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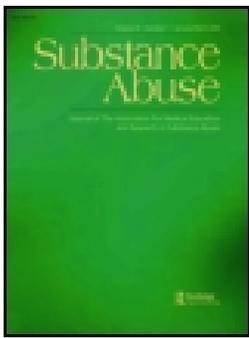
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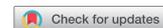


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ORIGINAL RESEARCH



Childhood trauma, combat trauma, and substance use in National Guard and Reserve soldiers

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ABSTRACT

Background: The goal of this work was to examine associations among childhood trauma, combat trauma, and substance use (alcohol problems, frequent heavy drinking [FHD], current cigarette smoking, and current/lifetime drug use) and the interaction effects of childhood trauma and combat exposure on those associations among National Guard/reserve soldiers. **Methods:** Participants ($N = 248$) completed an electronic survey asking questions about their military experiences, physical and mental health, and substance use. Childhood trauma and combat exposure were examined jointly in regression models, controlling for age, marital satisfaction, and number of deployments. **Results:** Childhood trauma was associated with current drug use (trend level, odds ratio [OR] = 1.44, 95% confidence interval [CI]: 0.97, 2.14; $P = .072$) in the main effect model; however, there was not a significant interaction with combat. Combat exposure had a significant interaction with childhood trauma on alcohol problems ($b = -0.56$, 95% CI: $-1.12, -0.01$; $P = .048$), FHD ($b = -0.27$, 95% CI: $-0.47, -0.08$; $P = .007$), and lifetime drug use (OR = 1.78, 95% CI: 1.04, 3.04; $P = .035$). There were no associations with either of the trauma measures and current cigarette smoking. **Conclusions:** These results demonstrate that childhood and combat trauma have differential effects on alcohol use, such that combat trauma may not add to the effect on alcohol use in those with greater child maltreatment but may contribute to greater alcohol use among those with low child maltreatment. As expected, childhood and combat trauma had synergistic effects on lifetime drug use. Screening for multiple types of trauma prior to enlistment and/or deployment may help to identify at-risk individuals and allow time for early intervention to prevent future adverse outcomes.

KEYWORDS

Childhood trauma; combat trauma; military; substance use

Introduction

The connection among deployment, combat trauma, and substance use has been well established in military populations.¹⁻⁸ For example, deployment to Iraq and/or Afghanistan was found to greatly increase the incidence of substance use disorders, particularly among service members in combat positions.⁹ However, combat exposure and deployment are not the only factors that need to be considered to understand substance use among soldiers. Research in both animals and humans has repeatedly shown that chronic or repeated stress over the life course is crucially important to consider in examining substance use and addiction.¹⁰⁻¹² Evidence from civilian populations has demonstrated that adult substance use is strongly related to childhood trauma, often exacerbated by more recent adult trauma.¹³⁻¹⁵ Childhood trauma, coupled with repeated stress after childhood, has been linked to substance use vulnerability, including initiation of use, escalation of use, problematic use, less motivation to quit, and more frequent relapse.¹¹ Early trauma, experienced during childhood, has been related to disordered brain function that may persist into adulthood.¹⁶ Early trauma appears to sensitize neural response pathways, which may lead to elevated risk for substance use initiation and risky behaviors by impacting impulsivity, decision-making, and

stress and reward systems, which may be exacerbated by additional traumatic exposures later in life.¹¹ Furthermore, effects of cumulative stress appear to be dose dependent, such that the cumulative number of events experienced predicts risk of alcohol and drug dependence.¹²

Early trauma exposures, prior to military experiences, are therefore important to consider when examining outcomes among military service members. Evidence regarding mental health outcomes, particularly posttraumatic stress disorder (PTSD), suggests that service members who experienced childhood and other non-military-related trauma in addition to military trauma are at greater risk for adverse outcomes.¹⁷⁻²⁰ Several studies have found that childhood trauma is associated with greater risk for PTSD and/or greater PTSD symptom severity among deployed soldiers.¹⁷⁻²¹ Specifically, in large pre- and post-deployment samples of soldiers, having experienced 2 or more adverse childhood events was associated with increased risk of depression and PTSD.¹⁷ Childhood physical assault greatly increased the risk of PTSD and PTSD combined with other comorbid disorders, such as major depressive disorder.²¹ Similar associations between childhood abuse and/or adverse experiences and higher rates of PTSD and/or more severe PTSD symptoms have been found in US Army active

