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Combat exposure, emotional and physical role limitations, and substance use among male United States Army Reserve and National Guard soldiers

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Abstract
Purpose Combat-exposed soldiers are at an increased risk for health problems that diminish quality of life (QOL) and substance use. We explored the cross-sectional associations between combat exposure and two measures of QOL, and the effect of substance use on those associations.
Methods Data are from the baseline wave of Operation: SAFETY, an ongoing survey-based study of United States Army Reserve/National Guard (USAR/NG) soldiers and their partners. Our sample consisted of male USAR/NG soldiers with a history of deployment ($N = 248$). Limitations in usual activity due to physical and emotional problems were assessed using the 36-Item Short-Form Health Survey (SF-36).
Results Greater combat exposure was independently associated with limitations in usual activity due to physical (regression coefficient = −0.35, 95% CI −0.55 to −0.16, $R^2 = 0.09$; $p < 0.01$) and emotional (regression coefficient = −0.32, 95% CI −0.56 to −0.09, $R^2 = 0.09$; $p < 0.01$) problems. Combat exposure had a significant interaction with frequent heavy drinking on physical role limitations (regression coefficient = −0.65, 95% CI −1.18 to −0.12, $R^2 = 0.12$; $p < 0.05$) and emotional role limitations (regression coefficient = −0.83, 95% CI −1.46 to −0.19, $R^2 = 0.12$; $p < 0.05$). Combat exposure also had a significant interaction with lifetime non-medical use of prescription drugs on physical role limitations (regression coefficient = 0.81, 95% CI 0.18–1.45, $R^2 = 0.11$; $p < 0.05$).
Conclusion Combat is an unmodifiable risk factor for poor QOL among soldiers; however, frequent heavy drinking and non-medical use of prescription drugs modifies the relationship between combat exposure and QOL. Therefore, substance use is a potential point of intervention to improve QOL among soldiers.

Keywords Military · Quality of life · Substance use · Frequent heavy drinking · Non-medical use of prescription drugs · Combat

United States military operations since September 11, 2001 account for nearly 7000 service member deaths and over 52,000 service member injuries [1]. In addition to the immediately evident morbidity and mortality associated with combat operations, there are many other long-term sequelae of traumatic combat exposure on soldiers that deserve further exploration. In particular, it is important to understand how combat exposure affects the overall well-being of soldiers after returning from deployment and to what extent substance use may affect this relationship.

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Background

Quality of life (QOL) is a meaningful measure of overall well-being that goes beyond morbidity, mortality, and economic status to assess how individuals perceive their lives and well-being. Further, this measure is predictive of mental and physical illness, productivity, and longevity, which are particularly relevant to public health and public policy efforts [2]. Among military populations, the complex relationships between combat exposure, quality of life, and substance use are important areas for research consideration.

Combat exposure and quality of life

Soldiers who experience combat during deployment are at risk for poor health and long-term sequelae [3]. Poor QOL due to combat may occur as a result of diminished mental health, physical health, or social and emotional well-being. Evidence suggests that QOL is lower among soldiers who have been deployed compared to never deployed soldiers, particularly among those who have experienced traumatic combat [4]. Military personnel who have been deployed are affected by a wide range of physical and mental problems that have the potential to diminish QOL; military hospitalization studies suggest that spinal injuries [5] and psychiatric conditions [6] requiring inpatient treatment are prevalent among deployed soldiers. Declines in QOL are more severe for soldiers suffering from service-related disorders, including post-traumatic stress disorder [7, 8], traumatic brain injury, and depression [7], which suggests that the greater the traumatic combat exposure, the lower the QOL post-deployment. Similarly, combat-exposed veterans are at an increased risk for other chronic conditions such as asthma, arthritis, lung diseases, and pain [3], which have the potential to impact physical and emotional well-being.

Combat exposure and substance use

In addition to QOL, evidence also suggests that combat exposure is independently associated with a greater risk of substance use and substance use disorders. In military populations, alcohol and drug use may be a maladaptive coping strategy to manage the stress associated with combat. Although never deployed soldiers have a lower prevalence of substance use than civilian populations [9], soldiers who have been deployed and experienced traumatic combat are at an increased risk for licit and illicit substance use [10], post-deployment problem drinking [11], new-onset heavy drinking, and alcohol problems [12]. Evidence from the literature suggests that, despite similarities in combat experiences, reserve soldiers differ from active duty soldiers and may be at a greater risk for alcohol misuse and other behavioral problems [13].

