Journal of Affective Disorders 283 (2021) 84–93

Contents lists available at ScienceDirect

Journal of Affective Disorders

journal homepage: www.elsevier.com/locate/jad

Symptoms of depression, anxiety, and post-traumatic stress disorder and their relationship to health-related behaviors in over 12,000 US military personnel: Bi-directional associations

Adela Hruby [a,b,c], Harris R. Lieberman [a], Tracey J. Smith [a,*]

[a] Military Nutrition Division, US Army Research Institute of Environmental Medicine, Natick, MA, United States
[b] Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc., Bethesda, MD, United States
[c] Tufts University School of Medicine, Department of Public Health and Community Medicine, and Tufts University Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy, Boston, MA, United States

ARTICLE INFO

Keywords:
Army
Navy
Air Force
Marine Corps
Coast Guard
Mental health
Psychological disorders
Exercise
Sleep
Survey

ABSTRACT

Background Military personnel are at greater risk of psychological disorders and related symptoms than civilians. Limited participation in health-promoting behaviors may increase presence of these disorders. Alternatively, these symptoms may limit engagement in health-promoting behaviors.

Methods Self-reported data from the 2015 Department of Defense Health Related Behaviors Survey were used to assess bi-directional relationships between health-related behaviors (obesity, physical activity [PA], alcohol, smoking, sleep) and self-reported psychological disorders (generalized anxiety disorder [GAD], depression, post-traumatic disorder [PTSD]) in U.S. military personnel.

Outcomes Among 12 708 respondents (14.7% female; 28.2% 17−24 y; 13.7% obese), self-reported depression was reported by 9.2%, GAD by 13.9%, and PTSD by 8.2%. Obesity and short sleep were associated with self-reported depression, GAD, and PTSD; current smoking was associated with higher odds of GAD; higher levels of vigorous PA were associated with lower odds of GAD; higher levels of moderate PA associated with lower odds of PTSD; and higher alcohol intake associated with higher odds of depression and PTSD. Self-reported depression, GAD, and PTSD were associated with higher odds of short sleep, obesity, and low levels of PA.

Interpretation Obesity, short sleep, and limited engagement in health-promoting behaviors are associated with higher likelihood of self-reported psychological disorders, and vice-versa. Encouraging and improving health-promoting behaviors may contribute to positive mental health in military personnel.

Introduction

Given unique occupational demands, active duty military personnel are frequently exposed to extreme stress including harsh environmental conditions and combat (Redmond et al., 2015, Adler and Castro, 2013, Castro, 2014). Sources of stress in this population may additionally include unexpected mobilizations and deployments, participation in humanitarian and disaster relief missions, and unpredictable duty assignments (Pflanz and Sonnek, 2002, Kelly and Vogt, 2009, Brooks and Greenberg, 2018). More typical stressors may also be present, such as low job satisfaction, family-related stress, and poor quality of professional relationships (Brooks and Greenberg, 2018). In part because of these demands, military personnel have been reported to be at greater risk than civilians of common psychological disorders, such as depression, anxiety, and post-traumatic stress disorder (PTSD) (Gadermann et al., 2012, Cohen et al., 2015, Kessler et al., 2014, Stahlman and Oetting, 2018, Kessler et al., 2005, Kessler et al., 2005, Brody et al., 2018, Russell et al., 2015). For example, an estimated 8.1% of U.S.

Abbreviations: AUDIT-C, Alcohol Use Disorders Identification Test for Consumption; BMI, Body mass index; CI, Confidence interval; GAD, Generalized anxiety disorder; GAD-7, Generalized Anxiety Disorder 7-Item Scale; HRBS, Health Related Behaviors Survey; hr, Hours; MPA, Moderate intensity physical activity; min, Minutes; OR, Odds ratio; PHQ-9, Patient Health Questionnaire-9; PTSD, Post-traumatic stress disorder; PCL-C, Post-Traumatic Stress Disorder Checklist–Civilian; VPA, Vigorous intensity physical activity; wk, Week; y, Year.

* Corresponding author at: Military Nutrition Division, US Army Research Institute of Environmental Medicine, 10 General Greene Avenue, Natick, MA01760, United States

E-mail address: tracey.smith10.civ@mail.mil (T.J. Smith).

https://doi.org/10.1016/j.jad.2021.01.029
Received 1 June 2020; Received in revised form 29 December 2020; Accepted 10 January 2021
Available online 15 January 2021

adults age 20 y and older reported depression in a given 2-week period between 2013 and 2016 (Brody et al., 2018). Among U.S. military personnel, prevalence estimates for depression over the same period range from 5.7% among those never deployed to 13.1% among those previously deployed based on several meta-analyses (Gadermann et al., 2012, Cohen et al., 2015).

Despite higher rates of these psychological disorders in military personnel, they are upon recruitment, broadly speaking, a healthier subset of the general population due to Service entry requirements. Military personnel may also benefit from factors that mitigate the effects of some stressors, such as specialized training in the management of stress, survival techniques, and coping strategies, as well as the camaraderie, structure, and ethos of the military, required exercise, and physical training (Castro, 2014). Research on relationships between health behaviors (e.g., exercise) and psychological disorders indicates that involvement in health-promoting behaviors may contribute to better mental health symptomology (Smith et al., 2014, Speed et al., 2019, Chekroud et al., 2018, Schuch et al., 2018, Azevedo Da Silva et al., 2012, Biddle et al., 2019, Alvaro et al., 2013, Li et al., 2018, Osgood et al., 2019, Gehrman et al., 2013, Rush et al., 2016, Stubbs et al., 2017, Smith et al., 2015, Kivimaki et al., 2009, Hall et al., 2015, Scott et al., 2008, Doré et al., 2016, Saneei et al., 2016). Prior literature has also pointed to a bidirectional relationship, that is, symptoms of poor psychological health are associated with low participation in health-related behaviors, thus leading to a cycle of poor adherence to health-related behaviors and worsening symptomology (Kivimaki et al., 2009, Hall et al., 2015, Hoerster et al., 2019, van den Berk-Clark et al., 2018, LeardMann et al., 2015, Pan et al., 2012).

In the present study, we tested hypotheses about cross-sectional, bidirectional associations between self-reported health-related behaviors (maintaining a healthy weight, exercising, not smoking, moderating alcohol intake, and adequate sleep) and psychological disorders (self-reported GAD, depression, and PTSD) in active duty military personnel who responded to the Department of Defense's 2015 Health Related Behaviors Survey (HRBS) (Meadows et al., 2018). While the HRBS and other instruments are designed to address broad domains of psychological function, they do not allow for questioning occupation-specific distress versus general or personality-associated distress. Nonetheless, investigating these relationships may inform improved responses to these phenomena that significantly impact military readiness (e.g., disability, absenteeism, and attrition), that result from the presence and interaction of these conditions (Hoge et al., 2005, Dall et al., 2007, White et al., 2016). We hypothesized that poor adherence to health-related behaviors would be associated with higher likelihood of psychological disorders, and those with self-reported psychological disorders would report lower adherence to health-related behaviors.

