

The burden of alcohol use disorders in US military veterans: results from the National Health and Resilience in Veterans Study

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ABSTRACT

Aims To analyze data from a large, contemporary, nationally representative sample of US veterans to evaluate: (1) the prevalence of life-time alcohol use disorder (AUD) and past-year AUD; (2) common psychiatric comorbidities associated with life-time AUD; and (3) correlates of life-time and past-year probable AUD. **Design** Data were analyzed from the National Health and Resilience in Veterans Study (NHRVS), a web-based survey of a random probability sample of a contemporary, nationally representative sample of US military veterans. **Setting** United States. **Participants** Nationally representative sample of 3157 US veterans aged 21 years and older. **Measurements** Life-time alcohol abuse and dependence were assessed according to DSM-IV diagnostic criteria using the Mini International Neuropsychiatric Interview, and combined into a single variable: AUD. Past-year probable AUD was assessed using the Alcohol Use Disorders Identification Test-Consumption (AUDIT-C). Correlates of AUD, including psychiatric comorbidities, suicidality and demographic characteristics, were also assessed. **Findings** The prevalence of life-time AUD and past-year probable AUD was 42.2% [95% confidence interval (CI) = 40.5–43.9%] and 14.8% (95% CI = 13.6–16.0%), respectively. Compared with veterans without AUD, those with life-time AUD had substantially elevated rates of life-time and current mood and anxiety disorders [odds ratios (ORs) = 2.6–4.1], drug use disorder (OR = 10.7), life-time suicide attempt (OR = 4.1) and current suicidal ideation (OR = 2.1). Younger age, male sex, lower education, lower annual household income and greater number of life-time traumatic events were associated independently with life-time AUD. Younger age, male sex, unpartnered marital status and a life-time diagnosis of major depressive disorder were associated independently with past-year probable AUD. **Conclusions** More than 40% of US military veterans have a life-time history of alcohol use disorder. Veterans with a life-time history of alcohol use disorder have substantial comorbid psychiatric burden, including elevated rates of suicidal ideation and attempts. Certain socio-demographic (e.g. younger age, male sex, lower education) and clinical (e.g. trauma burden, history of depression) characteristics are associated with increased risk of AUD.

Keywords Alcohol use disorder, anxiety disorder, comorbidity, dual diagnosis, epidemiology, military, mood disorder, veterans.

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INTRODUCTION

Alcohol use disorder (AUD) is characterized by a problematic pattern of alcohol use that is associated with clinically significant distress and/or functional impairment [1]. AUD is associated with a broad range of health and socioeconomic problems, including psychiatric comorbidities [2,3], motor vehicle accidents [4], domestic violence [5], fetal alcohol syndrome [6], cognitive impairment [7], poor medication adherence [8–10] and high economic cost and

lost productivity [11]. Despite the many psychosocial and economic consequences of AUD, as well as an even greater burden of AUD in certain subpopulations, such as US military veterans [12], only a few large-scale, nationally representative studies have been conducted on the prevalence and clinical correlates of AUD [13] and no such study has focused specifically on the US veteran population.

Several national and international large-scale surveys have been conducted to characterize the prevalence of AUD. One landmark study, the National Epidemiologic

Survey on Alcohol and Related Conditions (NESARC), conducted face-to-face interviews with more than 40 000 US adults. Results of this study revealed that the prevalence of life-time alcohol abuse and dependence was 17.8 and 12.5%, respectively, and that the prevalence of past-year alcohol abuse and dependence was 4.7 and 3.8%, respectively. Socio-demographic characteristics associated with AUD include being male, white, Native American, younger, unmarried and lower income [13].

Psychiatric disorders occur commonly with AUD. For example, results from the Epidemiologic Catchment Area Study (ECA) [14], which surveyed more than 20 000 US adults, revealed that those with a mental disorder were nearly three times more likely than those without a mental disorder to have an addictive disorder, with a life-time prevalence of 28.9% (22.3% specifically for AUD). Among those with an AUD, 36.6% had a comorbid mental disorder, which was 2.3 times more prevalent than those without an AUD. Similarly, results from the National Comorbidity Study (NCS), a nationally representative household survey of more than 8000 US adults, revealed that the majority of respondents with a diagnosis of AUD also had a history of at least one other mental disorder, with alcohol dependence having a stronger pattern of association than alcohol abuse. The largest odds ratios (ORs) of psychiatric disorders associated with AUD were with conduct disorder, antisocial personality disorder, anxiety disorders and affective disorders [15]. Finally, results from the NESARC found that AUD were associated with 1.6–3.5 times greater likelihood of co-occurring mood and anxiety disorders [2].

In the United States there are currently 21.8 million veterans, who represent almost 10% of the total population [16]. Veterans have a unique socio-demographic composition, including older age and predominantly male sex [16]. In addition, veterans are at increased risk for psychiatric morbidities that are associated with AUD [2,3]. Finally, heavy drinking is often normalized in military cultures [17]. Hence, characterization of the prevalence and correlates of AUD among veterans is important, as this information can be used to inform population-based prevention and treatment efforts that are specific to this population.

A burgeoning body of literature has examined the prevalence and correlates of AUD in veterans, but results vary considerably depending on how AUD was defined. For past-year probable AUD, results range from 6.2% using a conservative definition of past-year AUD defined using DSM-IV criteria [18] to 40.1% when using a less conservative Alcohol Use Disorders Identification Test–Consumption (AUDIT-C) cut-off of > 4 for men and > 3 for women [12]. Other studies have found a prevalence of 12.2% using two or more positive responses to the Cut-down, Annoyed, Guilt, Eye-opener (CAGE) questions [19] and 33.3% when using an AUDIT score > 8 and 21.8%

when using an AUDIT-C score > 5 for men and > 3 for women [20].