Substance use and quality of life

The effects of substance use on QOL can either be a mechanism of maladaptive coping that leads to poorer QOL outcomes, or a mechanism of self-medication that may improve some QOL outcomes. Compared to the general population, individuals who use opioids for non-medical purposes report lower QOL [14]. Among British soldiers, problem drinking is associated with functional impairment [15], and among Polish soldiers problem drinking is associated with poor social and emotional functioning [16]. Conversely, there is evidence to support that marijuana use may improve QOL among United States (US) military veterans with post-traumatic stress disorder by reducing anxiety, insomnia, and improving coping ability [17]. However, the literature on the relationship between substance use and quality of life among US Army Reserve/National (USAR/NG) soldiers has not been well established. This is important to consider as 40% of the US military is composed of reservists, and this group is distinctly different from US active duty soldiers and veterans and military populations outside of the US [13].

Substance use as a moderator

Substance use, QOL, and trauma have complex relationships that have been described in the literature for non-military populations. For example, among women in substance abuse treatment, previous trauma was associated with diminished QOL, but an intervention to address their substance use improved their QOL over a 6-month time period [18]. Likewise, trauma was associated with poor QOL among methamphetamine-dependent individuals, but a 12-month intervention to address their substance use improved their overall QOL [19]. Substance use may moderate the relationship between trauma and QOL, and interventions to address substance use may be an approach to improving QOL in populations that are at an otherwise increased risk for morbidity and mortality. However, the role of substance use as a moderator in the relationship between trauma and QOL is not known in military populations.

The relationships between combat exposure, substance use, and QOL are complex. Because combat exposure is an unmodifiable risk factor for declines in QOL among deployed service members, their subsequent substance use is a potential point of public health intervention to improve QOL. Given the gaps identified in the current literature, the present study aimed to explore these relationships cross-sectionally in a sample of male USAR/NG soldiers. We examined the associations between combat exposure and two QOL measures: limitations in usual activities due to physical and emotional problems. Additionally, we examined the moderating effects of frequent heavy drinking, lifetime

non-medical use of prescription drugs, and lifetime illicit drug use on those associations.

Methods

Data are from Operation: SAFETY (Soldiers and Families Excelling Through the Years), an ongoing survey-based study that aims to examine the health and well-being of USAR/NG soldiers and their partners [20–22]. This study was approved by the State University of New York at Buffalo's Institutional Review Board. The research protocol was also vetted through the Army Human Research Protections Office, Office of the Chief, Army Reserve, and the Adjutant General of the National Guard. Additionally, a certificate of confidentiality was obtained from the US Department of Health and Human Services to protect participant information from being disclosed in response to court or other legal orders.

Data collection

Between the summer of 2014 and the fall of 2015, Operation: SAFETY recruited USAR/NG soldiers and their partners from 47 units across New York, United States. Soldiers were given a brief description of the project and invited to participate. Participation of soldiers and their partners involved the completion of three online surveys (baseline with two 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. In order to be eligible for the study, all of the following inclusion criteria must have been met: (1) the couple is married or living as if married; (2) one member of the couple 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 one alcoholic beverage in the past year.

A total of 731 soldiers and partners were eligible for the study. Of those, 572 (78%) agreed to participate and 83% of couples ($N = 472$) completed some part of the survey. Only surveys in which both partners completed were included for follow-up ($N = 418$). Couples where a civilian partner screened for the study ($n = 11$) were less likely to enroll ($p < 0.001$). There were no differences in soldier health variables between those who enrolled and completed vs. those who enrolled and did not complete.

Operation: SAFETY is an ongoing study and the present study examines only data from the baseline wave from male soldiers who reported at least one lifetime deployment ($N = 248$). Participants had a mean (standard deviation [SD]) age of 33.39 (SD = 6.2) years, were predominantly Non-Hispanic white, married, and had at least some college education. The median family income was between $60,000 and $79,000 and the sample served an average of 11.87 (SD = 6.0) years in the military. On average, soldiers were deployed 10.6 (SD = 2.9) months during their most recent deployment and completed the baseline survey 4.6 (SD = 3.2) years after returning from deployment (Table 1).