Methods

The full details of the 2015 HRBS design, sampling strategies, questionnaires, and primary results have been published (Meadows et al., 2018). Informed consent was required and obtained at the beginning of the survey, and responses were voluntary and anonymous. For the present secondary analyses, a de-identified public use data file was obtained from the Defense Health Agency. Because the data were previously collected and de-identified, the protocol for the present study was deemed exempt (not human subject research) by both the U.S. Army Research Institute of Environmental Medicine (Natick, MA) and the Office of the Assistant Secretary of Defense for Health Affairs/TRICARE Management Activity, Human Research Protection Office.

Of 1,374,590 service members in the eligible population, 201 990 were invited to participate in the anonymous HRBS online survey. The overall response rate was 8.6%; there were 16 699 usable, eligible responses (Meadows et al., 2018). For the present analyses, only respondents with complete, relevant data were included (N=12 708). Comparisons of characteristics between included and excluded participants using unweighted*t* tests or *chi*-squared tests are available in Supplemental Table 1.

All variables described below are derived from the questions and possible response sets in the 2015 HRBS questionnaire (Meadows et al., 2018).

Health behaviors

Seven health-related behaviors were assessed: maintaining a healthy weight, moderate intensity physical activity (MPA), vigorous intensity physical activity (VPA), strength training, cigarette smoking, alcohol intake, and sleep. BMI (kg/m^2) was pre-calculated in the publicly available data from reported height and weight and classified as <25.0, 25–29.9, and ≥30.0 kg/m^2. Respondents were asked about the frequency ("about every day" to "not at all in the past 30 days") and duration ("60 or more minutes" to "never in the past month") in unique questions addressing MPA, VPA, and strength training. Responses were recoded into: MPA: <150, 150–299, ≥300 min/wk; VPA: <75, 75–149, ≥150 min/wk; and strength training: <1, 1–2, ≥3 d/wk. Current smoking (yes; no) was defined as smoking any cigarette in the past 30 days based on questions about history and frequency of current smoking. Alcohol intake (drinks/wk) was coded based on the average frequency ("Never" to "Four or more times a week") and amount of alcohol consumed on a drinking day ("1 or 2" to "10 or more"). In sensitivity analyses, alcohol intake was also categorized as abstainer (<12 lifetime drinks), former (≥12 lifetime drinks but 0 days of drinking in the last 12 months), infrequent/light (≤3 drinks/wk in the past year), moderate (>3–≤14 drinks/wk for males, and >3–≤7 drinks/wk for females in the past year), and heavy (>14 drinks/wk for males, and >7 drinks/wk for females in the past year) (Centers for Disease Control and Prevention and National Center for Health Statistics, 2018). Participants reported hours of sleep in a typical 24-hr period on weekdays and weekend days. Hours were summed to a theoretical week and averaged for typical sleep (hrs/d). In sensitivity analyses, sleep was categorized as short (<7), normal (≥7–≤9), and long (>9 hrs/d) (Watson et al., 2015).

Self-reported psychological disorders

Self-reported symptoms of three psychological disorders were assessed in the same military population: GAD, depression, and PTSD (all yes; no). Self-reported GAD was assessed using the Generalized Anxiety Disorder 7-Item Scale (GAD-7) (Spitzer et al., 2006). The GAD-7 assesses how often in the last 2 weeks (ranging from "not at all" [score=0] to "nearly every day" [score=3]) participants experienced one or more of seven symptoms (e.g., worrying, trouble relaxing, restlessness) which are key features of the Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV diagnostic criteria (Spitzer et al., 2006). The score range is 0–21. Respondents with sum scores ≥10 (moderate) were categorized as having GAD (Meadows et al., 2018).

Self-reported depression was assessed by the Patient Health Questionnaire-9 (PHQ-9), a brief depression screener that asks participants on how many days in the past 2 weeks (ranging from "not at all" [score=0] to "nearly every day" [score=3]) they experienced depressive symptoms (e.g., feeling hopeless, having trouble falling asleep, disinterestedness) (Kroenke et al., 2001). Symptoms captured align with the nine criteria for depression from the DSM-IV. The score range is 0–27. Respondents with summed scores ≥15 (moderate to severe symptomology) were categorized as having depression (Meadows et al., 2018, Kroenke et al., 2001).

Self-reported PTSD was assessed using the PTSD Checklist–Civilian (PCL-C) scale which includes 17 items corresponding to key PTSD symptoms (Weathers et al., 1993). The PCL-C was used because it assesses PTSD symptoms related to all psychological traumas, not just those directly related to military service (Meadows et al., 2018). Participants were asked how much in the past 30 days (ranging from "not at all" [score=1] to "extremely" [score=5]) they had been bothered by

these symptoms. The score range is 17–85. Respondents with summed scores ≥50 (severe) were categorized as having PTSD (Meadows et al., 2018).

Sociodemographic variables and covariates

Sociodemographic variables included sex, age, minority status, education, service branch, pay grade, and marital status. Most variables were pre-grouped in the publicly available dataset to preserve participant anonymity. For example, respondents were asked to report age, which was pre-grouped into categories: 17–24; 25–34; 35–44; ≥45 y. Respondents were also asked if they had ever been told by a doctor that they had any of nine medical conditions: high blood pressure, high blood sugar or diabetes, high cholesterol, respiratory problems, arthritis, heart disease or other heart condition, ulcer, skin cancer, or another type of cancer. Affirmative responses were summed for a count of total medical diagnoses.

Several addictive behaviors were included as covariates: problematic drinking, illicit drug use, and prescription drug misuse. The Alcohol Use Disorders Identification Test for Consumption (AUDIT-C) was used to define self-reported hazardous drinking or an alcohol use disorder (Meadows et al., 2018, Bush et al., 1998, Bradley et al., 2007). Binge drinking was defined as any response >1 d in response to the question, "In the past 30 days, on how many days did you have 5 (male)/4 (female) or more drinks on the same occasion?" Problematic drinking (yes; no) was defined as binge drinking on more than one occasion in the past month or a high AUDIT-C. Illicit drug use (yes; no) was defined as any reported use in the past year of one or more of 12 illicit substances, including marijuana. Misuse of prescription drugs (yes; no) was defined as any reported use without a prescription in the past year of stimulants, attention enhancers, sedatives, tranquilizers, muscle relaxers, barbiturates, pain relievers, anabolic steroids, or anti-depressants (Meadows et al., 2018).

Deployment history and combat exposure, although assessed in the 2015 HRBS, was not available in the publicly released data set.

