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PTSD symptoms and substance use problems in traumatic injury patients: A 24-month follow-up

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A B S T R A C T

Background: People who experience traumatic injuries may be at risk for a variety of post-injury emotional and behavioral sequalae. In particular, the level of trauma experienced in relation to those injuries may place individuals at increased risk for substance use-related problems. Given the lack of research directly investigating the impact of injury-related PTSD on substance use problems post-injury, we conducted a secondary analysis of a study of injured patients to explore this issue.
Methods: To address the hypothesis that those experiencing more trauma at baseline were at increased risk for substance use problems at follow-up, this study utilized a prospective longitudinal design to investigate the relationship between traumatic injury, PTSD symptoms, and drug use problems over a 24-month follow-up period in 215 patients with traumatic injuries admitted for treatment to an urban Level 1 trauma center. The main study aim was to investigate whether the baseline major of trauma was associated with higher levels of substance use problems at follow-up, controlling for key background variables. Accordingly, we conducted mixed model longitudinal regression analysis where the 10-item DAST was regressed on time, demographic variables (age, sex, race, and income), and initial post-injury PTSD symptoms (as measured by the PCL-5 assessed two weeks post-injury). Separate analyses were conducted using continuous and binary measures of the DAST-10.
Results: Forty-two percent of the sample exceeded the clinical threshold for PTSD. Elevated PTSD symptoms increased the risk for the emergence of substance use problems over the follow-up period. The impact of PTSD symptoms remained when we looked at continuous and binary indicators of substance use problems, and when we controlled for retrospectively reported substance use problems. Male sex, older age, and lower income were also associated with the emergence of substance use problems.
Conclusion: PTSD symptoms occurring immediately post-injury, when elevated, lead to an increased risk for the emergence of substance use problems at follow-up. Substance use problems at follow-up are not merely a continuation of problems experienced before the injury. These findings underscore the importance of screening and of psychologically focused interventions soon after the traumatic injury experience.

1. Introduction

People who experience severe traumatic physical injury often have significant emotional reactions to that injury. Numerous studies have shown that post-traumatic stress disorder (PTSD) often follows serious injury (e.g., Wiseman et al., 2013; Starr et al., 2004), with one study suggesting that PTSD may be present in as many as 58% of traumatic injury patients (Zatzick et al., 2004). The comorbidity between PTSD and substance misuse has been well-established (e.g., Chilcoat and Menard, 2003; Brady et al., 2004). Given this link, those who experience elevated PTSD symptoms as the result of their injuries should have an elevated risk for substance use problems post-injury. Despite this potentially elevated risk, few studies have directly examined the relationship between PTSD symptoms in the immediate aftermath of a traumatic injury and future substance use behavior. In this study, we investigated the extent to which substance use problems are experienced after traumatic injuries. Further, we examined the extent to which post-injury substance problems are a consequence of the adverse psychological sequelae (i.e., PTSD symptoms) following injury.

1.1. Previous research on substance use and injury

Considerable research has documented the consumption of alcohol as a precursor or correlate of injuries leading to emergency department

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(ED) visits (e.g., Cherpitel et al., 2017; Vitale & van de Mheen, 2006), especially for injuries related to violence (e.g., Bakke et al., 2016). Additionally, those with a preexisting alcohol use or substance use disorder have an increased risk for traumatic injuries. For example, in a study of traumatic injury patients, over half had a lifetime substance use disorder (Soderstrom, 1997), while another study of women ages 15 and older found those presenting with a substance use disorder were more likely to be injured (Bernstein et al., 2014).