Surveys were administered through a secure HIPAA-compliant online survey programming software, StudyTrax™, which allowed for data encryption. Participants living in the Western New York area were invited to the State University of New York at Buffalo Center for Health Research to complete their consent and online surveys, either together or separately. For participants living outside of the Western New York area, separate login information was sent to each partner's email. Participants created their own unique password and then were given an online version of the same consent form and survey. Baseline surveys took approximately 2½ h to complete, while the follow-ups lasted 90 min. For their time, soldiers and partners each received a $60 check for baseline and $70 for each of the follow-ups ($200 per person/$400 couple over the study period).

Measures

Combat exposure

Participants with a history of deployment completed the Deployment Risk and Resilience Inventory-2 [DRRI-2; 23], a measure of deployment-related stressors validated for use in non-clinical military populations [24]. Participants

Table 1 Demographic characteristics

Characteristic	Mean (standard deviation) or *N* (%)
Age (years)	33.4 (6.2)
Race	
White	216 (87.1%)
Other	32 (12.9%)
Education	
<High school—high school graduate	35 (14.1%)
Some college	149 (60.1%)
College degree	64 (25.8%)
Median family income	$60,000 to $79,000
Married	187 (75.4%)
Cohabitating	61 (24.6%)
Total years served	11.9 (6.0)
Length of most recent deployment (months)	10.6 (2.9)
Time since most recent deployment (years)	4.6 (3.2)

reported on 17 objective events and circumstances occurring in their most recent warzone experience, ranging from 1 (Never) to 6 (Daily or almost daily). Items include statements 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.' The DRRI-2 had high internal consistency in this sample ($\alpha = 0.94$).

Physical and emotional role limitations

Participants completed the 36-Item Short-Form Health Survey (SF-36) to assess for limitations in usual activity due to physical and emotional problems. The SF-36 has been shown to be a valid and reliable measure of QOL [25]. Physical and emotional role scores can range from 0 to 100, with higher scores indicating fewer limitations (better QOL). The internal consistency of physical role limitations ($\alpha = 0.86$) and emotional role limitations ($\alpha = 0.88$) was good. Physical and emotional role scores were weakly correlated (Pearson product-moment correlation coefficient = 0.31, $p < 0.001$).

Frequent heavy drinking

Consistent with other work [26], heavy drinking was assessed using the maximum report of two items: (1) the reported frequency of getting drunk, ranging on a 9-point scale from never to every day in the past year, and (2) the frequency in the past year of five or more drinks in a single setting, ranging from never to every day on a 9-point scale.

Lifetime non-medical use of prescription drugs and lifetime illicit drug use

To assess lifetime non-medical use of prescription drugs (NMUPD) and illicit drug use, we used the NIDA Modified ASSIST 2.0 (Alcohol, Smoking, and Substance Involvement Screening Test). This instrument was vigorously tested with three phases to examine and ensure reliability and validity across diverse settings and cultures [27]. NMUPD was defined as using a prescription drug without a medical provider's prescription, in greater amounts, more often, longer, or for a reason other than as prescribed. We dichotomized lifetime use (yes/no) for NMUPD and illicit drug use for our analyses.

Covariates

We included age, race (white vs. other), income, and marital satisfaction in our adjusted models to control for potential confounding effects. Aging is associated with declines in QOL [28]. Additionally, soldiers' war era and combat experiences are likely to differ by age group. QOL has also been shown to differ by race. Blacks report worse functioning than their white counterparts of similar health status [29], while being white non-Hispanic has been shown to be a positive protective factor of successful aging among military populations [30]. There are also racial differences in the distribution of military jobs [31], which is likely to influence the combat experiences of soldiers by race. Likewise, these varying roles and combat experiences correspond to different levels of income. Low socioeconomic status has also been shown to be associated with poor QOL in civilian populations [32]. Marital satisfaction was also included in our models. Combat exposure has been shown to be associated with intimate partner violence severity among USAR/NG soldiers [20]. Marital satisfaction is also positively associated with QOL [33]. The Marital Adjustment Test (MAT), a 15-item Likert-based scale, was used to assess marital satisfaction [34]. Questions include the extent of agreement with their spouse on issues such as 'Handling family finances,' 'Demonstrations of affection,' and 'Philosophy of life.' In addition, questions assess the degree of happiness that the individual has in their relationship, as well as whether or not they would marry their spouse again, 'if [they] had to live [their] life over again.' Responses to each question are summed for a total relationship satisfaction score, and higher scores indicate a stronger marriage/romantic partnership. The MAT had good reliability ($\alpha = 0.76$).

