consumption. In the context of the self-medication hypothesis, it could be that individuals experiencing heightened levels of PTSD's internalizing symptoms have increased willingness to accept the consequences of drinking in an attempt to cope with these symptoms. Therefore, regardless of alcohol consumption level, this results in increased adverse consequences due to alcohol use. In the context of the substance use preceding PTSD theory (Jacobsen et al., 2001; Lijffijt et al., 2014), it could be that individuals high in willingness to accept the consequences of alcohol use could be more at risk of experiencing trauma, and therefore development of PTSD symptoms. Therefore, the consequences of alcohol use could be most related to internalizing factors of PTSD over alcohol consumption because it was the consequences (e.g., trauma) that led to the trauma and development of PTSD, and perhaps heightened internalizing symptoms due to the circumstances from which the trauma arose. However, due to the cross-sectional nature of this study we are unable to determine causality. Further work using longitudinal designs is needed to elucidate causal relations between trauma, PTSD and alcohol use problems.

Another possible underlying mechanism could be dimensions of emotional dysregulation (e.g., impulsivity, difficulties engaging in goal-directed behavior), which has been shown to mediate relationships between PTSD and alcohol consequences (Tripp, McDevitt-Murphy, Avery, & Bracken, 2015); however, this study did not investigate specific symptom clusters of PTSD and their relation to alcohol consequences. Another reason for the relationship between alcohol consequences and internalizing symptoms could be due to symptom overlap on the measures. For example, several of the items on the AUDIT-CQ factor contain behaviors considered maladaptive or characteristic of severe alcohol use disorder (see Table 3). Additionally, item 7 on the AUDIT-CQ factor ('How often during the last year have you had a feeling of guilt or remorse after drinking?') overlaps with symptoms on the negative affect and anhedonia factors.

Our results are consistent with past research that has found a distinction between dysphoric arousal and anxious arousal in relations to alcohol use. For example, a study by Trautmann et al. (2015) that utilized the five-factor PTSD model with DSM-IV data found that dysphoric arousal, but not anxious arousal, symptoms were related to alcohol use (Trautmann et al., 2015). This adds support for differentiating between dysphoric arousal and anxious arousal symptoms, which has been proposed in past studies (Elhai et al., 2011).

We must address the lack of findings on relations for alcohol consumption. We cannot make a definite temporal conclusion for occurrence of PTSD symptoms due to the cross-sectional nature of the study. It is possible there are temporal differences on when alcohol consumption could be at its highest in the development of PTSD symptoms, and when alcohol consequences could be at its highest in individuals with PTSD. This is a question that merits further study in future longitudinal research. Additionally, the use of timeline follow back interviews, which have been found to be a good measure of alcohol consumption behavior, could be utilized in future studies to obtain more detailed information on frequency and quantity of alcohol use.

Results of the current study have two central clinical implications. First, they highlight the need to assess for alcohol-related consequences in veterans with internalizing PTSD symptoms such as dysphoric arousal, negative affect, and anhedonia. Second, they underscore the importance of assessing beyond mere alcohol consumption (i.e., AUDIT-C), to the adverse consequences of alcohol use. Assessing for alcohol consequences can provide a more thorough assessment of alcohol-related problems that may be linked to PTSD symptoms

There are strengths and limitations to this study. Strengths include the following: this is one of the first studies to examine the association between a contemporary structural model of DSM-5 PTSD symptoms, and alcohol consumption and consequences at the factor level; it extends previous research in finding significant relations between internalizing symptoms of PTSD and alcohol consequences; and it revealed distinctions between PTSD's dysphoric arousal and anxious arousal symptoms. Limitations to this study include: use of self-reported symptomatology; cross-sectional nature of the sample; investigation of a veteran sample, which may limit generalizability of results; and measurement of lifetime PTSD and 12-month alcohol use created a discrepancy in timeframes for the measured constructs. Notwithstanding these limitations, this study adds to the literature by assessing the 7-factor hybrid model of PTSD's association with alcohol consumption and consequences at the latent factor level. Further research is needed to evaluate the generalizability of these results in other populations of trauma survivors; assess longitudinal associations between PTSD symptom factors and alcohol consumption and consequences; and evaluate the efficacy of interventions targeting internalizing PTSD symptoms in mitigating risk for and treating alcohol use problems in veterans and other at-risk populations.

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