While previous studies have consistently found that substance use is a *precursor* to traumatic injury, the research establishing traumatic injury as a risk factor for, or precursor to, substance use *post-injury* is not as well established. Much of the research on post-injury substance use focuses on use patterns over time. This research suggests that the injury experience interrupts substance use patterns so that there is less use in the period immediately following the injury, with substance use returning to a baseline level within some period of time after the injury. For example, a recent meta-analysis investigating substance use in one group of traumatically injured patients—those who experience traumatic brain injury (TBI)—found a decrease in substance use following the injury, specifically in people with moderate-severe injuries (VanderVeen, 2021). It should be underscored that those with traumatic brain injury have unique characteristics which are likely to influence post-injury substance consumption differently from those with other types of traumatic injury. Nevertheless, consistent with this finding, longitudinal studies of other types of trauma patients reported a decline in alcohol and substance use in the month after their injury (Dunn et al., 2003) and reduced risky alcohol use at six months after the injury (Warren et al., 2014). Similarly, spinal cord injury patients were more likely to be categorized as "abstainers" if less time had passed since their injury (Tate et al., 2004). Other studies have shown increased alcohol and substance use over time when varying (mostly longer) follow-up periods are employed. In a study of adolescent trauma patients who were admitted to surgical services of a level 1 trauma center, alcohol use was highest 12 months post-injury (Dunn et al., 2008), and alcohol use had returned to pre-injury levels by four months in a sample of adult trauma patients (Dunn et al., 2003). Similarly, a study of TBI patients found that participants' alcohol use increased between one-month post-injury and six months post-injury (Pagulayan et al., 2016).

The studies cited above focused on general patterns of substance use behavior and not on potential psychological or environmental variables which could potentially impact (increase) substance use behavior post-injury. Given that substance use has a strong potential to undermine patient recovery (e.g., Athanasou, 2015; Cowperthwaite & Burnett, 2011), there is a need for studies that identify potential risk factors for increased substance use in injury patients. When injury patients are prescribed pain medications, the potential for adverse substance use outcomes may increase. Indeed, this linkage was confirmed in a study of adolescents (Bell et al., 2022). Nevertheless, the role of prescription opioids in post-injury substance use outcomes is complex and may depend on what substances in addition to opioids (such as benzodiazepines) are prescribed (e.g., Sprunger et al., 2022).

Multiple recent studies suggest that PTSD or symptoms of PTSD are associated with elevated drug and alcohol use in traumatic injury patients (Eiroa-Orosa et al., 2016; Fani et al., 2020; Hinojosa et al., 2024). These studies vary in the type of patients selected, the timing of the measurement of PTSD symptoms, and the nature of substances that are the focus of follow-up. Most relevant to the current study, we found only a single study that focused on a general measure of substance use problems (Fani et al., 2020); this study found that increasing levels of post-traumatic anhedonia were associated with greater substance use behavior six months post trauma. Thus, the extent to which post-injury patients seek out substances may have more to do with how they are processing the trauma than with the kinds of prescriptions they receive. Injury patients who struggle to process the trauma may use substances as a form of "self-medication" to cope with their painful emotional state. Researchers have explored the role of substance use as an attempt at self-medication of PTSD symptoms in other contexts (e.g., Tripp et al., 2019). Indeed, the term "self-medication" has come to refer to the hypothesis that the use of psychoactive substances might be influenced by the need to mitigate the negative psychological and somatic sequalae of trauma (Khantzian, 1997; Garland et al., 2013; Leeies et al., 2010). This hypothesis has been confirmed by multiple empirical studies. For example, in one analysis of a nationally representative study in the US, researchers found that 21.4% of individuals with PTSD used alcohol, drugs, or both to relieve symptoms of PTSD (Leeies et al., 2010). The potential for self-medication to influence behavior within the context of traumatic injury resulting in severe pain over an extended period may be exacerbated by the potential for "mutual maintenance" of pain and trauma. The mutual maintenance model suggests that PTSD and physical symptoms may "mutually maintain themselves" even in the absence of severe physical injury, i.e., even as physical symptoms abate (McAndrew et al., 2019). Post-traumatic stress symptoms may be associated with increased physical pain perceptions, ultimately prolonging pain perceptions and related disability (Giummarra et al., 2017) and thus potentially prolonging the risk for self-medication for severely injured patients.

Although these findings suggest that post-traumatic stress symptoms are an important risk factor for substance use problems, the impact of elevated PTSD symptoms post-injury on substance use problems over a longer follow-up period (e.g., over a two-year period) remains largely unexplored. Accordingly, this paper fills an important gap in the literature as we examine the association between elevated PTSD symptoms (treating PTSD as a single construct) immediately after traumatic injury and subsequent substance use problems over a 24-month follow-up period.