Veterans are at increased risk for various psychiatric conditions, with rates varying between studies. For example, a recent meta-analysis estimated that the prevalence of post-traumatic stress disorder (PTSD) in Operation Enduring Freedom/Operation Iraqi Freedom veterans was 23% [21], which is considerably higher than the 6.4–7.8% prevalence of PTSD in the general adult population [22,23]. The high comorbidity of PTSD and related disorders, such as depression, with AUD [24,25], coupled with an increased risk of developing AUD following deployment [26], underscores the importance of understanding the prevalence and correlates of AUD in military veterans. While multiple factors have been found to be associated with AUD in veteran samples, including younger age, trauma history, combat exposure and unpartnered marital status [19,27], the vast majority of studies have recruited convenience samples from VA settings or focused on veterans of specific war eras. Consequently, the population-based burden of AUD and their clinical correlates in the general US veteran population is unknown.

Because fewer than 20% of veterans utilize VA health-care services as their primary source of health-care [28], characterization of the prevalence and correlates of AUD in the general US veteran population is essential to understanding the population-based burden and clinical correlates of AUD. This information can help to inform prevention and treatment strategies, as well as policy initiatives geared toward mitigating risk for AUD in this growing segment of the population. To address this gap in the literature, we analyzed data from a large, contemporary, nationally representative sample of US veterans to evaluate: (a) the prevalence of life-time and past-year AUD; (b) common psychiatric comorbidities associated with life-time AUD; and (c) socio-demographic, military, and psychosocial correlates of life-time and past-year probable AUD.

METHODS

Participants

Data were drawn from the National Health and Resilience in Veterans Study (NHRVS), a nationally representative, simple random sample of 3157 US veterans aged 21 years and older. This sample was derived from KnowledgePanel, a survey research panel representing approximately 98% of US adults that is maintained by GfK Knowledge Networks, Inc. in Menlo Park, California. GfK Knowledge Networks uses probability-based sampling of household addresses from the US Postal Service's Delivery Sequence File (DSF), a method that allows for the inclusion of even those households with no telephone access. Participants are additionally provided with a computer and accompanying internet access to participate, if

required. GfK Knowledge Networks operates a modest incentive program to encourage participation and create member loyalty. Members can enter special raffles or can be entered into special sweepstakes with both cash rewards and other prizes. In the current study, participants received 30 000 'points' equal to \$30 for completion of the survey.

Assessments

Alcohol use disorders

Life-time alcohol abuse and dependence were assessed according to DSM-IV diagnostic criteria using the Mini-International Neuropsychiatric Interview (MINI [29]) and were combined into a single category of AUD. A two-level variable was created based on participant responses: (1) No life-time history of AUD; and (2) life-time history of AUD.

The AUDIT-C was used to assess past-year probable AUD. Scores on the AUDIT-C range from 0 to 12, and a cut-off score of > 5 was used to identify probable AUD [30,31]. Prevalence estimates are also reported for cut-off scores of 4 and 6, which have also been applied in prior work [32,33].

Potential correlates of alcohol use disorders

Table 1 shows variables that were examined as potential correlates of life-time and past-year probable AUD.

Data analysis

Of the 3408 panelists who completed the initial screening question to ascertain veteran status, 3188 (93.5%) completed the survey. GfK Knowledge Networks statisticians computed post-stratification weights created based on the demographic composition of veterans in KnowledgePanel and calibrated these weights against data from the most contemporaneous US Census Bureau Current Population Survey (age, gender, ethnicity, education, metropolitan area, census region). These weights, which adjust for any survey non-response, as well as any non-coverage or under- and over-sampling resulting from the study-specific sample design, were applied to all inferential statistical analyses in order to render results representative of the US veteran population. To reduce bias related to item-level missing data on the MINI alcohol abuse/dependence module and AUDIT-C ($< 3\%$), these values were imputed using an iterative Markov chain Monte Carlo (MCMC) method. Data analyses proceeded in four steps using IBM SPSS Statistics for Windows version 22.0. First, weighted frequency and cross-tabulation analyses were conducted in order to calculate the prevalence of life-time and current probable AUD. Secondly, a series of logistic regression analyses adjusted for socio-demographic and military variables were conducted in order to examine associations between life-time AUD and comorbid psychiatric diagnoses and measures of suicidal ideation and attempts. Thirdly, a series of χ^2 analyses and independent *t*-tests were conducted to examine socio-demographic, military and psychosocial

Table 1 Potential correlates of life-time and past-year probable alcohol use disorder.