duty²² and Canadian military active duty¹⁹ members. Veterans who experienced relapse after PTSD treatment had significantly higher rates of childhood abuse, both physical and sexual, as well as higher rates of substance use.²³ Childhood maltreatment has also been shown to be related to alcohol misuse²⁴ among active duty soldiers after returning from deployment. Furthermore, childhood adversity was linked to a variety of negative outcomes, including heavy drinking, among British active duty soldiers.²⁵ Griffith demonstrated that National Guard and reserve soldiers were 3 to 8 times more likely to report suicidal behavior if they had experienced childhood abuse.²⁶

In spite of these studies, to our knowledge, there has been limited examination of the synergistic or interactional effects of childhood trauma and combat trauma on substance use among soldiers, and even less among reserve or National Guard soldiers specifically. However, this subset of the military population is important to examine separately, as reserve soldiers may be particularly vulnerable to experiencing the adverse effects of combat and deployment.^{7,27} Unlike active duty military members, reserve soldiers have active civilian lives and careers and live in civilian communities, often far from centralized military support services.²⁸ When they are not deployed, their military participation consists of monthly drill weekends and annual training. Deployment for reserve soldiers then represents a significant disruption of their civilian lives, with potentially less support than that offered to full-time military members. As such, the stress and challenges of deployment are different for reserve soldiers, namely, being unaccustomed to prolonged absences from family,^{28,29} experiencing difficulties with finances, health care, and employment during transitions between military service and civilian life,^{29,30} and often being removed from centrally located support services.^{28,31} Given the previously described importance of considering chronic stress in examining substance use outcomes and the greater stress related to deployment that may be experienced by reserve soldiers, attention to the individual and cumulative effects of exposure to childhood and combat trauma are important to consider.

The goal of this paper, therefore, was to examine the associations among childhood trauma, combat trauma, and substance use (alcohol problems, frequent heavy drinking [FHD], current cigarette smoking, current and lifetime drug use) among National Guard and reserve soldiers. We first examined the independent effects of childhood trauma and combat on substance use outcomes. We then tested for the interactive effect of childhood trauma and combat on substance use outcomes to determine if soldiers who experienced both were at greater risk for substance use. This work is based on baseline data from an ongoing longitudinal study, Operation: SAFETY (Soldiers and Families Excelling Through the Years), which is broadly focused on the health of National Guard and reserve soldiers and their spouses.

Methods

The study protocol was approved by the University at Buffalo's institutional review board. The Army Human Research

Protections Office, Office of the Chief, Army Reserve, as well as the Adjutant General of the National Guard also vetted the study protocol.

Data collection

Recruitment

From summer 2014 to fall 2015, the Operation: SAFETY study recruited US Army Reserve and Army National Guard soldiers and their partners.^{32–34} Participants were recruited from a purposeful sample across the western New York region, which accounted for geographic variation, as well as inclusion of unit types (e.g., combat vs. support). Research staff presented the project at drill weekends. Soldiers were given an overview of the project and were told that participation for the soldier and their spouse would involve the completion of 3 online surveys (baseline and 2 yearly follow-ups), covering a variety of general health topics such as nutrition, physical and mental health, caffeine intake, sleep, substance use, romantic relationship, social network information, and deployment information and events. For their time, soldiers and their partners received \$60 for baseline and \$70 for each of the follow-ups (\$200 per person/\$400 couple over the study period).

Interested participants were invited to complete a screening form and were provided with an information packet to share with their partner. Potential participants were screened on 6 inclusion criteria: (1) the couple is married or living as if married; (2) one member of the dyad is a current Army Reserve soldier or National Guard soldier; (3) the soldier is between the ages of 18 and 45; (4) both partners are able to speak and understand English; (5) both partners are willing and able to participate; and (6) both partners have had at least 1 alcoholic beverage in the past year. Following this in-person screening, all soldiers were contacted within 1 week regarding their eligibility status.