Statistical analysis

All data and analyses were cross-sectional and included strata, clusters, and weights consistent with analyzing complex survey data. Characteristics (weighted least square means [SE] and N [weighted %]) of those participants with and without each psychological outcome were compared using least square adjusted means for continuous characteristics and Rao-Scott *chi*-squared tests for categorical characteristics.

To assess associations between behaviors as exposures and self-reported psychological disorders as outcomes (Supplemental Figure 1), we estimated adjusted odds ratios (OR) and 95% confidence intervals (CI) of reporting each psychological disorder using logistic regression, as follows: model 1 included all behaviors simultaneously, and age, sex, minority status, and number of medical diagnoses (demographic model); model 2 adjusted for model 1 and marital status, education, service branch, and pay grade (social model); model 3 adjusted for model 2 plus problematic alcohol use, illicit drug use, and prescription drug misuse (mediating behavior model). A fourth model (psychological comorbidity model) further adjusted for the two psychological disorders that were not the outcome of interest in the specific model (e.g., where depression was the outcome of interest in the specific model, model 4 adjusted for GAD and PTSD).

To assess associations between disorders as exposures, with behaviors as outcomes (Supplemental Figure 2), we estimated ORs (95%CIs) using logistic regression for behavior variables defined categorically, or least square means (SE) using linear regression for behavior variables defined continuously. Model 1 included age, sex, minority status, number of medical diagnoses, marital status, education, service branch, and pay grade (sociodemographic model); model 2 additionally included all behaviors that were not the outcome of interest in the specific model (behavioral model); model 3 additionally adjusted for problematic alcohol use, illicit drug use, and prescription drug misuse (mediating behavior model). Model 4 (psychological comorbidity model) further adjusted for the two psychological disorders that were not the exposure of interest in the specific model.

The survey procedures available in SAS (v9.4, Cary, North Carolina) for complex survey design were used. Statistical significance was set at a two-tailed α=0.05.

Role of the funding source: This work was supported by the US Army Medical Research and Development Command. The study sponsor had no role in the study design; in the collection, analysis, or interpretation of data; in the writing of the present report; or in the decision to submit the paper for publication.

Results

Of 12 708 eligible respondents with relevant data, 14.7% were female and 28.2% were age 17−24 y (Table 1). Of the behaviors, 13.7% were classified as obese; 36.5% reported <150 min/wk MPA; 49.7% reported <75 min/wk VPA; 14.2% were current smokers. Average sleep duration was 6.5 hr/night while alcohol intake was 3.8 drinks/wk. Of self-reported psychological disorders, 9.2%, 13.9%, and 8.2% scored as having depression, GAD, or PTSD, respectively (Table 1). In addition, 83% reported no disorder, while 4.8% endorsed symptomology of all three (Supplemental Table 2). Age, sex, and minority status distributions were not statistically different by self-reported psychological disorder, but service branch, pay grade, and education were significantly associated with presence of a disorder (Table 1). Self-reported GAD was statistically significantly more prevalent in not married respondents (12.0%) than married respondents (8.8%) (Table 1). Respondents who self-reported symptomology of either PTSD, GAD, or depression reported higher alcohol intake, fewer hours of sleep, higher presence of obesity and smoking, less physical activity, and more problematic alcohol use, illicit drug use, and misuse of prescription drugs, compared to those who did not report these conditions (Table1).

Results of adjusted logistic regressions of health behaviors as exposures with self-reported psychological disorders as outcomes (model 3) indicated that having obesity versus normal weight was associated with 86%, 50%, and 23% higher odds of depression, GAD, and PTSD, respectively (Table2). Further adjusting for psychological comorbidity (model 4) reversed the odds of PTSD. Moderate (150–299 min/wk) and high (≥300 min/wk) levels of MPA vs. low MPA (<150 min/wk) were generally associated with lower odds of each psychological disorder, particularly PTSD. High (≥150 min/wk) levels of VPA vs. low VPA (<75 min/wk) were generally associated with lower odds of each psychological disorder, particularly GAD. Moderate (1–2 d/wk), but not high (≥3 d/wk) levels of strength training, vs. low strength training (<1 d/wk) was associated with lower odds of depression and GAD, but not PTSD. Longer sleep, when modeled continuously, was associated with 16%, 24%, and 32% lower odds per hr/d of depression, GAD, and PTSD, respectively. When modeled categorically, short sleep (<7 hrs/d), but not long sleep (>9 hrs/d), was significantly associated with higher odds of each psychological disorder compared with normal sleep (≥7–≤9 hrs/d) (Supplemental Table3). Higher alcohol intake was associated with 3% and 2% higher odds for every additional drink per week of depression and PTSD, respectively (Table 2). When modeled categorically, being a heavy drinker vs. infrequent/light drinker was associated with higher odds of depression and GAD, as well as PTSD (but not after adjusting for depression and GAD). Other levels of drinking were variably associated with odds of psychological outcomes (Supplemental Table4). Current smoking vs. non-smoking was associated with 71% higher odds of GAD. Of problematic behaviors, problematic alcohol use was associated with lower odds of depression, and higher odds of GAD, after adjusting for psychological comorbidities (Table 2). Illicit drug use was associated with higher odds of each condition before adjusting for psychological comorbidities, and remained significant only for PTSD

Table 1
Characteristics of 12 708 respondents to the 2015 Health Related Behaviors Survey in US military personnel, by total sample and self-reported psychological disorder.*

