Examining the Role of Solitary Drinking in Alcohol Misuse and Functional Impairment Among Post-9/11 Veterans in the Context of PTSD

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EXAMINING THE ROLE OF SOLITARY DRINKING IN ALCOHOL MISUSE AND FUNCTIONAL IMPAIRMENT AMONG POST-9/11 VETERANS IN THE CONTEXT OF PTSD

by

Brooke E. Buckley

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Abstract

Post-9/11 veterans are at increased risk for developing PTSD and alcohol misuse. Many studies have examined the relationship between PTSD, alcohol misuse, and functional impairment and a few studies have examined the context in which drinking takes place. However, research has yet to examine solitary drinking in the context of PTSD. Using prospective data, the study tested the following hypotheses in a sample of post-9/11 veterans with PTSD via regression analyses: greater severity of PTSD would predict more time spent drinking alone (as a proportion of all drinking occasions), as would greater alcohol use and alcohol-related consequences, and a higher proportion of solitary drinking would predict worse functional impairment. It was also hypothesized that solitary drinking would predict future alcohol-related consequences. The hypotheses were not supported. The findings suggest that the more veterans with PTSD drink alcohol, they are likely to experience greater alcohol-related consequences, regardless of drinking in a solitary or social setting.

*Keywords*: PTSD, solitary drinking, alcohol, veterans, functional impairment
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Introduction

Combat veterans are at increased risk for both PTSD and alcohol misuse compared to civilians. According to the National Center for Veterans Analysis and Statistics (NCVAS, 2018), approximately 4.2 million veterans were deployed as part of combat operations after 9/11/01, typically to combat theatres in the Middle East. It is estimated that 11 – 20% of these veterans will have PTSD in a given year (National Center for PTSD [NCPTSD], 2018), and 10% of veterans with PTSD will also experience alcohol and/or other drug problems (National Institute of Drug Abuse [NIDA], 2019). The rate of PTSD diagnoses and substance misuse within the veteran population presents a significant public health concern.

Several studies have demonstrated a strong relationship between PTSD and alcohol misuse among veterans. Specifically, alcohol use has been found to be significantly associated with symptoms such as intrusion, arousal and reactivity, and negative alterations in mood and cognition (Walton et al., 2017). A study of veterans found that those with PTSD reported higher levels of drinking to cope, compared to veterans who did not meet criteria for PTSD (McDevitt-Murphy et al., 2015a). Another study of veterans showed that coping motives for drinking were associated with more severe alcohol-related consequences and mediated the relationship between PTSD symptoms and alcohol misuse (McDevitt-Murphy et al., 2017). Further, there is evidence suggesting that PTSD symptoms predict same-day alcohol use (Gaher et al., 2014; Possemato et al., 2015). Using experience sampling methods, Gaher and colleagues (2014) asked veterans about their PTSD symptoms and alcohol use in random two-hour time blocks between the hours and 10am and 2am. They found that higher levels of PTSD symptoms during the day were associated with increased alcohol use in the evening (Gaher et al., 2014). Similarly, using ecological momentary assessment (EMA), a type of experience sampling method that focuses
more on momentary than representative activities and experiences (Tay & Uy, 2018), Possemato et al. (2015) assessed veterans’ PTSD symptoms and alcohol use across four time blocks. The first assessment took place between 10:00 am to 12:59 pm which captured symptoms and alcohol use from the night before (7:00 pm – 10:00 am). The afternoon assessment occurred between 1:00 pm to 3:59 pm, capturing PTSD symptoms and alcohol use from the previous time block (10:00 am to 1:00 pm). The third assessment happened between 4:00 pm and 6:59 pm, capturing symptoms and use from 1:00 pm to 4:00 pm. The final assessment for the day took place between 7:00 pm and 9:59 pm and inquired about PTSD symptoms and alcohol use from the previous time block (4:00 pm to 7:00 pm). The authors found that increased PTSD symptom severity in the evening (4:00 pm to 7:00 pm) was associated with greater alcohol use overnight (between 7:00 pm and 10:00 am) (Possemato et al., 2015).

In order to gain insight into the experiences of veterans with PTSD who consume alcohol, it is important to address how PTSD may predict functional impairment and predict impairment across time (Fortenbaugh et al., 2020). Additionally, in their sample of 3,157 military veterans, Norman and colleagues (2018) found that co-occurring PTSD/Alcohol Use Disorder (AUD) was associated with greater functional impairment (i.e., cognitive, mental, physical functioning) than AUD alone, though, this association was equal to that of veterans with PTSD only. In their sample of 205 Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) veterans, Angkaw and colleagues (2015) found that while PTSD symptoms did not significantly predict increases in alcohol consumption, PTSD symptoms did significantly predict greater alcohol-related consequences and lower quality of life. Also, while alcohol consumption significantly predicted alcohol-related consequences, consumption did not significantly predict lower quality of life. However, alcohol-related consequences did
significantly predict lower quality of life. Furthermore, symptoms of PTSD such as intrusions and arousal, in conjunction with alcohol use, have been associated with a greater likelihood of engaging in aggressive behaviors among veterans with PTSD (Watkins et al., 2017). Such behavior may result in greater alcohol-related consequences and further impair functioning. Together, these findings emphasize the negative impact that PTSD and hazardous alcohol use can have on veterans’ functioning, as well as the complexity of the relationship between PTSD, hazardous alcohol use, and functioning in veterans.