Variable	Assessment
Socio-demographic variables	Age (continuous), gender (male, female), marital status (married/living with partner, not), education (high school or less, some college or higher), race (white, other), household income ($< \$30\,000$, $\$30\,000$ – $59\,999$, $\$60\,000$ – $84\,999$, $> \$85\,000$), employment status (unemployed, employed)
Military variables	Military branch (army, other), combat status (no exposure, exposure), military enlistment (enlisted, drafted)
Number of life-time traumas	Trauma History Screen (THS). 'Life-threatening illness or injury' was assessed as an additional trauma. Number of life-time traumatic events examined [34]
VA health-care Utilization	Respondents were asked: 'Is the VA your main source of healthcare?' (no/yes)
Life-time mental disorders	The Mini International Neuropsychiatric Interview [29] was used to assess life-time major depressive disorder, social anxiety disorder and drug use disorder
Life-time suicide attempt	Respondents were asked: 'Have you ever tried to kill yourself?' (no/yes)
Life-time nicotine dependence	Fagerström Test for Nicotine Dependence [35] was used to assess for life-time nicotine dependence
Life-time and current PTSD	Posttraumatic Stress Disorder Checklist-specific (range: 17–85 [36]). Life-time and past month time-frames were assessed. A cut-off score of > 50 was used to represent a probable diagnosis
Current depression and generalized anxiety	Current depression and anxiety symptoms were assessed using the Patient Health Questionnaire-4 (PHQ-4 [37])
Current suicidal ideation	Two questions adapted from the PHQ-9 [38] were used to assess suicidal ideation: 'How often have you been bothered by thoughts you might be better off dead?' and 'How often have you been bothered by thoughts of hurting yourself in some way?'. Suicidal ideation was defined as a positive endorsement of either of these questions (i.e. 'Several days' or more)

correlates of life-time AUD. Variables emerging as associated statistically significantly with life-time AUD at the $P < 0.05$ level in bivariate analyses were entered simultaneously into a multivariable binary logistic regression model with life-time AUD (no versus yes) modeled as the dependent variable. Fourthly, a parallel set of bivariate and multivariable analyses were conducted to examine socio-demographic, military and psychosocial correlates of past-year probable AUD. Life-time PTSD and depression were additionally incorporated into this model to test the self-medication hypothesis [39] that life-time histories of PTSD and depression may contribute to risk for past-year probable AUD.

RESULTS

The prevalence of life-time and past-year probable AUD was 42.2 and 14.8%, respectively. A total of 823 (weighted 26.2%) and 267 (weighted 9.4%) veterans had an AUDIT-C cut score of > 4 and > 6 , respectively. Table 2 displays prevalence estimates and 95% confidence intervals of life-time and past-year probable AUD among veterans in the full NHRVS sample, as well as by sex and age subgroups.

Table 3 shows associations between life-time AUD status, and comorbid psychiatric conditions. Life-time AUD was associated with an increased likelihood of all psychiatric disorders assessed relative to veterans without a life-time history of AUD, with magnitudes of ORs ranging from 2.6 for current major depression to 10.7 for life-time drug use disorder.

Table 4 displays socio-demographic and military correlates of life-time AUD. The multivariable analysis revealed that, compared to veterans without a history of AUD, veterans with life-time AUD were younger, more likely to be male, less likely to be in the \$30 000–59 999 household income range (compared to $< \$30 000$), less likely to have

at least some college education and reported a greater number of traumatic life events.

Table 5 displays socio-demographic and military correlates of past-year probable AUD. In the multivariable model, younger age, male sex, unpartnered marital status and life-time major depressive disorder emerged as being associated significantly with probable AUD. These same predictors emerged as significant when all socio-demographic, military and psychosocial correlates were entered into the model simultaneously.

DISCUSSION

Results of this study revealed that two of five US veterans screen positive for life-time AUD, which is higher than the prevalence of AUD observed in the general US adult population (30.3%) [13].

Further, despite employing a relatively conservative cut-off score of 5 on the AUDIT-C, 14.8% of veterans screened positive for past-year probable AUD, underscoring the elevated burden of AUD in this population. The use of screening measures, predominance of men in the sample, high rates of comorbid psychiatric illness and unique trauma exposure (e.g. combat) may, at least in part, account for these higher prevalence estimates of AUD.

The prevalence of life-time AUD peaked in the 45–59-year age group and decreased with age thereafter. This may be explained by increased AUD-related mortality as a function of increasing age [40]. The highest prevalence of past-year probable AUD (23.5%) in the current sample was observed in the youngest age group (21–44 years). Younger individuals, particularly those in the 18–25 age group, may be more likely to engage in binge drinking [41], which may increase the likelihood of screening positive for probable AUD on the AUDIT-C. The declining prevalence of past-year probable AUD as a

Table 2 Prevalence of life-time and past-year probable alcohol use disorder (AUD) in the full sample and age- and sex-based subsamples of US Veterans.

	Life-time AUD		Past-year probable AUD	
	Raw frequency	Weighted % (95% CI)	Raw frequency	Weighted % (95% CI)
Full sample	1284	42.2% (40.5–43.9%)	424	14.8% (13.6–16.0%)
Sex				
Female	78	24.0% (19.5–29.3%)	24	9.2% (5.9–12.5%)
Male	1206	44.0% (42.2–45.9%)	400	15.4% (14.1–16.7%)
Age group (years)				
21–29	20	35.3% (27.8–43.6%)	13	23.5% (16.4–30.6%)
30–44	106	39.8% (35.0–44.8%)	52	20.9% (16.8–25.0%)
45–59	359	49.0% (45.5–52.3%)	132	17.7% (15.1–20.3%)
60–74	651	45.8% (43.1–48.7%)	179	12.5% (10.7–14.3%)
75+	148	26.9% (23.4–30.8%)	48	9.6% (7.1–12.0%)

Percentages were calculated using post-stratification weights to be consistent with the demographic composition of US Veterans. CI = confidence interval.

Table 3 Psychiatric correlates of life-time alcohol use disorder (AUD) in US veterans.