		Total Sample	PTSD			GAD			Depression		
			No	Yes		No	Yes		No	Yes	
N		**12,708**	**11,974**	**734**		**11,455**	**1253**		**11,974**	**734**	
Characteristics	**Category**	**Mean (SEM) or N (wgt. %)**	**Mean (SEM) or N (wgt. %)**	**Mean (SEM) or N (wgt. %)**	***P* value**	**Mean (SEM) or N (wgt. %)**	**Mean (SEM) or N (wgt. %)**	***P* value**	**Mean (SEM) or N (wgt. %)**	**Mean (SEM) or N (wgt. %)**	***P* value**
Medical diagnoses ever	—	0.7 (0.0)	0.6 (0.0)	1.4 (0.1)	<.0001	0.6 (0.0)	1.1 (0.1)	0.0003	0.6 (0.0)	1.3 (0.1)	0.0002
Sleep, hrs/night	—	6.5 (0.1)	6.6 (0.0)	5.6 (0.1)	<.0001	6.7 (0.1)	5.8 (0.1)	<.0001	6.6 (0.1)	5.8 (0.0)	<.0001
Alcohol, drinks/wk	—	3.8 (0.4)	3.5 (0.3)	7.8 (2.0)	0.04	3.4 (0.3)	6.6 (1.2)	0.006	3.4 (0.2)	7.7 (2.0)	0.04
PHQ-9 Depression Scale	—	4.9 (0.3)	3.9 (0.2)	16.4 (0.3)	<.0001	3.3 (0.2)	15.0 (0.4)	<.0001	3.4 (0.2)	19.4 (0.3)	<.0001
GAD-7 Anxiety Scale	—	3.8 (0.3)	2.8 (0.2)	14.5 (0.6)	<.0001	2.0 (0.1)	14.8 (0.2)	<.0001	2.7 (0.2)	14.3 (0.2)	<.0001
PCL Scale for PTSD	—	26.1 (0.6)	22.9 (0.3)	62.8 (1.2)	<.0001	22.3 (0.3)	49.8 (1.7)	<.0001	23.5 (0.4)	52.5 (1.4)	<.0001
Age group, y	17–24	1448 (28.2)	1361 (28.5)	87 (24.3)	0.78	1244 (27.3)	204 (33.8)	0.10	1328 (27.4)	120 (36.0)	0.19
	25–34	4611 (41.7)	4378 (41.6)	233 (42.5)		4160 (41.9)	451 (40.6)		4349 (42.0)	262 (38.5)	
	35–44	4682 (23.0)	4394 (22.9)	288 (23.9)		4239 (23.6)	443 (19.5)		4434 (23.5)	248 (18.0)	
	≥45	1967 (7.1)	1841 (6.9)	126 (9.3)		1812 (7.3)	155 (6.1)		1863 (7.1)	104 (7.5)	
Sex	Male	8068 (85.3)	7650 (85.4)	418 (83.4)	0.67	7387 (85.9)	681 (81.4)	0.38	7661 (85.4)	407 (83.4)	0.70
	Female	4640 (14.7)	4324 (14.6)	316 (16.6)		4068 (14.1)	572 (18.6)		4313 (14.6)	327 (16.6)	
Service	Army	2407 (38.0)	2168 (37.0)	239 (49.8)	<.0001	2068 (37.4)	339 (41.7)	<.0001	2185 (37.4)	222 (44.4)	<.0001
	Navy	2309 (22.9)	2160 (22.8)	149 (24.6)		2049 (22.4)	260 (26.1)		2154 (22.7)	155 (24.6)	
	Marine Corps	1666 (14.1)	1537 (14.0)	129 (15.8)		1457 (13.1)	209 (20.6)		1544 (13.4)	122 (21.5)	
	Air Force	2977 (21.6)	2884 (22.8)	93 (8.2)		2802 (23.5)	175 (9.7)		2885 (23.0)	92 (8.0)	
	Coast Guard	3349 (3.3)	3225 (3.5)	124 (1.6)		3079 (3.5)	270 (1.9)		3206 (3.5)	143 (1.6)	
Pay grade	Enlisted	7422 (82.0)	6850 (81.1)	572 (91.6)	<.0001	6476 (80.3)	946 (92.4)	<.0001	6867 (80.9)	555 (92.5)	<.0001
	Officer	5286 (18.0)	5124 (18.9)	162 (8.4)		4979 (19.7)	307 (7.5)		5107 (19.1)	179 (7.5)	
Marital status	Married	8537 (57.1)	8117 (57.1)	420 (57.4)	0.93	7785 (57.8)	752 (53.1)	0.02	8135 (57.6)	402 (52.5)	0.34
	Not married	4171 (42.9)	3857 (42.9)	314 (42.6)		3670 (42.2)	501 (46.9)		3839 (42.4)	332 (47.6)	
Minority	Non-minority	8567 (60.8)	8159 (61.2)	408 (56.6)	0.79	7798 (60.8)	769 (60.8)	0.99	8126 (60.9)	441 (60.2)	0.82
	Minority	4141 (39.2)	3815 (38.8)	326 (43.4)		3657 (39.2)	484 (39.2)		3848 (39.1)	293 (39.8)	
Education	High school	1197 (20.2)	1104 (20.1)	93 (20.8)	0.11	1020 (19.5)	177 (24.2)	0.0002	1095 (19.8)	102 (23.7)	0.0004
	Some college	4449 (46.8)	4103 (46.0)	346 (56.3)		3870 (45.5)	579 (55.0)		4106 (45.7)	343 (58.3)	
	College	7062 (33.0)	6767 (33.9)	295 (22.9)		6565 (35.0)	497 (20.7)		6773 (34.5)	289 (18.0)	
BMI category, kg/m^2	<18.5	72 (0.5)	65 (0.5)	7 (0.4)	0.0002	64 (0.4)	8 (0.7)	<.0001	67 (0.5)	5 (0.3)	<.0001
	18.5–24.9	4484 (33.4)	4270 (34.1)	214 (25.8)		4082 (34.1)	402 (28.9)		4269 (34.2)	215 (25.3)	
	25–29.9	6540 (52.4)	6171 (52.5)	369 (51.5)		5906 (52.8)	634 (50.3)		6173 (52.6)	367 (51.1)	
	≥30	1612 (13.7)	1468 (12.9)	144 (22.2)		1403 (12.6)	209 (20.0)		1465 (12.7)	147 (23.3)	
Sleep, hrs/night	<7	7280 (61.4)	6660 (59.3)	620 (85.6)	<.0001	6302 (58.5)	978 (79.3)	<.0001	6697 (59.4)	583 (81.5)	<.0001
	7–≤9	5302 (37.4)	5199 (39.6)	103 (12.6)		5047 (40.3)	255 (19.3)		5168 (39.5)	134 (16.6)	
	>9	126 (1.2)	115 (1.1)	11 (1.8)		106 (1.2)	20 (1.4)		109 (1.1)	17 (2.0)	
MPA, min/wk	<150	5133 (36.5)	4774 (34.9)	359 (53.7)	<.0001	4531 (34.7)	602 (47.1)	<.0001	4752 (34.9)	381 (52.2)	<.0001
	150–299	5047 (39.1)	4799 (39.9)	248 (30.0)		4614 (40.2)	433 (32.4)		4822 (40.3)	225 (27.3)	
	≥300	2528 (24.5)	2401 (25.2)	127 (16.3)		2310 (25.1)	218 (20.5)		2400 (24.9)	128 (20.5)	
VPA, min/wk	<75	6939 (49.7)	6461 (48.2)	478 (65.9)	0.001	6146 (47.8)	793 (61.3)	<.0001	6449 (48.3)	490 (63.9)	<.0001
	75–149	1134 (8.7)	1087 (8.9)	47 (6.0)		1035 (8.8)	99 (7.7)		1083 (8.8)	51 (7.6)	
	≥150	4635 (41.6)	4426 (42.8)	209 (28.0)		4274 (43.3)	361 (31.0)		4442 (43.0)	193 (28.4)	
Strength training, d/wk	<1	4064 (29.6)	3734 (28.3)	330 (44.3)	<.0001	3507 (27.6)	557 (42.0)	<.0001	3696 (27.9)	368 (45.8)	<.0001
	1–2	3644 (25.0)	3483 (25.4)	161 (19.9)		3362 (26.0)	282 (18.8)		3494 (25.7)	150 (17.8)	
	≥3	5000 (45.5)	4757 (46.3)	243 (35.8)		4586 (46.5)	414 (39.2)		4784 (46.4)	216 (36.4)	
Current smoker	No	11,676 (85.8)	11,083 (86.8)	593 (73.9)	<.0001	10,633 (87.8)	1043 (73.3)	<.0001	11,074 (86.9)	602 (74.4)	0.001
	Yes	1032 (14.2)	891 (13.2)	141 (26.1)		822 (12.2)	210 (26.7)		900 (13.1)	132 (25.6)	
Drinking status	Abstainer	948 (12.3)	884 (12.5)	64 (9.5)	<.0001	862 (12.7)	86 (9.7)	<.0001	884 (12.4)	64 (11.0)	<.0001
	Former	1141 (9.6)	1041 (9.5)	100 (10.8)		985 (9.6)	156 (9.6)		1051 (9.5)	90 (10.5)	
	Infrequent/light	6755 (47.6)	6435 (48.4)	320 (38.0)		6194 (49.3)	561 (36.9)		6443 (48.8)	312 (35.6)	
	Moderate	2921 (22.4)	2790 (22.7)	131 (19.0)		2668 (22.1)	253 (24.3)		2790 (22.8)	131 (18.2)	
	Heavy	943 (8.2)	824 (6.9)	119 (22.7)		746 (6.3)	197 (19.6)		806 (6.5)	137 (24.7)	
Problematic alcohol use†	No	7214 (55.7)	6825 (56.7)	389 (43.9)	0.0001	6584 (57.9)	630 (42.0)	<.0001	6840 (56.8)	374 (44.7)	<.0001
	Yes	5494 (44.3)	5149 (43.3)	345 (56.1)		4871 (42.1)	623 (58.0)		5134 (43.2)	360 (55.3)	
Illicit drug use, last year	No	12,661 (99.1)	11940 (99.7)	721 (93.3)	<.0001	11421 (99.6)	1240 (96.2)	<.0001	11940 (99.5)	721 (95.0)	<.0001
	Yes	47 (0.9)	34 (0.3)	13 (6.7)		34 (0.4)	13 (3.8)		34 (0.4)	13 (5.0)	
	No			675 (92.4)	<.0001			<.0001		682 (92.6)	<.0001