In total, research staff met with 47 units across New York State, resulting in identification of 731 eligible soldiers and partners. Of those, 572 (78%) agreed to participate and 472 (83%) completed some part of the survey. Given that the nature of the main study was to examine spousal influence, only surveys where both partners completed the entire survey were included for follow-up ($n = 418$). The only difference between couples who enrolled and those who did not was that couples where a civilian partner screened for the study ($n = 11$) were less likely to enroll ($P < .001$). No differences existed between soldiers' screening health variables between those who enrolled and completed versus those who enrolled and did not complete.

Participants

The sample for the present analysis consisted of baseline data from a subset of the total sample: male soldiers who were deployed ($n = 248$). Female soldiers who were deployed were excluded from the analysis due to the small sample size ($n = 34$). See Figure 1 for a flow chart from recruitment to the analytic sample. The final study sample was predominantly non-Hispanic white, with at least some college education, and had a median family income of \$60,000 to \$79,000 (Table 1).

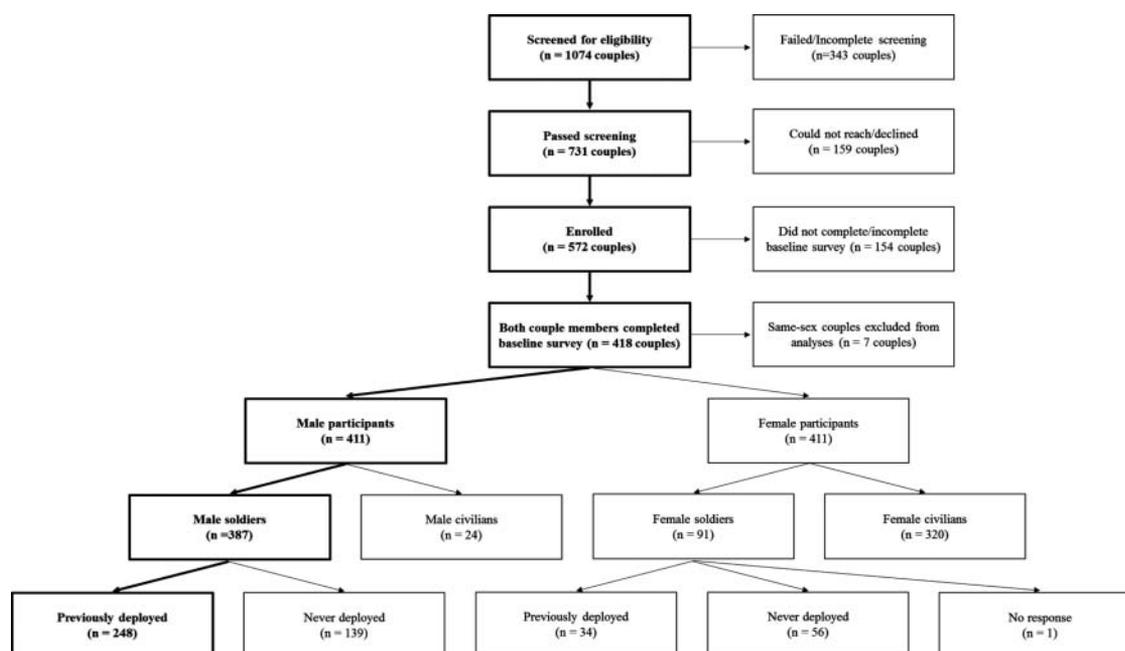


Figure 1. Operation: SAFETY recruitment from initial screening to analytic sample.

Survey administration

The surveys were administered through a secure HIPAA (Health Insurance Portability and Accountability Act of 1996)-compliant online survey programming software, StudyTrax, which allowed for data encryption. Soldiers and partners who lived in the area were invited to the university to complete their online surveys. Partners could come in together or separately and were each given a private room with a touchscreen computer on which to complete their survey. Informed consent was conducted in person with a research staff member. Because it is common for National Guard/reserve soldiers to live great distances from their unit location and it is possible for soldiers to be deployed during the study, participants could also complete the surveys remotely. In these cases, separate login information was sent to each partner's e-mail.

Table 1. Demographic characteristics.