	No life-time AUD (n = 1873)	Life-time AUD (n = 1284)	Life-time AUD versus no AUD
	Raw frequency (weighted %)	Raw frequency (weighted %)	Adjusted odds ratio (95% CI)
Psychiatric conditions ^a			
Life-time major depressive disorder	190 (9.9%)	327 (26.6%)	3.94 (3.18–4.90)***
Life-time social anxiety disorder	106 (6.0%)	166 (14.4%)	2.92 (2.24–3.80)***
Life-time PTSD	75 (4.4%)	137 (12.8%)	4.08 (3.01–5.54)***
Life-time nicotine dependence	197 (10.9%)	385 (31.1%)	3.64 (3.00–4.40)***
Life-time drug use disorder	60 (3.5%)	326 (27.0%)	10.73 (8.04–14.33)***
Life-time suicide attempt	53 (3.5%)	112 (11.4%)	4.12 (2.99–5.69)***
Current major depressive disorder	85 (5.1%)	127 (11.6%)	2.62 (1.97–3.48)***
Current PTSD	33 (2.4%)	69 (8.2%)	3.97 (2.67–5.89)***
Current generalized anxiety	82 (5.1%)	120 (12.0%)	2.76 (2.08–3.66)***
Current suicidal ideation	93 (6.6%)	138 (13.4%)	2.15 (1.67–2.77)***

Percentages and odds ratios were calculated using post-stratification weights. ^aOdds ratios were adjusted for age, sex, race, military branch and combat veteran status. Statistically significant association: *** $P < 0.001$; AUD = alcohol use disorder; PTSD = post-traumatic stress disorder; CI = confidence interval.

Table 4 Demographic, military and psychosocial characteristics of Veterans with life-time alcohol use disorder, and results of multivariable model of correlates of life-time alcohol use disorder (AUD).

	No life-time AUD (n = 1873)	Life-time AUD (n = 1284)			Life-time AUD versus no AUD
	Raw frequency (weighted %)	Raw frequency (weighted %)	χ^2 (d.f.)	P	Adjusted odds ratio (95% CI)
Male sex	1630 (87.7%)	1206 (94.7%)	44.18(1)	<0.001	3.06 (2.27–4.11)***
Non-Caucasian race	334 (24.5%)	185 (22.8%)	1.22(1)	0.270	–
Married or living with partner	1483 (76.7%)	999 (74.1%)	2.83(1)	0.093	–
Currently employed	763 (40.1%)	522 (41.7%)	0.85(1)	0.357	–
Annual household income (versus < \$30 000)			17.65(3)	0.001	
\$30 000–59 999	629 (35.5%)	380 (30.7%)			0.81 (0.66–0.99)*
\$60 000–84 999	390 (20.0%)	302 (21.5%)			1.04 (0.83–1.31)
>\$85 000	577 (24.2%)	378 (22.2%)			0.91 (0.72–1.23)
Education level (\geq some college)	1611 (69.1%)	1063 (63.6%)	10.48(1)	0.001	0.70 (0.59–0.83)***
Military branch (army versus other)	1110 (61.5%)	771 (61.7%)	0.06(1)	0.938	–
Combat veteran	614 (34.2%)	491 (35.0%)	0.23(1)	0.632	–
Military enlistment (% drafted)	280 (13.7%)	148 (10.5%)	7.00(1)	0.008	0.91 (0.73–1.15)
VA is primary source of health-care	285 (18.7%)	249 (20.0%)	0.79 (1)	0.375	–
	Mean (SE)	Mean (SE)	t(d.f.)		
Age (years)	61.19 (.37)	58.98 (.38)	16.74(1)	<0.001	0.99 (0.98–0.99)***
Number of life-time traumas	2.83 (.06)	4.14 (.08)	176.30(1)	<0.001	1.19 (1.16–1.23)***

Means and percentages were calculated using post-stratification weights. Adjusted odds ratios are adjusted for variables in the table that demonstrated differences between alcohol use groups. Statistically significant association: * $P < 0.01$; *** $P < 0.001$. SE = standard error; CI = confidence interval.

function of age may be explained, at least in part, by developmental maturation and ‘aging out’ of engagement in problematic drinking behaviors [42]. While these results provide some initial insight into the relation between age and AUD prevalence in military veterans, prospective cohort studies will be useful in understanding more clearly the developmental trajectories of AUD in this population, as well as inter-relationships between AUD and co-occurring psychiatric and physical health disorders.

As expected, veterans with life-time AUD had substantially elevated rates of life-time and current mood and anxiety disorder comorbidities (OR range = 2.6 for current depression to 4.1 for life-time PTSD), life-time drug use disorder (OR = 10.7), current suicidal ideation (OR range = 2.1) and life-time suicide attempt (OR range = 4.1). These findings are consistent with prior epidemiological studies of both general population and military veteran samples, which have similarly found that

Table 5 Demographic, military, and psychosocial characteristics of US veterans with and without past-year probable alcohol use disorder (AUD) and results of multivariable analysis of correlates of past-year probable AUD.