(*continued on next page*)

Table 1 (*continued*)

		Total Sample	PTSD			GAD			Depression		
			No	Yes		No	Yes		No	Yes	
N		**12,708**	**11,974**	**734**		**11,455**	**1253**		**11,974**	**734**	
Characteristics	**Category**	**Mean (SEM) or N (wgt. %)**	**Mean (SEM) or N (wgt. %)**	**Mean (SEM) or N (wgt. %)**	***P* value**	**Mean (SEM) or N (wgt. %)**	**Mean (SEM) or N (wgt. %)**	***P* value**	**Mean (SEM) or N (wgt. %)**	**Mean (SEM) or N (wgt. %)**	***P* value**
Misuse prescription drugs		12249 (96.1)	11574 (96.4)			11075 (96.3)	1174 (94.3)		11567 (96.4)		
	Yes	459 (3.9)	400 (3.6)	59 (7.6)		380 (3.7)	79 (5.7)		407 (3.6)	52 (7.4)	
PTSD	No	11,974 (91.8)	–	–		11,275 (98.2)	699 (52.6)	<.0001	11,647 (96.7)	327 (43.7)	<.0001
	Yes	734 (8.2)	–	–		180 (1.8)	554 (47.4)		327 (3.3)	407 (56.3)	
GAD	No	11,455 (86.1)	11,275 (92.0)	180 (19.4)	<.0001	–	–		11,292 (92.7)	163 (20.9)	<.0001
	Yes	1253 (13.9)	699 (8.0)	554 (80.6)		–	–		682 (7.3)	571 (79.1)	
Depression	No	11,974 (90.8)	11,647 (95.6)	327 (36.7)	<.0001	11,292 (97.8)	682 (47.7)	<.0001	–	–	
	Yes	734 (9.2)	327 (4.4)	407 (63.3)		163 (2.2)	571 (52.3)		–	–	

Abbreviations: GAD, generalized anxiety disorder; GAD-7, Generalized Anxiety Disorder 7-Item Scale; MPA, moderate intensity physical activity; PHQ-9, Patient Health Questionnaire-9; PCL, PTSD Checklist-Civilian; PTSD, post-traumatic stress disorder; VPA, vigorous intensity physical activity.

[*] Continuous characteristics are presented as weighted mean (SEM); categorical characteristics as N (weighted %). *P* values for differences between least square means by psychological disorder for continuous variables, and Rao-Scott modified chi-square test for categorical variables.

[†] Any binge drinking past month or high AUDIT-C.

after adjustment. Misuse of prescription drugs, with and without adjusting for psychological comorbidities, was significant only for odds of depression (Table 2).

Results of logistic regressions of disorders as exposures, with health behaviors as outcomes, indicated that, prior to adjusting for psychological comorbidities, those with self-reported depression vs. those without had higher odds of low MPA and VPA, fewer days of strength training, obesity, and current smoking, as well as fewer hours of sleep (Table 3). After adjusting for psychological comorbidity, associations were attenuated to non-significance except for low strength training, obesity, and sleep. Similarly, those with self-reported GAD vs. those without had higher odds of low MPA and VPA, fewer days of strength training, obesity, and current smoking, and fewer hours of sleep and higher alcohol intake, prior to adjusting for psychological comorbidity. After adjustment, associations were again attenuated, but remained significant for obesity, smoking, and sleep. Those with self-reported PTSD vs. those without had higher odds of low MPA and VPA, fewer days of strength training, and fewer hours of sleep, prior to adjusting for psychological comorbidity. After adjustment, associations were attenuated, and remained significant only for sleep. In sensitivity analyses with sleep or alcohol intake modeled categorically, each psychological disorder was significantly associated with higher odds of short sleep in fully adjusted models (Supplemental Table 5); and those with any psychological disorder vs. those without had higher odds of being heavy vs. infrequent/light drinker, although associations for PTSD were attenuated in more fully adjusted models (Supplemental Table 6).

Discussion

We observed bidirectional associations between several health-related behaviors, most consistently sleep and obesity, and self-reported symptomology of psychological disorders. While exercise, smoking, and alcohol intake also showed bidirectional associations with psychological disorders, models that adjusted for comorbid psychological disorders appeared to identify behaviors that may be especially worthy of interventions designed to reduce the risk of a specific disorder. For example, current smoking was consistently bidirectionally associated across all models with GAD, but not with depression or PTSD after adjusting for GAD. Healthcare providers may thus be guided to specifically address smoking when individuals present with GAD.