2. Methods

2.1. Sample

This study utilized a prospective longitudinal design to investigate the relationship between traumatic injury and subsequent substance use problems over a 24-month follow-up period. Adults who were seen in the ED at an urban Level 1 trauma center after experiencing a traumatic injury and who met study screening criteria were recruited for this study. The study screened a total of 1025 patients; they identified 524 eligible patients for the study and ultimately enrolled a total of 215 patients. As noted in Weis et al. (2021) and in Petranu et al. (2024), enrolled participants were required to have an injury event that was potentially traumatic that could have led to a DSM-5 defined PTSD diagnosis (American Psychiatric Association, 2013). Additionally, they needed to be English speaking, between 18–60 years old, and right-handed. Participants could not be included in the study if they could not meet the physical and emotional criteria necessary for MRI screening, if they had a severe head injury resulting in a Glasgow Coma Scale of less than 13 (Sternbach, 2000; Teasdale & Jennette, 1974), a spinal cord injury resulting in neurological deficit, an injury that was self-inflicted, vision or hearing impairments that were severe, current or past history of psychotic or manic symptoms, currently taking antipsychotic medications, substance use noted in the medical record, or on a police hold that was associated with the current ED visit. Individuals were either screened directly in the ED or via telephone shortly after discharge from the trauma unit. Participant demographics, baseline PTSD symptoms, and past-year substance use behavior were collected via self-report measures two weeks post-injury (T1). Subsequent substance use behavior was collected via self-report measures 3 months (T2), 6 months (T3), 12 months (T4), 18 months (T5), and 24 months (T6) post-injury. All patients enrolled provided written consent to participate in the study; the study was approved by the Medical College

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of Wisconsin Institutional Review Board. Study enrollment began in March 2016. The last patient was enrolled in October 2019 and the final follow up occurred in March 2020.

2.2. Measures

DAST: The study includes two measures of drug use problems, a retrospective measure and a measure concurrent with each follow-up wave. The retrospective measure was the 28-item Drug Abuse Screening Test (DAST-28; current sample Cronbach α = 0.88), which was administered at T1 to assess participants' substance use behaviors in the past year (Skinner, 1982). The DAST-28 is an empirically validated assessment of substance use behavior. Participants respond "YES" or "NO" to each item (e.g., *Have you used drugs other than those required for medical reasons?; Have you abused prescription drugs? Do you abuse more than one drug at a time? etc.*). A score of "1" is given for each YES response, except for questions 4, 5, and 7, where a score of "1" is given for a NO response. The total score ranges from 0 to 28, with higher scores indicating a greater likelihood of a substance use disorder. Concurrent drug use problems were assessed with the condensed 10-item version of this same scale (DAST-10), which was administered at 3, 6, 12, 18, and 24 months following the traumatic injury (Yudko et al., 2007). Scores on the DAST-10 range from 0 to 10, where a score of 0 indicates no substance use problem, 1–2 indicates low levels of drug use problems, 3–5 indicates moderate levels of drug use problems, 6–8 indicates substantial levels of drug use problems, and 9–10 indicates severe levels of drug use problems. For the purposes of this study, we refer to our DAST-10 outcomes as "substance use problems" throughout, with the caveat that the measure does not evaluate alcohol or tobacco-related behaviors.

PTSD: PTSD symptoms were measured using the self-report PTSD Checklist for the DSM-5 (PCL-5; current sample Cronbach α = 0.94) at T1 (Blevins et al., 2015). The PCL-5 is a well-established, empirically validated method of assessing the frequency and severity of PTSD symptoms one experienced in the past month (Bovin et al., 2016). Each item (e.g., *In the past month, how much were you been bothered by repeated, disturbing, and unwanted memories of the stressful experience?*) is rated on a 5-point Likert scale ranging from 0 (*not at all*) to 4 (*extremely*). Participants were instructed to answer each question based on symptoms related to the traumatic injury that led to their visit to the ED. Scores range from 0 to 80, with higher scores indicating greater severity of PTSD symptoms.

Demographics: In addition to sex, we included measures of race and ethnicity (White, Black or African American, Hispanic, and another race or ethnicity), income (with 11 possible response categories ranging from 0-$10,000 to greater than $100,000), and a continuous measure of age.