Analysis

All analyses were performed using Stata version 14.2 software (Stata Corporation, College Station, TX). We used descriptive statistics to characterize the study sample. Ordinary least squares regression models were used to explore the relationship between combat exposure and the two QOL measures among male soldiers with a history of deployment ($N = 248$). We examined both unadjusted and adjusted linear models. Our full adjusted models controlled for age, race (white vs. other), income, and marital satisfaction. The interaction effects of frequent heavy drinking (FHD), lifetime NMUPD, and lifetime illicit drug use with combat exposure were examined using interaction models. Separate models were then run holding each substance use variable constant to examine the conditional effects of combat exposure on QOL based on substance use (yes/no) [35]. We further examined our analyses for the normality of residuals and homoscedasticity. There was some deviation; however, given our sample size, ordinary least squares regression is fairly resistant to deviations. To confirm this, we explored robust regression methods [36], which yielded similar findings to our original ordinary least squares regression analyses. Given that ordinary least squares regression is a more common and understandable approach and our findings from

robust regression were similar, we have retained our original approach.

Results

Descriptive results

Among male soldiers who were deployed, the mean DRRI-2 score was 32.2 (SD = 16.5). In our sample, physical and emotional role limitation scores ranged from 0 to 100 (higher scores indicating fewer limitations), with a mean of 88.1 (SD = 26.4) and 85.2 (SD = 31.7), respectively. Further, 8% ($N = 20$) and 12% ($N = 30$) reported cutting down on the amount of time spent on work or other activities due to physical and emotional problems, respectively. Normative values have not been established for military populations, but these scores are consistent with population norms from the United Kingdom and Canada [37, 38]. Additionally, the average emotional role and physical role scores of these current USAR/NG soldiers were consistent with those of deployed Gulf War Theatre veterans [39]. The mean MAT score for marital satisfaction was 110.6 (SD = 28.4). The mean FHD score was 2.6 (SD = 1.4), with 34.7% ($N = 86$) drinking heavily at least monthly over the past year. Additionally, a significant proportion of the sample reported lifetime NMUPD (14.1%) and lifetime use of any illicit drug (53.6%).

Main effects

Physical role limitation

Greater combat exposure was associated with limitations in usual activity due to physical problems (regression coefficient = −0.36, 95% CI −0.56 to −0.16, $R^2 = 0.05$; $p < 0.001$). After controlling for age, race, income, and marital satisfaction, the association between combat exposure and physical role limitations persisted (regression coefficient = −0.35, 95% CI −0.55 to −0.16, $R^2 = 0.09$; $p < 0.01$) (Table 2).

Emotional role limitation

Greater combat exposure was also associated with limitations in usual activity due to emotional problems (regression coefficient = −0.30, 95% CI −0.54 to −0.06, $R^2 = 0.02$; $p < 0.05$). This association remained after controlling for age, race, income, and marital satisfaction (regression coefficient = −0.32, 95% CI −0.56 to −0.09, $R^2 = 0.09$; $p < 0.01$) (Table 2).

Interaction effects

Frequent heavy drinking

Combat exposure had a significant interaction with FHD on physical role limitations (regression coefficient = −0.65, 95% CI −1.18 to −0.12, $R^2 = 0.12$; $p < 0.05$) and emotional role limitations (regression coefficient = −0.83, 95% CI −1.46 to −0.19, $R^2 = 0.12$; $p < 0.05$), as shown in Table 3. The presence of FHD at least once a week strengthened the negative relationship between combat exposure and physical role score (Fig. 1), as well as the relationship between combat exposure and emotional role score (Fig. 2).