	No past-year probable AUD (n = 2716)	Past-year probable AUD (n = 424)			Past-year probable AUD versus no probable AUD
	Raw frequency (weighted %)	Raw frequency (weighted %)	Wald χ^2 (d.f.)	P	Adjusted odds ratio (95% CI)
Male sex	2419 (89.9%)	400 (94.2%)	8.23(1)	0.004	2.70 (1.77–4.14)***
Non-Caucasian race	442 (22.8%)	71 (28.4%)	6.62(1)	0.010	1.10 (0.87–1.40)
Married or living with partner	2151 (76.4%)	318 (70.0%)	8.83(1)	0.003	0.74 (0.59–0.92)*
Currently employed	1085 (39.1%)	195 (49.0%)	15.98(1)	<0.001	1.12 (0.88–1.41)
Annual household income (versus < \$30 000)			6.96(3)	0.073	–
\$30 000–59 999	882 (34.3%)	119 (25.5%)			
\$60 000–84 999	594 (20.7%)	96 (28.7%)			
>\$85 000	809 (22.8%)	141 (20.1%)			
Education level (\geq some college)	2311 (67.3%)	350 (64.3%)	1.66(1)	0.198	–
Military branch (army versus other)	1626 (61.9%)	246 (59.4%)	1.01(1)	0.314	–
Combat veteran	924 (34.2%)	172 (36.1%)	0.678(1)	0.410	–
Military enlistment (% drafted)	372 (12.7%)	54 (10.2%)	2.35(1)	0.126	–
VA health-care user	454 (19.0%)	77 (21.4%)	1.45(1)	0.229	–
Life-time PTSD	174 (7.5%)	37 (10.8%)	6.07(1)	0.014	1.06 (0.73–1.54)
Life-time major depressive disorder	422 (15.9%)	94 (24.2%)	19.28(1)	<0.001	1.41 (1.07–1.86)*
	Mean (SE)	Mean (SE)	t(d.f.)	P	
Age (years)	61.07 (.29)	55.92 (0.71)	6.89 (1)	<0.001	0.98 (0.97–0.99)***
Number of life-time traumas	3.38 (.05)	3.45 (0.13)	0.49 (1)	0.624	–

Means and percentages were calculated using post-stratification weights. Adjusted odds ratios are adjusted for variables in the table that demonstrated differences between alcohol use groups. * $P < 0.01$; *** $P < 0.001$. PTSD = post-traumatic stress disorder; CI = confidence interval.

the AUD is linked to elevated rates of psychiatric comorbidities [2,14,15,24,25]. While prospective studies of veteran samples would be useful in elucidating the causal relationship between AUD and suicidality, some researchers have suggested that a causal relationship exists [44] and may be driven by both proximal and distal risk factors [43,45]. Proximal risk factors include acute alcohol intoxication-related increases in psychological distress and aggressiveness, and distal factors include AUD and associated comorbid psychopathology and negative life events. It is often difficult to disentangle these risk factors [44,46], however, and mediators and moderators of the relation between AUD and suicidality may include personality traits including impulsivity [47,48], as well as socio-demographic factors such as older age [49], which may indicate a late-onset subtype of AUD associated with heightened negative affect and increased suicide risk. Whether causal or mediated by other factors, the strong associations between AUD and life-time suicide attempt and current suicidal ideation observed in the current study underscores the importance of AUD as contributing to suicidality risk in US military veterans. It also highlights the importance of screening and monitoring of suicidality in veterans with histories of AUD.

Results of this study also identified socio-demographic, military and psychosocial correlates of life-time and past-year probable AUD. Veterans who were unmarried and unpartnered had higher rates of past-year probable AUD. This is consistent with prior studies, which have found that married individuals drink less and have lower rates of AUD compared to those single or divorced individuals [50,51]. Explanations for this relationship include a shift of social networks toward redefining or re-establishing relationships with friends and family [52], as well as disapproval of substance use by the partner and fewer evenings socializing outside the home [53]. Marital distress predicts increased alcohol use [54], and spouses of alcoholics report lower marital satisfaction [38] as well as physical and emotional abuse [55], which can increase the likelihood of divorce/separation.

Greater cumulative trauma burden emerged as a significant correlate of life-time AUD. A probable explanation for this association is that it is mediated by trauma-related psychiatric disorders such as PTSD and major depressive disorder (MDD). Indeed, analyses of psychiatric comorbidities associated with AUD (Table 3) revealed fourfold greater rates of these disorders in veterans with life-time AUD relative to those without life-time AUD. Traumas that occur before [56], during [57] and after military service

[56] are associated with increased symptoms and likelihood of developing PTSD and MDD. Thus, the association between cumulative burden of life-time traumas and AUD risk is, at least in part, accounted for by comorbid trauma-related psychopathology. Traumatic and stressful life events may also exhaust future coping resources and increase vulnerability to subsequent negative experiences [58,59]. Research in veterans has shown that alcohol use may serve as a mechanism to cope with stress and negative affective states [60–62] which may, in turn, increase the likelihood of developing an AUD. Taken together, these findings suggest that comprehensive assessment of trauma histories, as well as monitoring and treatment of trauma-related psychopathology, may help mitigate risk for AUD in US veterans.

A life-time history of MDD was associated with an increased likelihood of past-year probable AUD. One possible explanation for this finding is the self-medication hypothesis [39], as subjective states of distress and suffering associated with MDD may increase the likelihood of self-medication with alcohol in attempt to alleviate these states. While prospective studies will be useful in ascertaining the directional association between MDD and AUD, these results suggest that assessment, monitoring and treatment of MDD may be helpful in mitigating risk for current AUD.