Characteristic (N = 248)	M or %	SD or n
Age	33.4	(6.2)
Race/ethnicity		
Non-Hispanic white	81.1%	(201)
Non-Hispanic black	4.4%	(11)
Hispanic	9.7%	(24)
Other	3.2%	(8)
Education		
<High school to high school graduate	14.1%	(35)
Some college	60.1%	(149)
College +	25.8%	(64)
Median household income	\$60,000 to \$79,000	
Marital status		
Married	75.4%	(187)
Cohabiting	24.6%	(61)
Military service		
Total years served	11.9	(6.09)
Number of deployments	1.6	(0.9)

Measures

Childhood trauma

The Comprehensive Child Maltreatment Scale (CCMS)³⁵ was used to assess 3 domains of childhood trauma: physical abuse, psychological abuse, and neglect. Each subscale is composed of 3 questions on each of the different forms of abuse (e.g., "Physically punished for wrongdoing") and broken down by 3 separate perpetrators ("Mother," "Father," and "Other adult/older adolescent (5 or more years older)"), for a total of 9 questions in each domain. In addition, there are 2 questions on whether the individual witnessed such behaviors being directed towards others in the household. Participants reported the frequency of events for each item on a 5-point scale (0 = *never or almost never* to 4 = *very frequently*) for a total score of 0 to 116. Greater scores indicate greater maltreatment during childhood. The CCMS has shown good internal consistency (e.g., total CCMS alpha = .93) and high test-retest reliability ($r = .92$).³⁵ In our sample, total CCMS alpha = .91.

Combat exposure

Combat exposure was assessed with the Combat Experiences Scale from the Deployment Risk and Resilience Inventory-2 (DRRI-2).³⁶ Participants reported on the frequency with which they encountered 17 objective events and circumstances occurring in their most recent warzone experience, ranging from 1 (*never*) to 6 (*daily or almost daily*). Items include things such as "I personally witnessed enemy combatants being seriously wounded or killed," "I was exposed to hostile incoming fire," and "I fired my weapon at enemy combatants." Scores range from 17 to 102, with higher scores indicating greater combat exposure (alpha = .94).

Alcohol problems

Alcohol problems were assessed with the AUDIT (Alcohol Use Disorders Identification Test).³⁷ The AUDIT consists of 10 items rated on a 4-point scale from 0 (*never*) to 4 (*daily or almost daily*), with scores ranging from 0 to 40 ($\alpha = .76$). Items include questions such as “Have you or someone else been injured because of your drinking?” and “How often during the last year have you had a feeling of guilt or remorse after drinking?”

Frequent heavy drinking

Consistent with other work³⁸ frequent heavy drinking was assessed using the maximum report of 2 items: (1) the reported frequency of getting drunk in the past year, ranging on a 9-point scale from *never* to *every day in the past year*; and (2) the frequency of 5 or more (for males) or 4 or more (for females) drinks in a single setting, ranging on a 9-point scale from *never* to *every day in the past year*.

Current and lifetime drug use

The National Institute on Drug Abuse (NIDA)-modified Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) 2.0 was used to assess current use (i.e., past 3 months) and lifetime use of drugs. Reported use within each time frame of any of the following substances was considered a positive screen for current and/or lifetime drug use: cannabis, cocaine, methamphetamine, inhalants, hallucinogens, street opioids, nonmedical use of prescription drugs, or any other specified illicit drug. The ASSIST was vigorously tested with 3 phases to examine and ensure reliability and validity across settings and cultures.³⁹

Current cigarette smoking

Current cigarette smoking was assessed with 2 questions: “In your entire life have you ever smoked 100 cigarettes?” and “Do you currently smoke cigarettes?” Endorsement of *both* of the aforementioned questions was considered a positive screen for current cigarette smoking. This approach allowed for the exclusion of individuals who have only recently tried cigarettes. This item was dichotomized to yes/no.

Marital satisfaction

Relationship functioning was assessed with the Marital Adjustment Test (MAT).⁴⁰ This 15-item instrument has been well validated in measuring overall marital satisfaction and adjustment of husbands and wives to each other. Scores range from 2 to 158, with higher scores indicating greater relationship adjustment ($\alpha = .76$).

Age

Participants provided their full date of birth. Age was calculated based on the date of the survey and the participant’s date of birth.

Number of deployments

Participants reported their total number of deployments. This item was dichotomized as 1/more than 1.