Non-medical use of prescription drugs

Combat exposure had a significant interaction with lifetime NMUPD on physical role limitations (regression coefficient = 0.81, 95% CI 0.18–1.45, $R^2 = 0.11$; $p < 0.05$) (Table 4). The presence of NMUPD changed the direction of the relationship between combat exposure and physical role score from negative to positive (Fig. 3).

Table 2 Effects of combat exposure, age, race, income, and marital satisfaction on quality of life

	Physical role limitation score regression coefficient [95% confidence interval]	Emotional role limitation score regression coefficient [95% confidence interval]
Combat exposure	−0.35** [−0.55, −0.16]	−0.32** [−0.56, −0.09]
Age	−0.63* [−1.20, −0.05]	−0.65 [−1.32, 0.02]
Race	−6.65 [−16.65, 3.36]	−5.19 [−16.87, 6.49]
Income	1.95 [−0.20, 4.11]	0.12 [−2.40, 2.64]
Marital Satisfaction	−0.02 [−0.14, 0.10]	0.20** [0.06, 0.33]

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 3 Interaction effects of combat exposure and FHD on quality of life, controlling for age, race, income, and marital satisfaction

	Physical role limitation score regression coefficient [95% confidence interval]	Emotional role limitation score regression coefficient [95% confidence interval]
Combat exposure × frequent heavy drinking	−0.65* [−1.18, −0.12]	−0.83* [−1.46, −0.19]
Combat exposure	−0.27* [−0.48, −0.06]	−0.16 [−0.42, 0.09]
Frequent heavy drinking	28.81* [4.46, 53.17]	27.26 [−2.04, 56.56]
Age	−0.72* [−1.28, -0.16]	−0.73* [−1.40, −0.63]
Race	−6.84 [−16.50, 2.82]	−4.83 [−16.45, 6.79]
Income	1.58 [−0.51, 3.68]	0.18 [−2.50, 2.54]
Marital satisfaction	0.01 [−0.10, 0.12]	0.21** [0.08, 0.35]

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

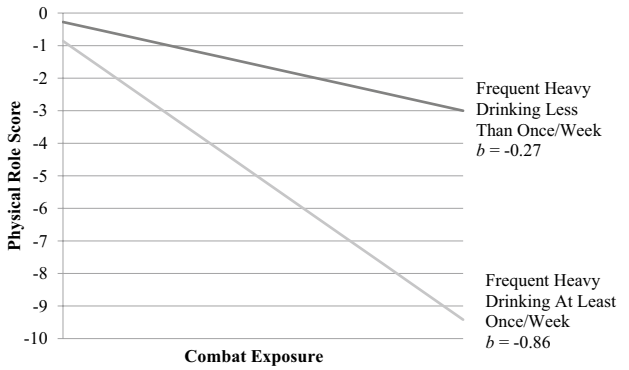

Fig. 1 Conditional effect of combat exposure on physical role score by frequent heavy drinking

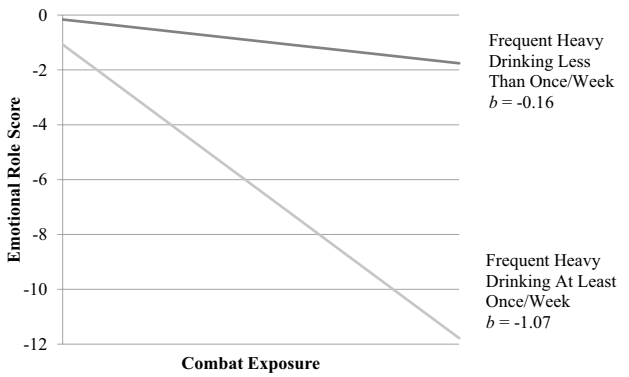

Fig. 2 Conditional effect of combat exposure on emotional role score by frequent heavy drinking

Illicit drug

There were no significant interactions between lifetime illicit drug use and combat exposure on physical or emotional role limitations (Table 5).