Sleep

Fewer hours of sleep and short sleep were associated with higher odds of each condition, and conversely, those with self-reported disorders had higher odds of fewer hours of sleep, and higher odds of short sleep, even after adjusting for all other health-related behaviors and psychological comorbidities. These findings are consistent theoretically and in the context of prior literature. Diagnostic criteria for PTSD, GAD, and major depressive disorder include sleep disturbance (American Psychiatric Association, 2000, American Psychiatric Association, 2013), and sleep-related questions are components of the PCL-C and PHQ-9 assessment instruments, while “trouble relaxing” is a component of the GAD-7. Studies suggest short sleep duration, insomnia, and other sleep disturbance are potential risk factors for and consequences of poor mental health (Biddle et al., 2019, Alvaro et al., 2013, Li et al., 2018, Osgood et al., 2019, Gehrman et al., 2013). Interrelationships and etiological trajectories of sleep disturbance, anxiety, depression, and PTSD, are complex and comorbid (Li et al., 2018, Jansson-Fröjmark and Lindblom, 2008, Johnson et al., 2006, Jacobson and Newman, 2017). Whether anxiety etiologically precedes sleep disturbance and depression, the high prevalence of anxiety, depression, and short sleep in this population may signal a future mental health burden. For example, military personnel with insomnia or short sleep, and subsequent trauma exposure, were at higher risk of developing PTSD (Gehrman et al., 2013), and sleep disturbance in the context of PTSD may alter other health-related behaviors, such as physical activity and substance use (Osgood et al., 2019, Talbot et al., July 15, 2014).

Obesity

We observed consistent bidirectional relationships between obesity and anxiety and depression, but not PTSD. Obesity, but not overweight or underweight (the latter potentially due to low prevalence in the sample), was associated with higher odds of depression and anxiety while those with depression or anxiety had higher odds of obesity. Relationships between obesity, depression, anxiety, and PTSD have been estimated in prior studies using cross-sectional and longitudinal approaches, often with bidirectional analyses in both cross-sectional and longitudinal approaches (Smith et al., 2014, Speed et al., 2019, Rush et al., 2016, Smith et al., 2015, Kivimaki et al., 2009, Hoerster et al., 2019, LeardMann et al., 2015, Pan et al., 2012, Luppino et al., 2010).

Table 2.
Odds of self-reported psychological disorders by health-related behaviors in 12 708 respondents to the 2015 Health Related Behaviors Survey in US military personnel. *

Behavior	Category	OR (95%CI) of depression				OR (95%CI) of GAD				Odds ratios of PTSD			
		Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
BMI category, kg/m^2	<18.5	0.60 (0.10, 3.56)	0.69 (0.11, 4.38)	0.69 (0.10, 4.58)	0.25 (0.03, 2.52)	2.42 (0.85, 6.87)	2.77 (0.94, 8.20)	2.94 (0.95, 9.09)	3.99 (0.71, 22.24)	1.02 (0.21, 4.92)	1.10 (0.22, 5.56)	1.16 (0.21, 6.47)	0.90 (0.13, 6.29)
	18.5–24.9 (ref.)	1	1	1	1	1	1	1	1	1	1	1	1
	25–29.9	1.16 (0.85, 1.60)	1.13 (0.82, 1.57)	1.12 (0.87, 1.45)	1.26 (0.93, 1.69)	1.02 (0.83, 1.26)	1.00 (0.81, 1.24)	0.97 (0.82, 1.15)	0.94 (0.79, 1.13)	0.95 (0.62, 1.44)	0.92 (0.60, 1.41)	0.89 (0.67, 1.18)	0.79 (0.60, 1.05)
	≥30	1.93 (1.59, 2.35)	1.88 (1.67, 2.11)	1.86 (1.71, 2.03)	1.77 (1.21, 2.59)	1.57 (1.37, 1.80)	1.54 (1.27, 1.86)	1.50 (1.23, 1.84)	1.29 (1.00, 1.67)	1.35 (1.10, 1.66)	1.28 (1.04, 1.57)	1.23 (1.04, 1.46)	0.82 (0.69, 0.97)
MPA, min/wk	<150 (ref.)	1	1	1	1	1	1	1	1	1	1	1	1
	150–299	0.61 (0.46, 0.82)	0.59 (0.44, 0.77)	0.58 (0.42, 0.80)	0.67 (0.43, 1.04)	0.77 (0.63, 0.95)	0.74 (0.60, 0.91)	0.75 (0.59, 0.94)	0.97 (0.74, 1.28)	0.62 (0.49, 0.80)	0.59 (0.47, 0.75)	0.59 (0.47, 0.73)	0.65 (0.45, 0.96)
	≥300 (ref.)	0.83 (0.62, 1.10)	0.78 (0.56, 1.08)	0.79 (0.58, 1.09)	0.97 (0.62, 1.50)	0.82 (0.71, 0.95)	0.78 (0.65, 0.93)	0.81 (0.68, 0.95)	1.03 (0.79, 1.33)	0.55 (0.45, 0.66)	0.50 (0.42, 0.60)	0.51 (0.39, 0.66)	0.35 (0.17, 0.73)
VPA, min/wk	<75 (ref.)	1	1	1	1	1	1	1	1	1	1	1	1
	75–149	0.88 (0.62, 1.27)	0.92 (0.60, 1.40)	0.96 (0.64, 1.43)	1.24 (0.89, 1.72)	0.86 (0.68, 1.08)	0.90 (0.70, 1.15)	0.93 (0.74, 1.17)	0.98 (0.54, 1.75)	0.73 (0.26, 2.10)	0.75 (0.24, 2.32)	0.80 (0.25, 2.57)	0.77 (0.17, 3.40)
	≥150	0.64 (0.53, 0.77)	0.64 (0.53, 0.76)	0.66 (0.53, 0.82)	0.83 (0.57, 1.21)	0.67 (0.58, 0.79)	0.68 (0.59, 0.79)	0.69 (0.60, 0.79)	0.77 (0.61, 0.97)	0.67 (0.58, 0.77)	0.65 (0.58, 0.74)	0.68 (0.59, 0.80)	0.86 (0.69, 1.07)
Strength training, d/wk	<1 (ref.)	1	1	1	1	1	1	1	1	1	1	1	1
	1–2	0.58 (0.48, 0.70)	0.59 (0.47, 0.75)	0.61 (0.50, 0.74)	0.60 (0.47, 0.77)	0.63 (0.52, 0.78)	0.64 (0.53, 0.78)	0.66 (0.53, 0.82)	0.73 (0.54, 0.99)	0.74 (0.50, 1.10)	0.74 (0.48, 1.14)	0.77 (0.54, 1.10)	1.15 (0.82, 1.60)
	≥3	0.81 (0.60, 1.10)	0.80 (0.56, 1.15)	0.77 (0.52, 1.14)	0.68 (0.47, 1.00)	0.90 (0.60, 1.35)	0.89 (0.59, 1.34)	0.88 (0.55, 1.42)	0.97 (0.59, 1.58)	0.99 (0.80, 1.21)	1.00 (0.80, 1.24)	0.95 (0.71, 1.28)	1.20 (1.01, 1.42)
Sleep	per hr/night	0.59 (0.56, 0.61)	0.60 (0.58, 0.63)	0.60 (0.56, 0.64)	0.84 (0.81, 0.87)	0.58 (0.54, 0.62)	0.60 (0.55, 0.66)	0.60 (0.54, 0.66)	0.76 (0.68, 0.86)	0.51 (0.45, 0.58)	0.53 (0.47, 0.61)	0.52 (0.44, 0.61)	0.68 (0.59, 0.78)
Alcohol	per drink/wk	1.04 (1.02, 1.06)	1.04 (1.02, 1.06)	1.04 (1.02, 1.06)	1.03 (1.01, 1.06)	1.03 (1.03, 1.04)	1.03 (1.03, 1.03)	1.02 (1.01, 1.03)	1.00 (0.98, 1.02)	1.04 (1.03, 1.05)	1.04 (1.03, 1.05)	1.03 (1.01, 1.05)	1.02 (1.00, 1.05)
Smoking status	Non-smoker (ref.)	1	1	1	1	1	1	1	1	1	1	1	1
	Current smoker	1.48 (1.11, 1.98)	1.31 (1.05, 1.64)	1.28 (0.98, 1.66)	0.83 (0.68, 1.02)	1.91 (1.57, 2.32)	1.70 (1.41, 2.07)	1.60 (1.31, 1.96)	1.71 (1.21, 2.41)	1.71 (1.25, 2.35)	1.53 (1.20, 1.96)	1.42 (1.03, 1.96)	1.07 (0.68, 1.70)
Problematic alcohol use†	No (ref.)			1	1			1	1			1	1
	Yes			0.86 (0.73, 1.01)	0.63 (0.45, 0.88)			1.25 (0.97, 1.62)	1.56 (1.21, 2.01)			1.02 (0.60, 1.72)	0.93 (0.42, 2.10)
Illicit drug use, past yr	No (ref.)			1	1			1	1			1	1
	Yes			9.71 (1.85, 50.89)	1.69 (0.22, 13.08)			7.66 (1.90, 30.83)	1.04 (0.28, 3.80)			21.11 (5.01, 88.92)	11.69 (4.01, 34.09)
Misuse prescription drugs, past yr	No (ref.)			1	1			1	1			1	1
	Yes			1.53 (1.12, 2.09)	1.71 (1.27, 2.29)			1.14 (0.73, 1.79)	0.85 (0.41, 1.77)			1.31 (0.95, 1.81)	0.99 (0.54, 1.82)
Depression	No (ref.)								1				1
	Yes								16.18 (13.65, 19.18)				5.66 (3.69, 8.66)
GAD	No (ref.)				1								1
	Yes				17.10 (14.39, 20.34)								16.05 (8.03, 32.07)