Data analysis

Descriptive statistics were used to characterize the study sample by reporting means and standard deviations for continuous variables and distributions for categorical variables. Childhood trauma and combat exposure were each considered in unadjusted univariate regression models for each substance use outcome. In our main effects models, we examined the independent effects of soldiers’ childhood trauma and combat exposure on alcohol problems, FHD, current cigarette smoking, and current and lifetime drug use. Given the different ranges of the childhood trauma and combat exposure measures, the scales were standardized to allow for comparison.

Both increasing age and increasing number of military deployments may provide greater opportunities for lifetime traumatic exposures. Additionally, we know from previous work that marital satisfaction is associated with increased resiliency for mental health outcomes among soldiers³³ and that reservists with stronger relationships were more likely to report that they coped well with deployment.³¹ Therefore, adjusted models controlled for age, marital satisfaction, and number of deployments (1 vs. more than 1). Finally, the possible synergistic effects of combat exposure and childhood trauma on substance use were examined using interaction models while controlling for age, marital satisfaction, and number of deployments. Predictive margins were calculated to further examine these interactions at the 10th and 90th percentiles of DRRI and CCMS scores. We used linear regression models for continuous outcomes (alcohol problems and FHD) and logistic models for binary outcomes (current cigarette smoking, current and lifetime drug use). Missing data were minimal. All analyses were performed using Stata version 14.2 software (StataCorp, College Station, TX).

Results

Descriptive results

Among male soldiers who were deployed, the mean (M) and standard deviation (SD) CCMS and DRRI scores were $M = 10.8$, $SD = 12.0$ and $M = 32.2$, $SD = 16.5$, respectively. The prevalence of substance use was current cigarette smoking 20.2% ($n = 50$), current drug use 6.5% ($n = 16$), and lifetime drug use 56.5% ($n = 140$). The AUDIT score was $M = 5.1$, $SD = 4.0$ and 19.0% ($n = 47$) of the sample had an AUDIT score ≥ 8 , the recommended cutoff indicating hazardous drinking.³⁷ The frequent heavy drinking (FHD) score was $M = 2.6$, $SD = 1.4$ and 33.9% ($n = 86$) of the sample reported drinking heavily on at least a monthly basis over the past year. In the sample, 42.3% ($n = 105$) of the soldiers reported multiple deployments.

Main effects

Alcohol problems

Combat exposure was associated with alcohol problems in our first univariate model (regression coefficient = 0.77, 95% confidence interval [CI]: 0.28, 1.26; $P = .002$). In our second univariate model, childhood trauma was not associated with alcohol problems. In our full model (see Table 2), including combat exposure and childhood trauma, the association between

Table 2. Effects of male soldiers' combat exposure, childhood maltreatment, age, marital satisfaction, and number of deployments on their substance use.

Measure	Alcohol problems		Frequent heavy drinking		Current cigarette smoking		Current drug use		Lifetime drug use	
	Coefficient	95% CI	Coefficient	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
DRRI score	0.81**	0.33, 1.29	0.29**	0.12, 0.46	1.13	0.84, 1.54	0.96	0.54, 1.72	1.10	0.85, 1.43
CCMS score	0.21	-0.28, 0.70	-0.11	-0.29, 0.06	1.25	0.94, 1.66	1.44	0.97, 2.14	1.61**	1.14, 2.27
Age	-0.10*	-0.19, -0.02	-0.04**	-0.07, -0.01	0.97	0.91, 1.02	0.92	0.82, 1.02	0.98	0.94, 1.03
Marital satisfaction	-0.03**	-0.05, -0.01	-0.01	-0.01, 0.00	1.00	0.99, 1.01	1.00	0.98, 1.01	0.99**	0.98, .99
Number of deployments	0.58	-0.47, 1.62	0.35	-0.03, 0.73	1.03	0.52, 2.04	0.62	0.18, 2.16	0.92	0.52, 1.63

* $P < .05$; ** $P < .01$; *** $P < .001$.

combat exposure and alcohol problems persisted, even after controlling for age, marital satisfaction, and number of deployments (regression coefficient = 0.81, 95% CI: 0.33, 1.29; $P = .001$; Table 2). Childhood trauma was not associated with alcohol problems in the full model.