Discussion

Our results indicate that among male USAR/NG soldiers, greater combat exposure is associated with greater limitations to usual activity due to both physical and emotional problems. These relationships persisted even after controlling for age, race, income, and marital satisfaction. Additionally, these effects were modified by FHD and NMUPD, which demonstrate that, although greater combat exposure is associated with lower QOL, behavioral factors including substance use can alter the relationship between combat exposure and QOL. Although combat exposure is an unmodifiable risk factor for declines in QOL, interventions addressing substance use may improve QOL among deployed soldiers.

Our findings are consistent with findings from the Millennium Cohort Study, which also demonstrated diminished mental and physical health among those with combat-related post-traumatic stress disorder [8]. A limited number of studies have examined the complicated relationships that may exist between military combat exposure, QOL, and substance use. Evidence suggests that combat is associated with an increased risk of alcohol problems [4, 11, 12, 40–43] and other licit and illicit substance use [10, 40, 42, 44]. Likewise, there is a strong relationship between combat exposure and an increased risk for diminished QOL [4, 7, 41–43, 45, 46].

Table 4 Interaction effects of combat exposure and lifetime NMUPD on quality of life, controlling for age, race, income, and marital satisfaction

	Physical role limitation score regression coefficient [95% confidence interval]	Emotional role limitation score regression coefficient [95% confidence interval]
Combat exposure × lifetime NMUPD	0.81* [0.18, 1.45]	0.20 [−0.54, 0.95]
Combat exposure	−0.44*** [−0.65, −0.23]	−0.34** [−0.59, −0.10]
Lifetime NMUPD	−28.10* [−51.18, −5.01]	−17.99 [−45.06, 9.08]
Age	−0.59* [−1.17, −0.02]	−0.71* [−1.39, −0.04]
Race	−6.16 [−16.20, 3.89]	−3.24 [−15.02, 8.54]
Income	1.64 [−0.52, 3.80]	−0.19 [−2.73, 2.34]
Marital satisfaction	−0.02 [−0.13, 0.10]	0.18* [−0.59, −0.10]

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

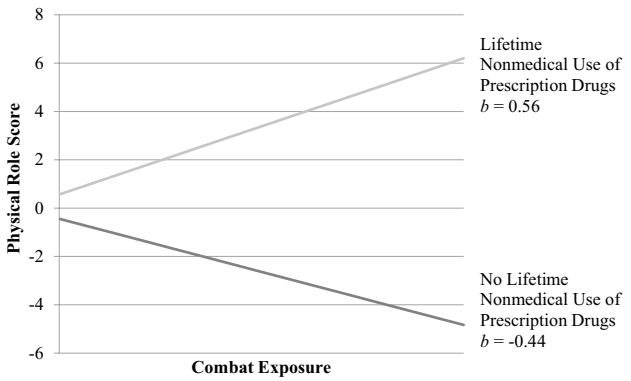

Fig. 3 Conditional effect of combat exposure on physical role score by lifetime non-medical use of prescription drugs

Substance use has also been associated with a reduced QOL [14–16, 47].

Despite the evidence exploring the complex relationships between combat exposure and QOL, combat exposure and substance use, and substance use and QOL separately, to our knowledge no studies have examined all three constructs together while considering substance use as a potential moderator in the relationship between combat exposure and QOL in any military populations. Given the evidence surrounding the relationship between trauma and QOL, trauma and substance use, as well as the relationships between substance use and QOL in non-military populations [18, 19], our findings represent significant gains in knowledge in how substance use moderates the relationship between combat

Table 5 Interaction effects of combat exposure and lifetime illicit drug use on quality of life, controlling for age, race, income, and marital satisfaction

	Physical role limitation score regression coefficient [95% confidence interval]	Emotional role limitation score regression coefficient [95% confidence interval]
Combat exposure × lifetime illicit drug use	−0.01 [−0.40, 0.39]	0.01 [−0.46, 0.47]
Combat exposure	−0.34* [−0.61, −0.08]	−0.32* [−0.63, −0.01]
Lifetime illicit drug use	−3.87 [−18.43, 10.70]	−3.70 [−20.72, 13.32]
Age	−0.65* [−1.23, −0.08]	−0.67 [−1.35, 0.00]
Race	−6.92 [−16.95, 3.11]	−5.43 [−17.15, 6.30]
Income	1.91 [−0.26, 4.07]	0.08 [−2.45, 2.61]
Marital satisfaction	−0.04 [−0.16, 0.08]	0.18* [0.04, 0.32]