**Solitary vs. Social Drinking**

High rates of drinking in the military have been well-documented (Kime, 2019). While there may be a variety of reasons for this, it is important to consider the culture supporting alcohol use in the military. A focus group study of active-duty army personnel found that service members perceived there to be many contributors to excess drinking, including environmental factors (e.g., aggressive marketing by bars located near military establishments) as well as social factors such as the military culture and peer pressure (Besse et al., 2018).

Although models relating PTSD, alcohol misuse, and psychosocial functioning have been studied extensively, little attention has been paid to the contexts in which drinking occurs, such as in social or solitary settings among individuals with PTSD. Studies with other populations suggest, however, that solitary drinking may be associated with a more severe psychological profile. For example, one study found that solitary drinking was associated with psychosocial impairment and alcohol-related problems in adolescents and young adults (Skrzynski & Creswell, 2020a). Young adults in that study who reported drinking solitarily were also more likely to engage in risky behaviors, report depressive symptoms, and have more legal issues compared to young adults who only drink in social settings (Skrzynski & Creswell, 2020a). In
another study (Acuff et al., 2020), participants between the ages of 18 and 30 completed a version of the Alcohol Purchase Task (a measure of the reinforcing value of alcohol; APT) wherein they were instructed to read three vignettes, outlining social, solitary, and neutral hypothetical situations in which they could buy alcohol. After reading each vignette, participants were asked how many drinks they would purchase at various price points. Participants’ typical weekly alcohol consumption and alcohol-related problems were also assessed. Results showed that while alcohol demand was significantly greater in the social APT, increased alcohol demand (a measure of alcohol’s reinforcing value) was associated with greater alcohol-related problems in both social and solitary contexts. Additionally, the authors suggested that greater solitary drinking may a risk factor for greater alcohol consumption and related problems, as there was greater hypothetical expenditure in the solitary APT, signifying a greater motivation for solitary drinking. Further, in a community sample of adults (M_{age} = 35.2), self-reported social drinking was associated with greater consumption in within-person analyses, but less consumption in between-person analyses. Specifically, participants who reported a greater proportion of social drinking occasions were less likely to report episodes of heavy drinking than participants who reported a greater proportion of solitary drinking occasions. However, participants were more likely to drink more when they were drinking with others (Acuff et al., 2021).

With respect to veterans with PTSD, patterns of social vs. solitary drinking have not been examined; however, the literature on drinking motives may offer some insight. Drinking to cope with negative emotions or interpersonal experiences (tension reduction drinking) has been linked with solitary drinking in studies of emerging adults (Bilevicius et al., 2018; Corbin et al., 2020; Keough et al., 2015). Conversely, social drinking has been associated with drinking motives reflecting enhancement of positive emotions or interpersonal experiences (Corbin et al., 2020;
Waddell et al., 2020). Corbin and colleagues (2020) found that solitary drinking was significantly associated with coping motives and tension reduction drinking in a community sample of adults. Additionally, the relationship between solitary drinking and negative consequences may be mediated by coping motives (Corbin et al., 2020; Waddell et al., 2020). Another study suggests that solitary drinking may mediate the relationship between negative affect and hazardous drinking (Bilevicius et al., 2018). However, these relationships have yet to be demonstrated in veteran samples, specifically, although prior research with veterans shows that coping motives have been associated with more severe patterns of alcohol use (McDevitt-Murphy et al., 2015a; McDevitt-Murphy et al., 2017).

Past research has demonstrated that there is a significant relationship between PTSD symptoms and drinking to cope with negative emotions, which has also been shown to mediate the relationship between PTSD symptoms and problematic alcohol use (McDevitt-Murphy et al., 2015a; McDevitt-Murphy et al., 2017; Miller et al., 2017). Specifically, drinking to cope with negative affective states like depression and anxiety has been associated with greater binge drinking frequency and higher levels of alcohol-related consequences, specifically in veterans (McDevitt-Murphy, 2015a; McDevitt-Murphy et al., 2017). It is important to note, however, that veterans with PTSD also reported social motives for drinking, to a similar degree as veterans who engaged in hazardous drinking but did not meet full criteria for PTSD (McDevitt-Murphy et al., 2015a). In their study on veterans’ drinking motives (with 66% of the sample meeting criteria for a PTSD diagnosis), Schreiner and colleagues (2020) found that most veterans reported social reasons for drinking, which reflected both enhancement and coping motives. Although veterans endorsed enhancement motives (i.e., increased feelings of sociability, prosocial attributes, and belonging), they also reported drinking to cope in social settings (ability to endure/tolerate social
situations) (Schreiner et al., 2020). Together, this illustrates the complexity of drinking motives in solitary and social drinking contexts.