Frequent heavy drinking

Greater combat exposure was also associated with FHD in our first univariate model (regression coefficient = 0.28, 95% CI: 0.10, 0.46; $P = .002$). In our second univariate model, childhood trauma did not have a significant effect on FHD. In our full model, including combat exposure and childhood trauma, the association between combat exposure and FHD persisted after adjusting for age, marital satisfaction, and number of deployments (regression coefficient = 0.29, 95% CI: 0.12, 0.46; $P = .001$; Table 2). Childhood trauma was not associated with frequent heavy drinking in the full model.

Current cigarette smoking

In univariate models, neither combat exposure nor childhood trauma was associated with current cigarette smoking. The full model also failed to show any associations.

Current drug use

In our first univariate model, combat exposure was not associated with current drug use. However, childhood trauma had a trend-level association with current drug use in our second univariate model (odds ratio [OR] = 1.40, 95% CI: 0.96, 2.02; $P = .077$). This trend-level association persisted in our full model, even after controlling for age, marital satisfaction, and number

of deployments (OR = 1.44, 95% CI: 0.97, 2.14; $P = .072$; Table 2). Combat exposure remained nonsignificant.

Lifetime drug use

There was no association between combat exposure and lifetime drug use in our first univariate model. Conversely, childhood trauma was significantly associated with lifetime drug use in our second univariate model (OR = 1.73, 95% CI: 1.23, 2.44; $P = .002$). This association persisted in our full model, even after controlling for age, marital satisfaction, and number of deployments (OR = 1.61, 95% CI: 1.14, 2.27; $P = .006$; Table 2). Combat exposure remained nonsignificant.

Interaction effects

Alcohol problems

Combat exposure had a significant interaction with childhood trauma on alcohol problems (regression coefficient = -0.56, 95% CI: -1.12, -0.01; $P = .048$), as shown in Table 3. Childhood and combat trauma had a differential effect on alcohol problems. In the presence of high childhood trauma, increasing combat exposure was not associated with a greater likelihood of alcohol problems; however, in the presence of low levels of childhood trauma, greater combat exposure was associated with a greater likelihood of alcohol problems (Figure 2).

Frequent heavy drinking

Combat exposure had a significant interaction with childhood trauma on frequent heavy drinking (regression coefficient = -0.27, 95% CI: -0.47, -0.08; $P = .007$; Table 3). Similar to

Table 3. Interaction effects of male soldiers' combat exposure and childhood trauma on substance use, controlling for age, marital satisfaction, and number of deployments.

Measure	Alcohol problems		Frequent heavy drinking		Lifetime drug use	
	Coefficient	95% CI	Coefficient	95% CI	OR	95% CI
DRRI score × CCMS score	-0.56*	-1.12, -0.01	-0.27**	-0.47, -0.08	1.78*	1.04, 3.04
DRRI score	0.71**	0.22, 1.20	0.24**	0.06, 0.41	1.31	0.95, 1.83
CCMS score	0.25	-0.24, 0.74	-0.10	-0.27, 0.08	1.84**	1.24, 2.73
Age	-0.10*	-0.19, -0.02	-0.04**	-0.07, -0.01	0.98	0.94, 1.03
Marital satisfaction	-0.03**	-0.04, -0.01	-0.01	-0.01, 0.00	0.99**	0.98, 0.99
Number of deployments	0.59	-0.45, 1.62	0.35	-0.02, 0.73	0.95	0.54, 1.69

* $P < .05$; ** $P < .01$; *** $P < .001$.

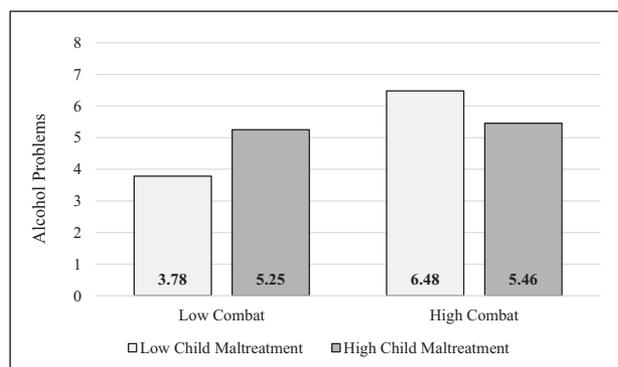


Figure 2. Predictive margins of alcohol problems by combat exposure and child maltreatment.

alcohol problems, in the presence of low levels of childhood trauma, increasing combat exposure was associated with a greater likelihood of frequent heavy drinking (Figure 3).