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

exposure and QOL. Our findings indicate that among reserve soldiers who experienced considerable combat exposure, FHD has a negative effect on the QOL. Soldiers who engage in FHD may not meet criteria for alcohol use disorder, but FHD is risky and may lead to chronic health problems [48, 49], contributing to further declines in QOL. Conversely, our findings indicate that NMUPD may have a positive effect on QOL. This suggests that these soldiers may be self-medicating for undiagnosed or undertreated physical and/or mental health conditions that are ameliorated by the use of these prescription drugs. Despite this effect, NMUPD may lead to addiction, accidental overdose, and death [50, 51].

These findings have implications for screening, diagnosis, and treatment of these soldiers. Given that only 55% of separated veterans from the post-September 11, 2001 era receive care from the Veterans Administration (VA) [52], that USAR/NG soldiers are less likely to access VA healthcare than veterans separated from active duty [53, 54], and that USAR/NG soldiers often do not meet eligibility requirements to receive care from the VA [55], a large proportion of this population may not be receiving adequate care. Many may also be receiving their healthcare in civilian settings [53, 54]. Civilian providers may be unaware of their patients' military status [53, 56–58] and therefore may miss the connection between military service and their patients' well-being. Moreover, a majority of private primary care physicians struggle to consistently assess for and effectively address alcohol and other substance use with their patients [59, 60], and therefore NMUPD may not be recognized. Our findings highlight an important area for healthcare improvement in a population that is at increased risk for substance use [48] and subsequent declines in QOL. Additional evidence from the Millennium Cohort Study suggests that poor QOL is also a risk factor for subsequent post-traumatic stress disorder [61], which is also associated with alcohol abuse [62] and NMUPD [63]. Providers should be consistently screening for FHD and NMUPD in their patients, as it may be an indicator that other health concerns are being underaddressed. Future studies are needed to examine further the factors related to healthcare setting, NMUPD, and QOL.

The findings of this study should be interpreted within the context of its limitations. Data are cross-sectional; however, Operation: SAFETY is an ongoing study and future longitudinal analyses can be conducted to determine if these cross-sectional findings hold, and to further examine if there are changes in QOL over time or if separating from the military has any effect on these relationships. Additionally, future longitudinal analyses should examine potential mediators acting in the relationship between combat exposure and QOL. A second limitation is that the present work focuses only on male USAR/NG soldiers, so our findings cannot be generalized to other populations. The proportion of our overall soldier sample that is female (19%) is consistent with national estimates of female USAR/NG soldiers [64]; however, a very small proportion of these women reported a previous deployment with combat exposure. This is to be expected as female soldiers were, until recently, restricted from participating in most combat roles. As with all survey-based studies, our findings are subject to information and response bias. Given the range of responses for combat exposure and QOL, any misclassification was likely non-differential. Further, underreporting of drug and alcohol use would have led to an underestimation of the true conditional effects of substance use on the relationship between combat exposure and QOL. Despite these limitations, the present work also has several notable strengths, including the use of validated measures for combat exposure, QOL, and substance use. Additionally, the use of a continuous combat exposure measure allowed us to examine a range of combat experiences among deployed soldiers, rather than assuming that all combat experiences have an equal effect on QOL. The results of this work represent novel findings in an understudied population.

Conclusion

These findings indicate that greater combat is associated with limitations to usual activity due to physical and emotional problems and that this relationship is moderated by NMUPD and FHD. Combat exposure is an unmodifiable risk factor for declines in QOL among USAR/NG soldiers. Therefore, interventions that might buffer the inverse relationship between combat exposure and QOL are imperative to efforts aimed at reducing morbidity and mortality among combat-exposed soldiers. More systematic screening for under-recognized forms of substance use, such as FHD and NMUPD, may be important to address as a part of overall efforts to improve QOL. Such approaches might include targeted interventions to reduce problematic substance use and interventions to improve the management of undertreated physical and mental health conditions among USAR/NG soldiers returning from combat.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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