To summarize, research suggests that veterans may use alcohol to facilitate social interactions (Demers, 2011; McDevitt-Murphy et al., 2015b), and they may report engaging in drinking to cope with unpleasant emotional states, such as PTSD-related negative affect. Both PTSD and excessive drinking may contribute to functional impairment (Balderrama-Durbin et al., 2015). To date, research has not investigated patterns of solitary drinking and how such patterns may relate to PTSD symptoms, alcohol-related consequences, or functional impairment in the context of PTSD, although research on other populations suggests that solitary drinking is associated with greater levels of severity, including higher levels of alcohol related consequences.

The Current Study

The study aimed to examine solitary drinking patterns in a sample of veterans with PTSD using data collected via ecological momentary assessment (EMA). Specifically, we tested the following hypotheses:

1. Greater PTSD severity at baseline would predict a higher proportion of solitary drinking occasions during the EMA phase.

2. Greater alcohol consumption and alcohol-related consequences at baseline would predict a higher proportion of solitary drinking during the Ecological Momentary Assessment (EMA) phase.

3. A higher proportion and frequency of solitary drinking during the EMA phase would predict greater alcohol-related consequences after the EMA phase.
4. A higher proportion of solitary drinking will predict worse functional impairment at the post-EMA assessment.

Method

Participants

This study used data collected from a completed study of veterans. All participants in the study were veterans with at least one deployment to a combat zone after 9/11/2001 (N = 72; M_{age} = 37.34 years; SD = 7.88). The sample was predominantly male (n = 63, 87.5%; female = 9, 12.5%). With respect to race and ethnicity, a majority of the sample was White (n = 43, 59.7%), followed by African American (n = 24, 33.3%), Asian American (n = 1, 1.4%), Hispanic/Latinx (n = 4, 5.6%), and other (n = 4, 5.6%). All participants met criteria for PTSD based on the Clinician-Administered PTSD Scale for DSM-5.

Measures

The PTSD Checklist for DSM-5 (PCL-5; Weathers et al., 2013) is a 20-item self-report measure assessing the DSM-5 criteria for PTSD. Respondents are asked to indicate the degree to which they were bothered by symptoms of PTSD in the past 30 days using a 5-point Likert scale, ranging from 0 (not at all) to 4 (extremely). Total scores can range from 0 to 80, and higher scores indicate greater PTSD symptom severity. In veteran samples, this measure has demonstrated good test-retest reliability, convergent and discriminant validity, and internal consistency (α = .96) (Bovin et al., 2016).

The Clinician Administered PTSD Scale for the DSM-5 (CAPS-5; Blake et al., 1995; Weathers et al., 2018) is a structured diagnostic interview designed to assess for PTSD based on the DSM-5 criteria. It also measures PTSD symptom frequency and severity. Frequency is recorded as a number of times or a percentage of time experienced, depending on how it is
reported by the respondent. Symptom severity is rated on a 5-point Likert scale, ranging from 0 (absent) to 4 (extreme). Total scores can range from 0 to 80, and higher total scores indicate greater PTSD symptom severity. Participants meet criteria for a PTSD diagnosis if they report experiencing a traumatic event and endorse at least one symptom of intrusion associated with the event (i.e., flashbacks, memories, dreams), one avoidance symptom (i.e., efforts to avoid memories or external reminders related to the event), two symptoms related to negative mood or cognition (i.e., persistent fear, belief that the world is dangerous), and two symptoms related to arousal and reactivity (i.e., hypervigilance, difficulties concentrating, sleep disturbances). In two separate veteran samples, this measure has demonstrated good convergent and discriminant validity, interrater and test-retest reliability, and high internal consistency (α = .88) (Weathers et al., 2018).

The Timeline Follow-Back (TLFB; Sobell & Sobell, 1996) assesses alcohol consumption over the past 30 days using a calendar-based format. Information about the quantity and frequency of standard drinks consumed in the past month is obtained by a trained interviewer. Standard drinks are defined as 12 ounces of beer, 5 ounces of wine, and 1.5 ounces of hard liquor. Scores on the TLFB are calculated by simply tabulating the total number of drinking days and drinks per drinking day. Higher scores indicate a greater number of drinking days and a greater number of drinks consumed per drinking day during the past month. The TLFB has demonstrated strong reliability in psychiatric outpatient settings (Carey et al., 2004).