Lifetime drug use

Combat exposure had a significant interaction with childhood trauma on lifetime drug use (OR = 1.78, 95% CI: 1.04, 3.04; $P = .035$; Table 3). Childhood and combat trauma had a synergistic effect on lifetime drug use; the presence of both high levels of childhood trauma and high combat exposure was associated with the greatest likelihood of lifetime drug use (Figure 4).

There were no significant interactions for smoking or current drug use.

Discussion

Our results indicate that childhood trauma and combat trauma have differential effects on alcohol problems and frequent heavy drinking but have a synergistic effect on lifetime drug use among male National Guard and reserve soldiers who have experienced combat. In the interaction models, soldiers with high levels of childhood trauma were at increased risk of alcohol problems and frequent heavy drinking; combat exposure did not significantly increase this risk. However, among soldiers with low levels of childhood trauma and high levels of combat exposure, combat exposure significantly interacted with childhood trauma, resulting in greater likelihood of both frequent

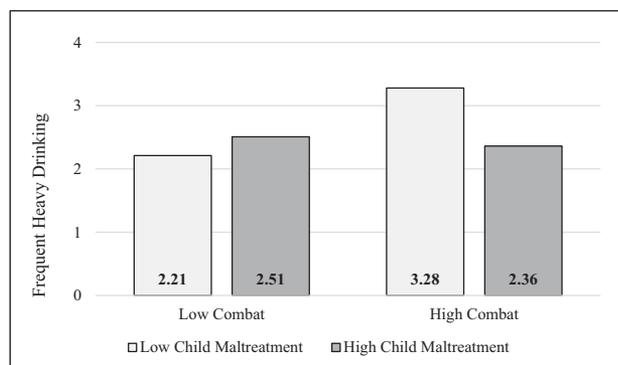


Figure 3. Predictive margins of frequent heavy drinking by combat exposure and child maltreatment.

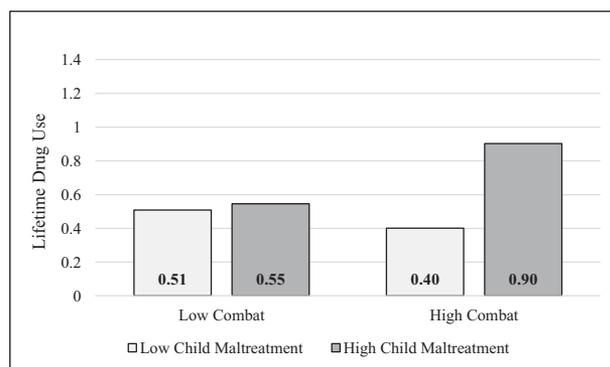


Figure 4. Predictive margins of lifetime drug use by combat exposure and child maltreatment.

heavy drinking and alcohol problems. To our knowledge, this is the first work to demonstrate this type of interaction.

Our findings that demonstrate differential effects of childhood and combat trauma on alcohol problems and frequent heavy drinking are counterintuitive. The stress sensitization hypothesis would suggest that adverse childhood experiences may lead to greater sensitivity to future trauma (e.g., combat) and therefore a greater likelihood of adverse outcomes.^{41,42} Previous work has similarly demonstrated conflicting results in this area, finding a dose-dependent response for childhood traumas on depression, PTSD, and health-related quality of life among active duty Marines,⁴³ but no relationship between childhood trauma and alcohol abuse. Research with a sample of Navy recruits, however, documented a significant relationship among childhood physical and sexual trauma and problematic drinking.⁴⁴ However, both of these studies were conducted with a sample of *never-deployed* individuals and therefore did not account for additional adult trauma exposures, including combat. It is possible that among those with high child maltreatment, there is a ceiling effect of trauma with respect to its effect on the likelihood of alcohol problems and frequent heavy drinking. Therefore, the additional effect of combat trauma is only seen among those with low child maltreatment. Furthermore, our study was conducted with a community sample of National Guard/reserve soldiers, rather than a clinical sample, and therefore may be capturing less severe alcohol problems. Kim and colleagues⁴¹ likewise demonstrated that among individuals with only moderate alcohol intake, stressful life events had a *greater* effect on alcohol craving among individuals with *no* history of childhood maltreatment compared with those with childhood maltreatment. This underscores the fact that combat trauma, when combined with even low levels of childhood trauma, may result in a greater risk for problematic alcohol use.