Methodological limitations of this study must be noted. First, AUD and psychiatric comorbidities were assessed using DSM-IV-based self-report measures rather than structured diagnostic interviews. Self-report measures may overestimate the prevalence of AUD and other psychiatric disorders compared to structured diagnostic interviews [63], and prevalence and correlates of AUD may differ if DSM-5-based instruments were to be employed. Nevertheless, we employed a more conservative AUDIT-C cut score of ≥ 5 [30,31] to reduce the number of false positives in our case definition of past-year probable AUD; however, this more conservative cut-off score may underestimate the burden of past-year probable AUD, particularly in certain subgroups of veterans (e.g. women). Secondly, the cross-sectional and retrospective nature of data collection precludes assessment of the temporal associations between AUD and psychiatric comorbidities; longitudinal studies will be useful in elucidating these associations. Thirdly, while the NHRVS surveyed a nationally representative sample of US veterans, the sample was comprised predominantly of older white men from the GfK Knowledge Networks survey panel who agreed to participate in this study. Thus, additional research is needed to evaluate psychiatric comorbidities and risk and protective factors for AUD in other general population samples, as well as subgroups of veterans who may be at elevated risk for AUD, such as younger male veterans. Thirdly, the results of some AUD comorbidity analyses should be

interpreted with caution due to relatively small sample sizes. For example, the total number of veterans with life-time drug use disorder was 386 and, of those, 60 did not have an AUD; thus, the large OR = 10.73 may be inflated due to the small sample size.

CONCLUSION

The results of this study suggest that a considerable percentage of US veterans—42.2%—have a life-time history of AUD, and that 14.8% screen positive for past-year probable AUD. They indicate further that AUD is associated with a substantially elevated burden of psychiatric comorbidities, suicidality and drug use disorder. Finally, results of this study suggest that younger age, male sex and history of MDD are independent risk correlates of current probable AUD. Future work will be useful in assessing the generalizability of these results using DSM-5-based structured interview measures of AUD and comorbid disorders; assessing risk prediction models that are unique to subpopulations of veterans at elevated risk for AUD (e.g. younger men); and evaluating the efficacy of prevention and treatment efforts that target risk factors for AUD that are unique to veterans.

Declaration of interests

None.

References

1. Volk R. J., Cantor S. B., Steinbauer J. R., Cass A. R. Alcohol use disorders, consumption patterns, and health-related quality of life of primary care patients. *Alcohol Clin Exp Res* 1997; **21**: 899–905.
2. Grant B. F., Stinson F. S., Dawson D. A., Chou S. P., Dufour M. C., Compton W. *et al.* Prevalence and co-occurrence of substance use disorders and independence mood and anxiety disorders: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry* 2004; **61**: 807–16.
3. Hasin D. S., Goodwin R. D., Stinson F. S., Grant B. F. The epidemiology of major depressive disorder: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry* 2005; **62**: 1097–6.
4. Chou S. P., Dawson D. A., Stinson F. S., Huang B., Pickering R. P., Zhou Y. *et al.* The prevalence of drinking and driving in the United States, 2001–2002: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Drug Alcohol Depend* 2006; **83**: 137–46.
5. Caetano R., Nelson S., Cunradi C. Intimate partner violence, dependence symptoms and social consequences of drinking among white, black and Hispanic couples in the United States. *Am J Addict* 2001; **10**: 60–9.
6. Lemoine P., Harousseau H., Borteyru J. P., Menuet J. C. Children of alcoholic parents—observed anomalies: discussion of 127 cases. *Ther Drug Monit* 2003; **25**: 132–6.