2.3. Data analysis

We employed Stata 18 (StataCorp, 2023) software to conduct mixed model regressions using continuous DAST-10 scores and mixed model logistic regression to predict binary DAST-10 scores (comparing those with scores of 3 or higher to those with scores of 2 or lower; this cutoff reflects a at least a level of "moderate" problems). In these models, we included the following fixed effects: A four-category dummy variable for follow-up wave (with the 3-month follow-up as the reference group), sex (with male as the reference group), age (as a continuous measure), a three-category dummy variable for race (with Black or African American as the reference group), and a continuous measure for the PCL-5 score as measured at baseline right after the traumatic injury. Additional regressions were run controlling for retrospective (past year) reports of drug use problems using the DAST-28. Note that since we used random effects regression techniques, we were able to include all participants in the analyses, regardless of whether they provided complete data across all follow-up waves.

3. Results

3.1. Participant demographics

Table 1 describes the overall demographics of the sample. Participants ranged in age from 18 to 59 years, with an average age of around 33 years. Just over half the sample (52%) were women. In terms of race and ethnicity, this was a heterogeneous sample. Non-Hispanic Black participants were the modal category (56%), followed by non-Hispanic White (26%) and Hispanic or Latinx (9%). Most participants were treated for injuries related to motor vehicle crashes (68%); over one in ten participants were treated for injuries related to an assault or altercation (12%). The sample was predominantly low income, with over half the sample reporting annual family income of $40,000 or less.

3.2. Participant retention

The initial sample size consisted of 215 subjects at baseline. Participation dropped to 177 (82%) at the 3-month follow-up, 193 (90%) at the 6-month follow-up, 135 (63%) at the 12-month follow up, 109 (51%) at the 18-month follow-up, and 80 (37%) at the 24-month follow-up. Note that data collection was halted for most participants after the 12-month visit due to COVID lock downs, resulting in the low retention rate at 18 months. We note that the typical pattern of steady decline in participation across follow up waves did not characterize this study. Analyses for this study focus on those who completed DAST-10 interviews at any of the five follow-ups. We strongly suspect that retention is better at T3 (six-month follow-up) than T2 (three-month follow-up) because T3 was a longer assessment and therefore the remuneration was higher than in the T2 assessment. T3 was a full 6-hour day with blood draw and MRI, and thus substantially more compensation (compared to T2 with only self-report and cognitive battery). We see this

Table 1
Participant Demographics.

Characteristic	Value
Age, years	
Mean (SD)	32.9 (10.7)
Range	18–59
Sex, n (%)	
Female	112 (52.1%)
Male	103 (47.9%)
Race/Ethnicity, n (%)	
Non-Hispanic Black	121 (56.3%)
Non-Hispanic White	56 (26.0%)
Hispanic or Latinx	20 (9.3%)
Non-Hispanic Asian	4 (1.9%)
Another race or ethnicity	14 (6.5%)
Mechanism of injury, n (%)	
Motor vehicle crash	146 (67.9%)
Assault/altercation	25 (11.6%)
Pedestrian struck	8 (3.7%)
Motorcycle Crash	8 (3.7%)
Fall	6 (2.8%)
Domestic violence	4 (1.9%)
Stab	2 (.09%)
Gun shot	1 (.05%)
Other	15 (7.0%)
Annual family income, n (%)	
$0 – $10,000	44 (20.5%)
$10,000 – $20,000	31 (14.4%)
$20,000 – $30,000	37 (17.2%)
$30,000 – $40,000	17 (7.9%)
$40,000 – $50,000	18 (8.4%)
$50,000 – $60,000	16 (7.4%)
$60,000 – $70,000	13 (6.0%)
$70,000 – $80,000	13 (6.0%)
$80,000 – $90,000	3 (1.4%)
$90,000 – $100,000	9 (4.2%)
Greater than $100,000	11 (5.1%)

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exact same pattern in our other studies – the longer days with more compensation have higher retention.

3.3. Missing values analysis

There were 199 participants who completed at least one follow-up DAST-10. In terms of follow-up completion rates, of these 199 participants, 34% (n = 67) completed the measure at all five follow-ups, 18% (n = 35) completed four follow-ups, 19% (n = 37) completed three follow-ups, 24% (n = 47) completed two follow-ups, and 6% (n = 12) completed just one follow-up DAST-10. Using ordinary least squares regression, we regressed total number of completed follow ups (ranging from 0 to 5) on sex, age, race, income and PCL-5 score. The only variable significantly associated with number of completed follow-ups was age (t = 3.48; p < 0.01), indicating that older participants were more likely to complete more follow-ups. Among those who completed at least one follow-up (the 199-member subsample considered in this analysis), age was only a marginally significant predictor of number of completed interviews (t = 1.94; p < 0.10). These findings underscore the importance of controlling for age in models looking at the impact of trauma on subsequent substance use problems.