The Drinker Inventory of Consequences (DrInC; Tonigan & Miller, 2002) is a 50-item self-report measure aimed at identifying the negative consequences of alcohol misuse. It assesses alcohol misuse across five domains, which include interpersonal, intrapersonal, physical, social, and impulsive control. For each alcohol-related consequence, respondents indicate “No/Yes”
(0/1) if they have ever suffered that consequence in their lifetime, as well as the frequency of the consequence within the past three months on a 4-point Likert scale, ranging from 0 (never) to 3 (daily). Total lifetime scores (DrInC-L) can range from 0 to 45 and total recency scores (DrInC-R) can range from 0 to 135. Higher scores indicate greater alcohol-related consequences. In a sample of adults who use alcohol, the DrInC has proven to be a reliable and valid measure of alcohol-related consequences (Forcehimes et al., 2007) and has also demonstrated good internal consistency (α = .96) in a sample of veterans who consume alcohol (Hahn et al., 2015).

The World Health Organization Disability Assessment Schedule, 2nd version (WHODAS 2.0; Üstün et al., 2010) is a clinical interview that assesses functional impairment across six domains: cognition, mobility, self-care, getting along with others, life activities (i.e., cooking, cleaning, shopping, work or school activities), and participation in society. On a 5-point Likert scale ranging from 1 (none) to 5 (cannot do or extreme), participants indicate how much difficulty they have had in these domains, as well as the number of days they experienced such difficulties, in the past 30 days. The current study will use a global functioning disability score, which is the sum of total scores for each domain. Total scores can range from 36 to 180, and higher scores on the WHODAS indicate greater functional impairment. The WHODAS has proven to be a valid and reliable measure (α = .96) (Üstün et al., 2010). In a veteran sample where participants endorsed at least one symptom of PTSD, the WHODAS has demonstrated good internal consistency (α = .97) (Bovin et al., 2019).

The frequency and proportion of solitary and social drinking were determined using participant responses to Ecological Momentary Assessment (EMA) prompts. The EMA prompts were developed by the study investigators of Project BRAVE to assess activities, context, and emotions throughout the day in the veterans’ personal environments. These prompts gathered
information such as location, activity, purpose of activity, whether the experience was enjoyable or not, whether the participant was alone or with others, alcohol consumption, quantity of alcohol consumed, and a daily global rating of PTSD symptom severity. In the present investigation, frequency of solitary drinking reflects the number of prompts where a participant reported drinking while alone. The proportion of solitary drinking was calculated as the frequency of drinking while alone, divided by the total number of prompts where the participant indicated consuming alcohol. The frequency and proportion of social drinking were calculated similarly: the number of prompts a participant reported drinking with others (frequency), and then this frequency was divided by the total number of prompts where the participant reported consuming alcohol (proportion).

**Procedure**

Participants were recruited via community flyers, community events, outreach to veteran/military organizations and groups, and social media advertising. To be eligible for the study, participants had to be US military veterans who had served at least one post-9/11/2001 deployment. To be enrolled in the EMA phase of the study, veterans needed to meet diagnostic criteria for PTSD, according to DSM-5. After providing informed consent, participants completed a comprehensive assessment battery that included a combination of self-report and interviewer-administered instruments.

Participants who were eligible and willing to participate in the EMA phase were provided with instructions by a research assistant and were then asked to initiate a three-week period of participating in EMA using a handheld device provided by the research project. EMA data were collected via mobile devices which prompted veterans throughout the day to record their activities and experiences, up to a maximum of 10 prompts per day. Veterans were also expected
to self-initiate the completion of both morning assessments, which asked about past-day activities and sleep quality, and evening assessments, which asked about PTSD symptom severity during the day and if they had assistance. Participants were compensated with an escalating incentive schedule for each prompt they responded to and could earn up to $350. Following EMA, participants returned for two more comprehensive assessments, one at the end of the three-week time period and one four weeks later.

**Data Analytic Plan**

Based on recommendations by Tabachnik and Fidell (2013) and Kline (2011), data were assessed for outliers and normality. The data were assessed for skewness and kurtosis, and were transformed when necessary, using recommendations from Tabachnik and Fidell (2013). Skewness and kurtosis values of the CAPS-5 and post-EMA WHODAS scores were within the range of normal distribution (±1.5). Past month drinking and DrInC-Recent consequences underwent log10 transformations and proportion of solitary drinking underwent square root transformation. No outliers were identified and pairwise deletion was used in cases of missing data.

Prior to conducting analyses, we considered possible covariates of age, gender, race/ethnicity, and marital status and included any of these that showed a significant relationship to the dependent variable. To test the first hypothesis, that higher CAPS-5 severity at baseline would predict a greater proportion of solitary drinking, the CAPS-5 total score was entered in the second block, after relevant covariates, and proportion of solitary drinking was the dependent variable. To test Hypothesis 2, that greater alcohol consumption and alcohol-related consequences at baseline would predict a higher proportion of solitary drinking during EMA, the quantity of alcohol consumed in the past month (measured by the TLFB) and alcohol-related
consequences (measured by the DrInC) were entered as predictor variables in the second block, following any relevant covariates, and the proportion of time spent drinking alone served as the dependent variable.