7. Bates M. E., Bowden S. C., Barry D. Neurocognitive impairment associated with alcohol use disorders: implications for treatment. *Exp Clin Psychopharmacol* 2002; **10**: 193–212.
8. Bazargan-Hejazi S., Bazargan M., Hardin E., Bing E. G. Alcohol use and adherence to prescribed therapy among under-served Latino and African-American patients using emergency department services. *Ethn Dis* 2005; **15**: 267–75.
9. Kamali M., Kelly B. D., Clarke M., Browne S., Gervin M., Kinsella A. *et al.* A prospective evaluation of adherence to medication in first episode of schizophrenia. *Eur Psychiatry* 2006; **21**: 29–33.
10. Tucker J. S., Burnam M. A., Sherbourne C. D., Jung F. Y., Gifford A. L. Substance abuse and mental health correlates of nonadherence to antiretroviral medications in a sample of patients with human immunodeficiency virus infection. *Am J Med* 2003; **114**: 573–80.
11. Harwood R., Fountain D., Livermore G. The Economic Costs of Alcohol and Drug Abuse in the United States, 1992. National Institute on Alcohol Abuse and Alcoholism and National Institute on Drug Abuse: Bethesda, MD; 1998.
12. Calhoun P. S., Elter J. R., Jones E. R., Kudler H., Straits-Troster K. Hazardous alcohol use and receipt of risk-reduction counseling among U.S. veterans of the wars in Iraq and Afghanistan. *J Clin Psychiatry* 2008; **69**: 1686–93.
13. Hasin D. S., Stinson F. S., Ogburn E., Grant B. F. Prevalence, correlates, disability, and comorbidity of DSM-IV alcohol abuse and dependence in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry* 2007; **64**: 830–42.
14. Regier D. A., Farmer M. E., Roe D. S., Locke B. Z., Keith S. J., Judd L. L. *et al.* Comorbidity of mental disorders with alcohol and other drug abuse. *JAMA* 1990; **264**: 2511–18.
15. Kessler R. C., Berglund P., Demler O., Jin R., Merikangas K. R., Walters E. E. Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the national comorbidity survey replication. *Arch Gen Psychiatry* 2005; **62**: 593–603.
16. United States Census, 2010. Available at: http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_10_1YR_S2101&prodType=table (accessed 17 April 2015).
17. Jones E., Fear N. T. Alcohol use and misuse within the military: a review. *Int Rev Psychiatry* 2011; **23**: 166–72.
18. Wagner T. H., Harris K. M., Federman B., Dai L., Luna Y., Humphreys K. Prevalence of substance use disorders among veterans and comparable nonveterans from the national survey on drug use and health. *Psychol Serv* 2007; **4**: 149–57.
19. Hankin C. S., Spiro A., Miller D. R., Kazis L. Mental disorders and mental health treatment among U.S. Department of Veterans Affairs outpatients: the Veterans Health Study. *Am J Psychiatry* 1999; **156**: 1924–30.
20. Hawkins E. J., Lapham G. T., Kivlahan D. R., Bradley K. A. Recognition and management of alcohol misuse in OEF/OIF and other veterans in the VA: a cross-sectional study. *Drug Alcohol Depend* 2010; **109**: 147–53.
21. Fulton J. J., Calhoun P. S., Wagner H. R., Schry A. R., Hair L. P., Feeling N. *et al.* The prevalence of posttraumatic stress disorder in Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) veterans: a meta-analysis. *J Anxiety Disord* 2015; **31**: 98–107.
22. Kessler R. C., Sonnega A., Bromet E., Hughes M., Nelson C. B. Posttraumatic stress disorder in the National Comorbidity Survey. *Arch Gen Psychiatry* 1995; **52**: 1048–60.
23. Pietrzak R. H., Goldstein R. B., Southwick S. M., Grant B. F. Prevalence and axis I comorbidity of full and partial posttraumatic stress disorder in the United States: results from wave 2 of the National Epidemiologic Survey on Alcohol and Related Conditions. *J Anxiety Disord* 2011; **25**: 465–5.
24. Debell E., Fear N. T., Head M., Batt-Rawden S., Greenberg N., Wessely S. *et al.* A systemic review of the comorbidity between PTSD and alcohol misuse. *Soc Psychiatry Psychiatr Epidemiol* 2014; **49**: 1401–25.
25. Lai H. M., Clearly M., Sitharthan T., Hunt G. E. Prevalence of comorbid substance use, anxiety and mood disorders in epidemiological surveys, 1990–2014: a systemic review and meta-analysis. *Drug Alcohol Depend* 2015; **154**: 1–13.
26. Kelsall H. L., Wijesinghe M. S., Creamer M. C., McKenzie D. P., Forbes A. B., Page M. J. *et al.* Alcohol use and substance use disorders in Gulf War, Afghanistan, and Iraq War veterans compared with nondeployed military personnel. *Epidemiol Rev* 2015; **37**: 38–54.
27. Seal K. H., Cohen G., Waldrop A., Cohen B. E., Meguen S., Ren L. Substance use disorders in Iraq and Afghanistan veterans in VA healthcare, 2001–2010: implications for screening, diagnosis and treatment. *Drug Alcohol Depend* 2011; **116**: 93–101.
28. Wisco B. E., Marx B. P., Wolf E. J., Miller M. W., Southwick S. M., Pietrzak R. H. Posttraumatic stress disorder in the US veteran population: results from the National Health and Resilience in Veterans Study. *J Clin Psychiatry* 2014; **75**: 1338–46.
29. Sheehan D. V., Lecrubier Y., Sheehan K. H., Amorim P., Janavs J., Weiller E. *et al.* The Mini-International Neuropsychiatric Interview (M.I.N.I.): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *J Clin Psychiatry* 1998; **59**: 22–33.
30. Rumpf H., Hapke U., Meyer C., John U. Screening for alcohol use disorders and at-risk drinking in the general population: psychometric performance of three questionnaires. *Alcohol Alcohol* 2002; **37**: 261–8.
31. Dawson D. A., Grant B. F., Stinson F. S. The AUDIT-C: screening for alcohol use disorders and risk drinking in the presence of other psychiatric disorders. *Compr Psychiatry* 2005; **46**: 405–16.
32. Rosso G. L., Montomoli C., Candura S. M. AUDIT-C score and its association with risky behaviors among professional drivers. *Int J Drug Policy* 2016; **28**: 128–32.
33. Levola J., Aalto M. Screening for at-risk drinking in a population reporting symptoms of depression: a validation of the AUDIT, AUDIT-C and AUDIT-3. *Alcohol Clin Res* 2015; **39**: 1186–92.
34. Carlson E. B., Smith S. R., Palmieri P. A., Dalenberg C., Ruzek J. I., Kimerling R. *et al.* Development and validation of a brief self-report measure of trauma exposure: the Trauma History Screen. *Psychol Assess* 2011; **23**: 463–77.
35. Heatherton T. F., Kozlowski L. T., Frecker R. C., Fagerstrom K. O. The Fagerstrom test for nicotine dependence: a revision of the Fagerstrom tolerance questionnaire. *Br J Addict* 1991; **86**: 1119–27.
36. Weathers, F., Litz, B., Herman, D., Huska, J., Keane, T., editors. The PTSD Checklist (PCL): Reliability, Validity, and Diagnostic Utility. Annual Convention of the International Society for Traumatic Stress Studies, San Antonio, TX; 1993.
37. Kroenke K., Spitzer R. L., Williams J. B., Lowe B. An ultra-brief screening scale for anxiety and depression: the PHQ-4. *Psychosomatics* 2009; **50**: 613–21.