3.4. Distribution of key measures

Table 2 describes the means and standard deviations of the two key independent measures that were assessed at baseline, PCL-5 and DAST-28, and the main dependent variable, the DAST-10, that was assessed at each follow-up period. With an overall mean score of 28 on the PCL-5, a substantial portion of study participants (42.7%) reached or exceeded the clinical cutoff of 31 suggested by Geier et al. (2019) for probable PTSD at baseline in injured patients. The mean DAST-28 score was just below 3; as noted on Table 2, 10.7% of the sample had drug use-related problems that exceeded the clinical threshold. The DAST-10 scores at follow-up were consistently low. The percentage of participants with scores of 3 or higher (indicating clinically significant scores) was lowest at 3 months (4%) and increased to 8% until the 24-month follow-up where it approached 9%.

Table 3 summarizes the results of the mixed model regression predicting continuous DAST-10 scores at follow-up. With respect to time interval, the only significant effect was for the 6-month follow-up vs. baseline, where scores increased significantly from the first follow-up period. Women had significantly lower DAST-10 scores at follow-up than men, as did those with higher income levels. Older age was associated with increased DAST-10 scores. Additionally, those who were Hispanic had a higher level of drug use problems at follow-up compared to those who were Black. Our main psychosocial predictor, higher PTSD scores at baseline as indicated by the PCL-5, was significantly associated with elevated DAST-10 scores at follow-up. When the binary indicator of elevated DAST-10 scores was regressed on predictor measures (see Table 4), sex, age, and PCL-5 scores remained significant predictors (time, race, and income were no longer significant). Consistent with the continuous outcome model, elevated PCL-5 scores predicted higher levels of drug use problems, as measured by the DAST-10, at follow-up. We also explored time x PTSD symptom interactions in each of our models; none of these interaction terms were statistically significant.

Following up on these analyses, we evaluated models employing DAST-28 scores (past-year drug problems retrospectively reported at baseline) as fixed effects. In these additional models (which are not shown on tables), retrospective DAST-28 scores were highly significant predictors at follow-up for both the continuous and binary outcomes. All demographic fixed effects, except the binary indicator for the Hispanic vs. Black race contrast in the continuous model, became non-significant when past-year substance use problems at baseline were evaluated in the model. Nevertheless, PTSD symptoms, as measured by the PCL-5, remained significant in both models. The continuous mixed model regression coefficient for PCL-5 decreased to 0.007 (95% CI: 0.003, 0.012; p = 0.001). The binary logistic mixed model regression coefficient for the PCL-5 decreased slightly to 0.051 (95% CI: 0.015, 0.087; p = 0.006).

Table 2
Baseline and Follow-Up Self-Report Measures.

Measure	Mean (SD)	% at or above cutoff score
PCL-5[a]	28.4 (18.5)	42.7%
DAST-28[b]	2.7 (3.9)	10.7%
DAST-10[c]		
3 months	0.7 (1.2)	4.2%
6 months	0.9 (1.4)	8.3%
12 months	0.8 (1.4)	8.1%
18 months	0.8 (1.4	8.3%
24 months	0.7 (1.3)	8.7%

Note. PCL-5 = PTSD Checklist for the DSM-5; DAST-10 & DAST-28 = Drug Abuse Screening Test (10 & 28-item versions).
[a] The cutoff score for the PCL-5 is 31.
[b] The cutoff score for the DAST-28 is 6.
[c] The cutoff score for the DAST-10 is 3.

Table 3
Mixed Model Longitudinal Regression Predicting Continuous DAST-10 Scores.