For Hypothesis 3, that the frequency of solitary drinking would uniquely predict alcohol-related consequences (as measured by the post-EMA DrInC subscales), we conducted a bivariate correlation analysis. To test the fourth hypothesis, that a higher proportion of solitary drinking would predict worse functional impairment, the proportion of time spent drinking alone served as the predictor variable in block two, following any relevant demographic covariates, and the WHODAS total score served as the dependent variable.

Results

Descriptive statistics for the full sample are shown in Table 1. Mean scores on all of the measures of interest tended to be in the low severity range. All participants met criteria for PTSD. In terms of alcohol consumption, at baseline, participants reported an average of 6 drinking occasions per month and consuming an average of 21 standard drinks, based on the TLFB. During the three-week EMA period, participants reported an average of 7 drinking occasions, with solitary drinking reflecting 46.29% of all drinking occasions. Accordingly, mean scores on the WHODAS were also relatively low, indicating a mild degree of functional impairment.

Independent samples t-tests were used to identify potential covariates of sex, race, and marital status on proportion of solitary drinking and functional impairment. The only significant difference was a sex difference on functional impairment. Average scores on the WHODAS (after the EMA phase) for male and female participants were 61.41 (SD = 32.13) and 88.56 (SD
Male participants reported less functional impairment than Female participants, \( t(63) = -2.30, p = .03, 95\% \text{ CI} [-50.69, -3.60]. \)

Table 2 presents correlations among baseline measures of PTSD, alcohol use, alcohol-related consequences, and post-EMA functional impairment. Total number of drinking days in the past month and total number of drinks consumed prior to the EMA phase were both moderately correlated with the drinking frequency variables derived from the EMA period. Both baseline variables were more strongly related to the total number of drinking occasions than to frequency of solitary drinking specifically. The baseline DRINC – Lifetime consequences score was weakly correlated with the total number of drinking occasions during the EMA phase, and the baseline DRINC- Recent consequences score was moderately correlated with both the frequency of solitary drinking and total number of drinking occasions. Further, the post-EMA WHODAS was moderately correlated with baseline PCL-5 and CAPS-5 scores but not with measures of alcohol use or consequences.

To test the first hypothesis, that greater PTSD severity at baseline would predict a higher proportion of solitary drinking, CAPS-5 was entered as the predictor variable and the proportion of solitary drinking was entered as the dependent variable. The model was not significant \( F(1, 48) = .50, p = .48, \) thus we did not find support for Hypothesis 1. The results of this analysis are presented in Table 3.

To test Hypothesis 2, that greater alcohol consumption and alcohol-related consequences at baseline would predict higher proportion of solitary drinking during EMA, we entered both TLFB-total number of drinks and DrInC-Recent consequences as predictor variables. The model was not significant, \( F(2, 47) = 1.08, p = .35. \) Therefore, our second hypothesis was not supported. Results of this analysis are presented in Table 3.
To test Hypothesis 3, we conducted correlation analyses to assess the strength of the association between that frequency and proportion of solitary drinking occasions during EMA and post-EMA DrInC subscale scores. Frequency, but not proportion, of solitary drinking was significantly correlated with all five DrInC subscale scores. Frequency of social drinking was also significantly correlated with each subscale, as was the frequency of total drinking occasions, suggesting that there is not a specific relationship between solitary drinking and alcohol-related consequences. These findings are presented in Table 4.

To test the fourth hypothesis, that greater proportion of solitary drinking occasions would predict worse functional impairment at the post-EMA assessment, we conducted a hierarchical multiple regression. Sex was the only demographic variable that was significantly related to the post-EMA WHODAS score, and was entered in Step 1, although this was not significant. Thus, a simple regression was performed to determine if proportion of solitary drinking occasions predicted the post-EMA WHODAS score. The proportion of solitary drinking was entered and produced a nonsignificant model. Thus, our hypothesis that a higher proportion of solitary drinking would predict worse functional impairment was not supported. Results of these regression analyses are presented in Table 5.

**Discussion**

This study examined the extent to which patterns of solitary drinking related to PTSD, alcohol consumption, alcohol-related consequences, and functional impairment in a sample of veterans who met criteria for PTSD. The present results showed that future solitary drinking was not predicted by PTSD. Results from this study also showed that greater alcohol consumption and higher levels of recent alcohol-related consequences at baseline did not significantly predict higher proportion of solitary drinking during EMA. However, frequency of solitary drinking did
significantly predict all domains of alcohol-related consequences, although this relationship was not unique to solitary drinking, as a similar pattern was evident for both social drinking frequency and total drinking frequency. Importantly, the proportion of solitary drinking was not significantly correlated with any domain of alcohol-related consequences. Rather, total number of drinking occasions (combining solitary and social) showed a slightly stronger relationship to future alcohol-related consequences than solitary or social drinking alone. Lastly, we found that the proportion of solitary drinking occasions did not significantly predict functional impairment assessed following EMA. Thus, the results did not support our predictions that solitary drinking would be associated with a more severe level of PTSD, more severe drinking (in terms of consequences), and greater functional impairment.