38. Whisman M. A., Sheldon C. T. Psychiatric disorders and dissatisfaction with social relationships: does type of relationship matter? *J Abnorm Psychol* 2000; **109**: 803–8.
39. Bolton J. M., Robinson J., Sareen J. Self-medication of mood disorders with alcohol and drugs in the National Epidemiologic Survey on Alcohol and Related Conditions. *J Affect Disord* 2009; **115**: 367–75.
40. American Psychiatric Association (AMA) Diagnostic and Statistical Manual of Mental Disorders, 4th, text rev. edn. Washington, DC: AMA; 2000.
41. Naimi T. S., Brewer R. D., Mokdad A., Denny C., Serdula M. K., Marks J. S. Binge drinking among US adults. *JAMA* 2003; **289**: 70–5.
42. Winograd R. P., Littlefield A. K., Sher K. J. Do people who 'mature out' of drinking see themselves as more mature? *Alcohol Clin Exp Res* 2012; **36**: 1212–18.
43. Huffard M. R. Alcohol and suicidal behavior. *Clin Psychol Rev* 2001; **21**: 797–811.
44. Borges G., Walters E. E., Kessler R. C. Associations of substance use, abuse, and dependence with subsequent suicidal behavior. *Am J Epidemiol* 2000; **151**: 781–9.
45. Hughes J. R. Smoking and suicide: a brief overview. *Drug Alcohol Depend* 2008; **98**: 169–78.
46. Borges G., Cherpitel C., MacDonald S., Giesbrecht N., Stockwell T., Wilcox H. A case-cross-over study of acute alcohol use and suicide attempt. *J Stud Alcohol* 2004; **65**: 708–14.
47. Conner K. R., Duberstein P. R. Predisposing and precipitating factors for suicide among alcoholics: empirical review and conceptual integration. *Alcohol Clin Exp Res* 2004; **28**: 6S–17.
48. Gonzalez V. M., Bradizza C. M., Collins R. L. Drinking to cope as a statistical mediator in the relationship between suicidal ideation and alcohol outcomes among underage college drinkers. *Psychol Addict Behav* 2009; **23**: 443–51.
49. Conner K. R., Beautrais A. L., Conwell Y. Moderators of the relationship between alcohol dependence and suicide and medically serious suicide attempts: analyses of Canterbury Suicide Project Data. *Alcohol Clin Exp Res* 2003; **27**: 1556–61.
50. Chilcoat H. D., Breslau N. Alcohol disorders in young adulthood: Effects of transitions into adult roles. *J Health Soc Behav* 1996; **37**: 339–49.
51. Hilton M. E. The demographic distribution of drinking patterns in 1984. In: Clark W. B., Hilton M. E., editors. *Alcohol in America: Drinking Practices and Problems*. Albany, NY: SUNY Press; 1991, pp. 73–86.
52. McGoldrick M., Carter E. A. The family life cycle. In: Walsh E., editor., editor. *Normal Family Processes*. New York: Gardner Press; 1982, pp. 167–95.
53. Bachman J. G., O'Malley P. M., Schulenberg J. E., Johnston L. D., Bryant A. L., Merline A. C. The Decline of Substance Use in Young Adulthood: Changes in Social Activities, Roles and Beliefs. Laurence Erlbaum Associates: Mahwah, NJ; 2002.
54. Dawson D. A., Grant B. F., Chou S. P., Stinson F. S. The impact of partner alcohol problems on women's physical and mental health. *J Stud Alcohol Drugs* 2007; **68**: 66–75.
55. Leonard K. E., Das Eiden R. D. Husbands' and wives' drinking: unilateral or bilateral influences among newlyweds in a general population sample. *J Stud Alcohol* 1999; **13**: 130–8.
56. Clancy C., Graybeal A., Tompson W., Badgett K., Feldman M., Calhoun P. et al. Lifetime trauma exposure in veterans with military-related posttraumatic stress disorder: association with current symptomatology. *J Clin Psychiatr* 2006; **67**: 1346–53.
57. Jacobson I. G., Ryan M. A., Hooper T. I., Smith T. C., Amoroso P. J., Boyko E. et al. Alcohol use and alcohol-related problems before and after military combat deployment. *JAMA* 2008; **300**: 663–75.
58. Hobfoll S. E. Conservation of resources: a new attempt at conceptualizing stress. *Am Psychol* 1989; **44**: 513–24.
59. Holmes T., Masuda M. Life change and illness susceptibility. In: Dohrenwend B., Dohrenwend B. P., editors. *Stressful Life Events: Their Nature and Effects*. Oxford, UK: Wiley; 1974, pp. 45–63.
60. Kehle S. M., Reddy M. K., Ferrier-Auerback A. G., Erbes C. R., Arbisi P. A., Polusny M. A. Psychiatric diagnoses, comorbidity and functioning in national Guard troops deployed to Iraq. *J Psychiatr Res* 2011; **45**: 126–32.
61. Dixon L. J., Leen-Feldner E. W., Ham L. S., Feldner M. T., Lewis S. F. Alcohol use motives among traumatic event-exposed, treatment-seeking adolescents: associations with posttraumatic stress. *Addict Behav* 2009; **34**: 1065–8.
62. Ullman S., Townsend S., Starzynski L., Long L. Correlates of comorbid PTSD and polysubstance use in sexual assault victims. *Violence Vict* 2006; **21**: 725–43.
63. Bradley K. A., DeBenedetti A. F., Volk R. J., Williams E. C., Frank D., Kivlahan D. R. AUDIT-C as a brief screen for alcohol misuse in primary care. *Alcohol Clin Exp Res* 2007; **31**: 1208–17.