Variable	Coefficient	Bootstrap SE	95% CI (normal based)	p
Time period				
6 mo. vs. 3 mo.	0.178	0.081	[0.019, 0.337]	0.028*
12 mo. vs. 3 mo.	0.108	0.084	[-0.046, 0.261]	0.198
18 mo. vs. 3 mo.	0.123	0.081	[-0.036, 0.281]	0.132
24 mo. vs. 3 mo.	−0.129	0.140	[-0.403, 0.145]	0.358
Sex (F vs. M)	−0.447	0.073	[-0.589, −0.305]	0.000*
Age (continuous)	0.007	0.003	[0.008, 0.013]	0.014*
Race				
White vs. Black	−0.006	0.083	[-0.170, 0.157]	0.939
Hispanic vs. Black	0.699	0.171	[0.363, 1.035]	0.000*
Other vs. Black	0.024	0.114	[-0.247, 0.199]	0.835
Income (continuous)	−0.044	0.013	[-0.069, −0.018]	0.001*
PCL-5 score	0.013	0.004	[0.008, 0.017]	0.000*

Note. DAST-10 = 10-item version of the Drug Abuse Screening Test; PCL-5 = PTSD Checklist for the DSM-5; CI = confidence interval.

Table 4
Mixed Model Longitudinal Regression Predicting Binary DAST-10 Scores.

Variable	Coefficient	Bootstrap SE	95% CI (normal based)	p
Time period				
6 mo. vs. 3 mo.	0.574	1.020	[-1.426, 2.573]	0.574
12 mo. vs. 3 mo.	0.637	0.678	[-0.691, 1.966]	0.347
18 mo. vs. 3 mo.	0.535	1.335	[-2.082, 3.151]	0.689
24 mo. vs. 3 mo.	−0.108	1.118	[-2.298, 3.151]	0.923
Sex (F vs. M)	−2.092	0.698	[-3.460, −0.724]	0.003*
Age (continuous)	0.056	0.018	[0.022, 0.091]	0.001*
Race				
White vs. Black	0.921	0.705	[-0.461, 2.303]	0.191
Hispanic vs. Black	1.651	0.867	[-0.048, 3.350]	0.057
Other vs. Black	0.179	1.307	[-2.238, 2.740]	0.891
Income (continuous)	−0.174	0.107	[-0.385, 0.037]	0.107
PCL-5 score	0.066	0.016	[0.035, 0.096]	0.000*

Note. DAST-10 = 10-item version of the Drug Abuse Screening Test; PCL-5 = PTSD Checklist for the DSM-5; CI = confidence interval.

4. Discussion

4.1. Major findings

We found that elevated PTSD symptoms immediately following traumatic injury, as well as several key demographic variables, increased the risk for substance use problems in the 24-month follow-up

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period. The impact of PTSD symptoms remained when we looked at binary and continuous indicators of substance use, and when we controlled for retrospectively reported substance use. The findings mostly align with prior research on substance use comorbidity.

4.2. Comparison with other studies

We do note, however, some divergence between our findings and other studies focused on the risk for substance use among those with traumatic injury. Prior research suggested that increases in specific PTSD symptoms (e.g., anhedonia) during the post-injury period were critical to subsequent substance use risk (e.g., Fani et al., 2020). Our study, however, demonstrates that elevated overall PTSD symptoms at baseline may be a useful predictor of subsequent substance use. Furthermore, the significant associations between PTSD symptoms and substance use problems persisted after controlling for past-year substance use problems, which suggests that substance use among those with traumatic injury is not just a continuation of pre-injury behavior. Although our findings are consistent with the notion that pre-injury substance use predicts post-injury substance use/substance use problems (Dunn et al., 2003; Dunn et al., 2008; Whiteside et al., 2016), the findings underscore the unique contribution of injury-related psychological distress to substance use problems at follow-up. Accordingly, they underscore the importance of psychological screening for those with serious injuries, so that potential preventative interventions to avert substance use problems can occur.

Few prior studies have focused on potential demographic factors that could enhance risk for substance use problems following traumatic injury. Our findings suggest that independent of the post-traumatic stress symptoms associated with the injury, older participants, men, and individuals with low income may be particularly vulnerable to substance use problems following traumatic injury. As men are often reluctant to disclose psychiatric symptoms and are less likely to engage with helping professionals than women in a variety of contexts (Shepherd et al., 2023; Silvestrini and Chen, 2023), it is important that health professionals take extra steps to sensitively engage traumatically injured men in the screening process and to assiduously track them at follow-up. Low-income injured patients may be particularly challenging to connect to treatment as they have reduced resources to pay for needed services despite their increased risk for substance use problems. Patients with public insurance (Medicaid) admitted to trauma care should be reminded that their insurance covers substance use and mental health treatment services that they may need as they recover from their injuries. Older patients, especially those with health-related problems, are more likely to experience isolation and loneliness than others (Gerlach et al., 2024); these factors are associated with substance use and substance use problems (e.g., Ingram et al., 2020). Accordingly, providers may need to ensure that older trauma victims have adequate social supports during the months after they experience their serious injuries.