Contrary to the literature that has demonstrated a strong relationship between PTSD and alcohol use among veterans (Jakupcak et al., 2010; Mahoney et al. 2020; Possemato et al., 2015, Walton et al., 2017), and between PTSD and alcohol-related consequences (Angkaw et al., 2015; Gaher et al., 2014), the present study found no significant relationships between PTSD and alcohol consumption or consequences. It is noteworthy that the present findings depart even from studies with similar populations that reported significant associations between PTSD severity and measures of alcohol-related consequences (McDevitt-Murphy et al., 2015a) and coping motives (Lehavot et al., 2014), even in the absence of a significant relationship between PTSD and alcohol consumption. This discrepancy may reflect differences in the inclusion criteria for the present investigation and prior studies, many of which recruited participants who reported hazardous drinking, which was not an inclusion criterion for the present study. Indeed, the present sample reported a relatively low mean level of alcohol use. Additionally, while it was a requirement for participants to meet PTSD diagnostic criteria for the present study, the lack of
support for our first hypothesis may be partially explained by participants who met this criterion but reported lower levels of severity, thus, suggesting a restriction in range of PTSD severity.

Furthermore, the present study had an older sample compared to previous studies of solitary drinking, which had younger samples with ages ranging from 18 – 30 years old (Bilevicious et al., 2018; Corbin et al., 2020; Keough et al., 2015; Waddell et al., 2020). The average age of the current sample was 37.34 years, similar to many studies of veterans (McDevitt-Murphy et al., 2015a; McDevitt-Murphy et al., 2017), but outside of the emerging adult range, which has been the focus of most past research on solitary drinking. Alcohol use generally decreases with age, with young adults being the largest consumers of alcohol (Substance Abuse and Mental Health Services Administration [SAMHSA], 2019). In their report on age, period, and cohort effects in alcohol use, Keyes (2022) suggested that alcohol use typically declines with age, though there may a current shift towards onset and peak alcohol use occurring later in development. A similar pattern can be seen in reports of risky alcohol use. Shmulewitz and colleagues (2021) found that, across four age groups (18 – 29 years, 30 – 44 years, 35 – 64 years, and ≥65 years), the prevalence of risky alcohol use between 2001 – 2002 was highest in the 30 – 44 age group (34%). The prevalence of risky alcohol use between 2012 – 2013 was highest in 45 – 65 age group. Still, rates of risky drinking were lower in the ≥ 65 age group, further supporting the finding that alcohol use decreases over time. This may partially explain the low frequency of alcohol consumption in the current sample. It is also worth noting that this notion contradicts past findings. Skrzynski and Creswell (2020b) found that solitary drinking was more common in older adults compared to younger adults, as well as in people who were not married. Furthermore, Skrzynski and Creswell (2020b) found that prevalence of solitary drinking among older adults ranged from 30% - 40%, whereas rates of solitary drinking among
adolescents and young adults ranged from 14% - 24%. Given that studies focused on solitary drinking have largely sampled young adults, past literature suggests it may be more pathological to drink solitarily, particularly at an age where most drinking occurs in social contexts and for social motives (i.e., feeling at ease, feeling more social, conformity). Furthermore, previous studies of solitary drinking have been both prospective (Bilevicious et al., 2018) and cross-sectional (Corbin et al., 2020; Keough et al., 2015), but none, to our current knowledge, have yet assessed solitary drinking using EMA methods. It is possible that we did not find support for our predictions due to some methodological aspects of the present study.

In partial support of Hypothesis 3, the frequency of solitary drinking was a stronger predictor of alcohol-related consequences than the proportion of solitary drinking. However, the frequency of solitary drinking did not predict future alcohol-related consequences better than the frequency of drinking occasions overall. The finding that total drinking occasions were more strongly related to future alcohol-related consequences suggests that solitary drinking was not a particularly pernicious pattern in this sample of veterans with PTSD. These findings are similar to those reported in two investigations of solitary vs. solitary drinking in samples of young adults (Acuff et al., 2020; Acuff et al., 2021). The results of these studies suggest that while alcohol-related consequences are present in both solitary and social drinking contexts, solitary drinking may be a greater risk factor for greater alcohol consumption and alcohol-related problems, even though participants were more likely to drink in social contexts. Had we performed both between- and in-person analyses, we may have found more nuanced results related to solitary drinking in the context of PTSD.

In summary, the present results showed that, for combat veterans with PTSD, higher frequency of alcohol consumption was associated with a greater number of alcohol-related
consequences, and that such consequences were not affected by drinking alone or with others. This study makes a novel contribution to the literature in that it is the first to examine solitary drinking in the context of PTSD in a sample of military veterans. This study was prospective, assessing data from across three timepoints: at baseline (pre-EMA), during EMA, and post-EMA. EMA data were collected over the course of three weeks in real time, minimizing the risk of inaccurate retrospective recall.