Our results also demonstrate that soldiers with both high levels of childhood trauma and combat exposure had the greatest likelihood of lifetime drug use. The relationship between childhood trauma and illicit drug use is well documented.^{13–15} More severe trauma in childhood has a strong, linear relationship with the odds of having initiated illicit drug use in adolescence.⁴⁵ Additionally, research has shown an additive effect of multiple trauma experiences on use of multiple substances.⁴⁶ Evidence on the developmental implications of trauma in

childhood compared with later trauma suggests that severe trauma in childhood may disrupt developmental processes, leading to complex impairment across emotion regulation and interpersonal skills.^{47–49} The additional trauma of combat exposure later in life is associated with greater risk of drug use in our sample. However, given the cross-sectional nature of the current analyses, it is not possible to determine if participants' drug use predated their combat exposure. Future waves of longitudinal data from this study will help to further illuminate this relationship.

We found no association in our sample among either childhood or combat trauma and current cigarette smoking. This is surprising, given the well-documented association between trauma, PTSD, and cigarette smoking.^{50,51} Research has shown that military-related stress⁵² and deployment⁵³ increase rates of smoking among soldiers, as a possible maladaptive coping mechanism. Although our rates of smoking are in line with other similar studies, it is possible that heaviness of smoking, rather than a simple dichotomous measure of smoking, is what is driving the association between trauma and smoking shown in other studies. For instance, we have a prevalence of smoking of 20%; however, based on the Heaviness of Smoking Index,⁵⁴ the majority of smokers in our study are light smokers.

Further research is needed to better understand soldiers' likelihood of engaging in substance use. Future longitudinal analysis generated by ongoing data collected in this study may help to answer some of these questions by looking at trends in drug use over time.

Limitations

This work is subject to limitations. First, the data represent baseline data from an ongoing longitudinal study. Longitudinal data will help to strengthen these findings by allowing us to tease out some of the temporal relationships between trauma and substance use. Second, all data are self-report and therefore subject to bias. However, this is common in epidemiological surveys and self-report data have been shown to be reliable estimates of behavior. Third, the study sample consisted of a non-randomized group of individuals who volunteered to participate in the study, which may limit generalizability; however, efforts were made to purposefully sample from National Guard and reserve units across the entire region, with specific attention to including a diversity of unit types and geographic areas. Finally, the small sample size of combat deployed females precluded us from examining outcomes for this population. Future work in this area is important, especially with the increasing combat exposure experienced by female soldiers.

Conclusions

Overall, our results demonstrate that childhood and combat trauma significantly interact and are associated with increased risk of alcohol problems, frequent heavy drinking, and lifetime drug use among National Guard and reserve soldiers. Given that interaction effects were found, even among individuals with lower levels of childhood trauma, and given high prevalence of childhood trauma among military service members,⁵⁵ screening for trauma prior to enlistment and/or deployment

may help identify at-risk individuals and allow time for early intervention to prevent future adverse outcomes. Knowing that cumulative trauma may be associated with worse outcomes,^{16,41,42,56} it is important to evaluate all sources of trauma in military populations, not just combat exposure. Our results also demonstrate that even low levels of childhood trauma, when combined with later combat exposure, may increase the risk for use of certain substances. A better understanding of the full extent of trauma in military personnel will help improve prevention and identification of substance use problems in this population both during and after separation from service.

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Author contributions

G.G.H. and D.L.H. conceived of, designed, and implemented the study. R.A.H. and D.L.H. conducted the statistical analysis. B.M.V. conducted the literature review, with support from R.C.D., and wrote the first draft of the manuscript. Sections of the manuscript were contributed by R.A.H., R.C.D., and D.L.H. All authors critically reviewed the manuscript for content. All authors contributed to and approved the final manuscript.

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