4.3. Limitations

Although this is a racially diverse sample, it is not a random sample of traumatic injury patients. These are patients who agreed to be enrolled in the present study and are mainly representative of the urban center from which they were drawn. Another limitation concerns the heterogeneity of the causes for the injuries leading to hospital admissions for the sample. Research suggests that those with injuries associated with certain circumstances (e.g., burn victims, interpersonal violence) may have a greater risk of subsequent substance use. Additionally, we did not track information about prescription medications administered post-injury which may impact the risk for substance use-related problems at follow-up. Finally, we note that a considerable number of participants did not complete more than three waves of follow-up data. This potential limitation was addressed through our data analytic approach. In this approach (mixed model regression), every person is included in the analysis; that is, all person-level observations are included in the analysis, regardless of the number of follow-up data points available. Nevertheless, potential biases in who remained in the study over the course of the five follow-up periods may have impacted the findings in ways which we cannot fully address. Another limitation is that we focused on a measure of substance problems as an outcome as opposed to tracking participants' use of specific substances. While focus on use of individual substances may give more specific information about behaviors, such information is potentially less clinically relevant. In contrast, since the DAST-10 is a global indicator of problems related to substance use, it may serve as a more useful warning light flagging potentially clinically consequential and relevant issues that may need to be addressed during injury recovery. All our behaviorally focused survey measures are based on self-report, so the study is also limited to the extent that people may not report accurately about their own behavior.

4.4. Implications for research and intervention

While we note an emerging body of literature addressing the consequences of trauma related to injury, there is clearly a need for further follow-up research. Future studies should clearly document the types of medical, psychological, and psychosocial interventions that trauma injury patients receive and the potential impact those interventions may have on substance use outcomes. Those with serious injuries requiring treatment in trauma units may often be prescribed medications such as opioids and other analgesics with strong potential for dependency and associated problems. If patients are not prescribed sufficient pain medications when they need them, there is also the potential for participants to seek out street drugs to address these issues. Both scenarios create the potential for the kinds of problems that would be reflected in elevated DAST-10 scores. This underscores the importance of understanding how specific pharmacological and medical interventions for those experiencing traumatic injuries impact recovery and the nature of physical and behavioral health problems experienced in the aftermath.

While the development of evidence-based integrated clinical interventions for PTSD and substance use is still in progress, research supports the use of exposure-based approaches such as Concurrent Treatment of PTSD and Substance Use Disorders using Prolonged Exposure (COPE; Brady et al., 2001; Killeen et al., 2011), as well as non-exposure-based approaches such as Seeking Safety (Sherman et al., 2023). Alternatively, other research indicates that sequential (vs. integrated) treatments for substance use (with the focus on alcohol use) disorder and PTSD using established interventions for each condition (e.g., motivational interviewing, prolonged exposure) can be effective (Flanagan et al., 2018). Recent meta-analyses, however, suggest the efficacy and likely superiority of trauma-focused treatment approaches such as COPE, especially when combined with pharmacotherapy for drug or alcohol use, over other approaches (Hien et al., 2023).

Finally, there is a need for studies that document the additional services that traumatic injury patients seek out, whether they are readmitted to the health care system for issues related to their initial trauma and/or their trauma-related health intervention, and whether they are at risk for repeated traumatic injury and other health conditions down the line. Traumatic injury patients comprise an extremely high-risk group in need of multiple health interventions, and they should be a high priority for future health care services researchers.

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Michael Fendrich: Writing – original draft, Software, Methodology, Formal analysis, Conceptualization. **Kevin Petranu:** Writing – review & editing, Methodology, Formal analysis, Data curation, Conceptualization. **Lauren Nickel:** Writing – review & editing. **Christine L. Larson:** Writing – review & editing, Funding acquisition, Data curation. **Terri A. deRoon-Cassini:** Writing – review & editing, Project administration, Funding acquisition, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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