Despite these strengths, this study was not without limitations. First, the sample for this study was predominantly White and male, which corresponds to the veteran population (see NCVAS, 2021). Thus, this limits the generalizability of the findings to other populations. Also, the small sample size in this study limits our ability to investigate whether the same pattern of results would be found within subgroups based on racial or gender identity. Future studies should strive to recruit more diverse samples, so that the findings may be more generalizable.

Second, our method for determining the occurrence of social or solitary drinking events was imperfect. This investigation reflects a secondary analysis of data that were not collected with this analysis in mind. The solitary drinking variable was created after the initial study was completed by gathering data from EMA questions that inquired about alcohol consumption and the presence of another person at the time. Thus, we were unable to distinguish between participants who were meaningfully interacting with another person while drinking, and those who were drinking in the presence of another person but were not engaging with them. For example, participants may have reported that another person (e.g., spouse, child) was present when they were drinking, but the other person may have been engaging in a different activity and not drinking. Future studies using EMA or daily diaries should specifically ask whether the participant was drinking alone, drinking with others but being the only person drinking, and
drinking with others who were also drinking. These additional questions will likely aid in
gathering the most accurate information about drinking context and avoid problems associated
with retrospective recall. Furthermore, quantity of alcohol consumed should also be considered
when examining social and solitary drinking, as this may influence the relationship between
drinking context and alcohol-related consequences.

In conclusion, it appears that solitary drinking may not be a particularly harmful pattern
among veterans with PTSD. Unsurprisingly, alcohol use frequency was related to alcohol-related
consequences but the degree to which participants drank in solitary contexts did not show any
unique contribution to alcohol-related harm. Results of this study highlight the complexity of
solitary drinking, particularly in the context of PTSD. The current findings show that while the
frequency of solitary drinking is not the only significant predictor of alcohol-related
consequences, it is worthy of further exploration. This should be considered when evaluating or
treating clients who endorse high frequencies of drinking, regardless of whether they were
drinking solitarily or socially. Finally, the current findings suggest that a higher proportion of
solitary drinking may not be associated with more severe psychological profiles and that the
frequency of drinking may be better indicators of future consequences.
References


https://doi.org/10.1016/j.addbeh.2014.11.031


https://doi.org/10.35946/arcr.v42i1.02


### Appendix A

#### Table 1

**Descriptive Statistics**

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<td>Male</td>
<td>63</td>
<td></td>
<td>87.5%</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>9</td>
<td></td>
<td>12.5%</td>
<td></td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>43</td>
<td></td>
<td>59.7%</td>
<td></td>
</tr>
<tr>
<td>Nonwhite</td>
<td>29</td>
<td></td>
<td>40.3%</td>
<td></td>
</tr>
<tr>
<td><strong>Marital Status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single or Divorced</td>
<td>28</td>
<td></td>
<td>38.9%</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>44</td>
<td></td>
<td>61.1%</td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td>37.34</td>
<td>7.88</td>
</tr>
<tr>
<td><strong>PTSD Checklist for the DSM-5 Total</strong></td>
<td></td>
<td>42.61</td>
<td>12.18</td>
<td></td>
</tr>
<tr>
<td><strong>CAPS-5 Total</strong></td>
<td></td>
<td>32.60</td>
<td>7.87</td>
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</tr>
<tr>
<td><strong>Drinker Inventory of Consequences</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Lifetime consequences Total</td>
<td>14.68</td>
<td>11.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recent consequences Total</td>
<td>9.11</td>
<td>16.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Timeline Follow Back</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of drinking days</td>
<td>6.01</td>
<td>7.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of drinks past month</td>
<td>21.81</td>
<td>36.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WHODAS, post-EMA</strong></td>
<td></td>
<td>65.17</td>
<td>33.90</td>
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<tr>
<td><strong>Drinking occasions, from EMA</strong></td>
<td></td>
<td>7.41</td>
<td>11.77</td>
<td></td>
</tr>
<tr>
<td><strong>Solitary drinking, from EMA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of occasions</td>
<td>3.43</td>
<td>9.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion</td>
<td>.62</td>
<td>.37</td>
<td></td>
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</tr>
</tbody>
</table>

*Note. CAPS-5 = Clinician Administered PTSD Scale for DSM-5; EMA = Ecological Momentary Assessment; WHODAS = World Health Organization Disability Assessment Schedule.