(continued on next page)

Table 2. (*continued*)

Behavior	Category	OR (95%CI) of depression Model 1	Model 2	Model 3	Model 4	OR (95%CI) of GAD Model 1	Model 2	Model 3	Model 4	Odds ratios of PTSD Model 1	Model 2	Model 3	Model 4
PTSD	No (ref.)				1				1				
	Yes				5.70 (3.34, 9.74)				15.70 (7.74, 31.86)				

Abbreviations: GAD, generalized anxiety disorder; MPA, moderate intensity physical activity; PTSD, post-traumatic stress disorder; VPA, vigorous intensity physical activity.

[*] Associations presented as adjusted odds ratios (95% CI). All models incorporated strata, clusters, and weights to account for the complex survey design. Model 1, behavioral and demographic model: adjusted for all behavioral variables simultaneously, and age (17–24, 25–34, 35–44, ≥45 y), sex (male, female), race (minority, non-minority), history of medical diagnoses (continuous, 0–9). Model 2, social model: adjusted for model 1, plus service branch (Army, Navy, Marines, Air Force, Coast Guard), marital status (married, unmarried), education (high school, some college, college degree), and pay grade (Officer, Enlisted). Model 3, problematic behavior model: adjusted for model 2, plus problematic alcohol use, illicit drug use, and misuse of prescription drugs (all yes/no). Model 4,psychological comorbidity model: adjusted for model 3, plus the other 2 possible psychological comorbidities (all yes/no).

[†] Any binge drinking past month or high AUDIT-C.

Table 3.
Odds of health-related behaviors by presence of self-reported psychological disorderin 12 708 respondents to the 2015 Health Related Behaviors Survey in US military personnel.[*]