*ns varied from 50 – 72 due to missing data.*
## Appendix B

### Table 2

Correlations Between Measures of PTSD, Alcohol Consumption, Alcohol-Related Consequences, and Functional Impairment

<table>
<thead>
<tr>
<th></th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
<th>8.</th>
<th>9.</th>
<th>10.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PCL-5 Total, pre-EMA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2. CAPS-5 Total, pre-EMA</td>
<td>.76**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3. DrInC – Lifetime consequences††, pre-EMA</td>
<td>.12</td>
<td>.10</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4. DrInC – Recent consequences†, pre-EMA</td>
<td>.08</td>
<td>.02</td>
<td>.41**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5. TLFB – Drinking Days†, pre-EMA</td>
<td>-.10</td>
<td>-.13</td>
<td>.10</td>
<td>.43**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6. TLFB – Past Month†, pre-EMA</td>
<td>-.13</td>
<td>-.17</td>
<td>.16</td>
<td>.55**</td>
<td>.95**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. WHODAS, post-EMA</td>
<td>.49**</td>
<td>.51**</td>
<td>.19</td>
<td>.24</td>
<td>-.07</td>
<td>-.10</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8. Proportion of Solitary Drinking, from EMA††</td>
<td>.12</td>
<td>.10</td>
<td>.16</td>
<td>.19</td>
<td>.20</td>
<td>.18</td>
<td>.06</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9. Frequency of Solitary Drinking, from EMA†</td>
<td>.12</td>
<td>.09</td>
<td>.23</td>
<td>.40**</td>
<td>.54**</td>
<td>.51**</td>
<td>.11</td>
<td>.68**</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10. Total Number of Drinking Occasions, from EMA†</td>
<td>.07</td>
<td>.05</td>
<td>.25*</td>
<td>.44**</td>
<td>.68**</td>
<td>.65**</td>
<td>.07</td>
<td>.25</td>
<td>.85**</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note. PCL-5 = PTSD Checklist for DSM-5; CAPS-5 – Clinician Administered PTSD Scale for DSM-5; DrInC = Drinker Inventory of Consequences; TLFB = Timeline Follow Back; EMA = Ecological Momentary Assessment; WHODAS = World Health Organization Disability Assessment Schedule; *p < .05; **p < .01

†Underwent Log10 transformation; ††Underwent square root transformation
### Appendix C

#### Table 3

*Linear Regressions: PTSD, Alcohol Use and Consequences, and Proportion of Solitary Drinking*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( b ) ( 95% ) CI ( SE ) ( \beta ) ( R^2 ) ( \Delta R^2 )</td>
<td>( b ) ( 95% ) CI ( SE ) ( \beta ) ( R^2 ) ( \Delta R^2 )</td>
<td>( b ) ( 95% ) CI ( SE ) ( \beta ) ( R^2 ) ( \Delta R^2 )</td>
</tr>
<tr>
<td></td>
<td>LL</td>
<td>UL</td>
<td>LL</td>
</tr>
<tr>
<td>CAPS-5</td>
<td>.01</td>
<td>.01</td>
<td>.02</td>
</tr>
<tr>
<td>DrInC – Recent Consequences</td>
<td>.08</td>
<td>-.15</td>
<td>.31</td>
</tr>
<tr>
<td>TLFB – Total Drinks per Month</td>
<td>.06</td>
<td>-.12</td>
<td>.25</td>
</tr>
<tr>
<td>Proportion of Solitary Drinking</td>
<td>5.26</td>
<td>-22.34</td>
<td>32.86</td>
</tr>
</tbody>
</table>

*Note.* \( Prop. = \) Proportion; \( CAPS-5 = \) Clinician Administered PTSD Scale; \( DrInC = \) Drinker Inventory of Consequences; \( TLFB = \) Timeline Follow Back; \( SE = \) Standard Error; \( CI = \) Confidence Interval; \( LL = \) Lower Level; \( UL = \) Upper Level
Appendix D

Table 4

*Correlations (r) Between the Proportions and Frequencies of Solitary and Social Drinking and Post-EMA DrInC-Recent Subscales*

<table>
<thead>
<tr>
<th>DrInC-Recent Subscales</th>
<th>Physical</th>
<th>Interpersonal</th>
<th>Intrapersonal</th>
<th>Impulse Control</th>
<th>Social Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of Drinking Occasions</td>
<td>.46*</td>
<td>.50*</td>
<td>.46*</td>
<td>.54*</td>
<td>.42*</td>
</tr>
<tr>
<td>Frequency of Solitary Drinking</td>
<td>.40*</td>
<td>.40*</td>
<td>.40*</td>
<td>.52*</td>
<td>.32*</td>
</tr>
<tr>
<td>Frequency of Social Drinking</td>
<td>.40*</td>
<td>.45*</td>
<td>.40*</td>
<td>.42*</td>
<td>.36*</td>
</tr>
<tr>
<td>Proportion of Solitary Drinking</td>
<td>.14</td>
<td>.05</td>
<td>.14</td>
<td>.21</td>
<td>-.04</td>
</tr>
<tr>
<td>Proportion of Social Drinking</td>
<td>-.01</td>
<td>.04</td>
<td>-.01</td>
<td>-.10</td>
<td>.07</td>
</tr>
</tbody>
</table>

*Note.* The proportion of social and solitary drinking underwent square root transformation; the DrInC subscales, frequencies of solitary and social drinking, and total drinking occasions underwent Log10 transformations; *p < .01