Mental health condition	Model	Low MPA (<150 min/wk) OR (95%CI)	Low VPA (<75 min/wk) OR (95%CI)	Low strength training (<1 d/wk) OR (95%CI)	Obesity (BMI ≥30 kg/m^2) OR (95%CI)	Current smoking OR (95%CI)	Sleep, hr/night b (SE)	*P*	Alcohol, drink/wk b (SE)	*P*
Depression (yes v. no)	1	1.99 (1.82, 2.18)	1.81 (1.51, 2.18)	2.14 (1.79, 2.55)	1.87 (1.39, 2.51)	1.79 (1.18, 2.72)	-0.74 (0.02)	<.0001	3.66 (1.55)	0.04
	2	1.53 (1.26, 1.85)	1.48 (1.35, 1.63)	1.45 (1.29, 1.63)	1.75 (1.35, 2.26)	1.30 (1.08, 1.57)	-0.68 (0.04)	<.0001	2.93 (1.43)	0.07
	3	1.52 (1.21, 1.91)	1.43 (1.33, 1.54)	1.47 (1.26, 1.71)	1.76 (1.38, 2.24)	1.27 (1.00, 1.62)	-0.70 (0.03)	<.0001	2.54 (1.31)	0.08
	4	1.25 (0.93, 1.69)	1.17 (0.96, 1.42)	1.39 (1.15, 1.67)	1.61 (1.25, 2.06)	0.93 (0.75, 1.14)	-0.19 (0.06)	0.006	1.95 (1.08)	0.10
GAD (yes v. no)	1	1.64 (1.40, 1.92)	1.64 (1.28, 2.09)	1.84 (1.46, 2.32)	1.61 (1.17, 2.22)	2.11 (1.59, 2.80)	-0.73 (0.02)	<.0001	2.81 (0.68)	0.002
	2	1.32 (1.13, 1.55)	1.42 (1.20, 1.67)	1.32 (1.06, 1.65)	1.54 (1.13, 2.09)	1.73 (1.47, 2.03)	-0.68 (0.02)	<.0001	2.07 (0.51)	0.002
	3	1.31 (1.09, 1.57)	1.40 (1.20, 1.63)	1.31 (1.01, 1.71)	1.53 (1.17, 2.00)	1.62 (1.37, 1.92)	-0.69 (0.03)	<.0001	1.42 (0.56)	0.03
	4	1.01 (0.81, 1.25)	1.21 (0.90, 1.62)	1.19 (0.86, 1.63)	1.34 (1.17, 1.52)	1.70 (1.27, 2.27)	-0.38 (0.09)	0.001	0.05 (0.48)	0.92
PTSD (yes v. no)	1	2.09 (1.62, 2.69)	1.94 (1.68, 2.24)	1.94 (1.65, 2.29)	1.43 (0.83, 2.45)	1.98 (1.42, 2.77)	-0.90 (0.07)	<.0001	3.65 (1.39)	0.03
	2	1.71 (1.40, 2.08)	1.53 (1.18, 1.98)	1.18 (1.00, 1.40)	1.29 (0.75, 2.20)	1.40 (1.08, 1.81)	-0.86 (0.08)	<.0001	2.87 (1.25)	0.04
	3	1.71 (1.38, 2.11)	1.48 (1.14, 1.93)	1.18 (1.01, 1.38)	1.28 (0.80, 2.03)	1.30 (0.92, 1.83)	-0.89 (0.07)	<.0001	2.26 (1.32)	0.12
	4	1.51 (0.98, 2.33)	1.22 (0.82, 1.82)	0.90 (0.69, 1.18)	0.82 (0.50, 1.33)	0.97 (0.60, 1.55)	-0.53 (0.12)	0.001	1.21 (0.96)	0.24

Abbreviations: GAD, generalized anxiety disorder; MPA, moderate intensity physical activity; PTSD, post-traumatic stress disorder; VPA, vigorous intensity physical activity.

[*] Associations presented as adjusted odds ratios (95% CI) or adjusted b (SE). All models incorporated strata, clusters, and weights to account for the complex survey design. Model 1, demographic model: adjusted for age (17-24, 25-34, 35-44, ≥45 y), sex (male, female), race (minority, non-minority), and history of medical diagnoses (continuous, 0-9). Model 2, sociobehavioral model: adjusted as for model 1, plus all behaviors which are not the behavioral outcome of interest, service branch (Army, Navy, Marines, Air Force, Coast Guard), marital status (married, unmarried), education (high school, some college, college degree), and pay grade (Officer, Enlisted). Model 3, problematic behavior model: adjusted as for model 2, plus problematic drinking, drug use in the past year, misuse of prescription drugs in the past year (all yes/no). Model 4, psychological comorbidity model: adjusted for model 3, plus the other 2 possible psychological comorbidities (all yes/no).

Depression may be causally related to obesity by diminishing interest or ability to engage in health-related behaviors such as exercise and restful sleep. However, the bidirectional associations in the present study remained robust after adjusting for all health-related behaviors suggesting alternate mechanisms in the present population (e.g., genetic influences (Speed et al., 2019, Kivimaki et al., 2011, Morris et al., 2019), hypothalamic-pituitary-adrenal (HPA) axis dysregulation, social/-occupational pressure (Pan et al., 2012, Luppino et al., 2010).

Not all research supports relationships between obesity and depression or other psychological disorders. The Whitehall II Cohort Study in U.K. civil service employees (mean age 44 years at baseline) found no association between obesity and incident "common" psychological disorders over 19-year follow-up (Kivimaki et al., 2009). However, the authors observed significant reverse associations: psychological disorders, in cumulative fashion, predicted incident obesity; chronic or repeated episodes increased risk of weight gain.

We did not observe associations between obesity and self-reported PTSD after adjusting for GAD and depression. This is in contrast to some studies that have reported links between PTSD, with or without depression, and prevalent and incident obesity or weight gain (Smith et al., 2014, Smith et al., 2015, Hoerster et al., 2019, LeardMann et al., 2015). It is possible that in the present study, GAD and depression accounted for most of the PTSD-obesity association. For example, in a study of Veterans, Hoerster, *et al.* concluded that PTSD symptoms

predicted BMI due to depression (Hoerster et al., 2019), a conclusion broadly consistent with the observations of the present study.

Physical activity

Decades of evidence support relationships between physical activity and mental health, and indicate modest physical activity prevents mental health disorders and/or leads to improved symptomology (Chekroud et al., 2018, Schuch et al., 2018, Azevedo Da Silva et al., 2012, Rush et al., 2016, Stubbs et al., 2017). However, there may be an upper threshold for this effect: moderate levels of activity appear favorable, excess levels may not be (Chekroud et al., 2018). Data from the present analyses are somewhat supportive of this idea, for example, MPA, at 150–299 min/wk, was associated with lower odds of depression, while higher levels of activity did not confer clear additional benefit. Thus, for specific psychological disorders, certain types and durations of exercise may be better than others. Results were particularly strong for VPA and anxiety, and MPA and PTSD, supporting studies showing higher levels of activity reduce both anxious state and trait symptomology (Stubbs et al., 2017, Gordon et al., 2017, Ensari et al., 2015). characteristics of both GAD and PTSD.

Alcohol intake

We observed alcohol intake was associated with higher odds of mental health symptomology, while problematic drinking was associated with higher odds of GAD, and lower odds of depression. Mental health conditions were not consistently associated with higher alcohol consumption after adjusting for all other health-related behaviors, although the directionality of these associations suggest a higher number of drinks per week among those with self-reported psychological disorders, even after accounting for problematic drinking behavior. When alcohol intake was modeled categorically, heavy drinking (habitual drinking) was more likely in the presence of GAD or depression, and problematic alcohol use in PTSD may be more episodic than habitual. Misuse of prescription drugs was associated with depression; and, illicit drug use, although reported in <1% of this sample, was associated with all three psychological disorders prior to adjustment for psychological comorbidity. Of note, low reported illicit drug use may be attributable to regulations requiring all Active Duty personnel to be drug-tested at least once per year and/or unwillingness to admit illegal activity (U.S. Department of the Army 2020). Our results indicate substance use and habitual heavy drinking in the context of PTSD may be mediated through depression, as suggested by the literature (Contractor et al., 2019).

Military resources to support prevention/treatment

A variety of resources are available for the prevention and treatment of mental health conditions and to support healthy behaviors in military personnel. The Army's Total Force Fitness framework addresses four main topic areas: physical fitness, mental fitness, nutrition, and social fitness (Uniformed Services University 2020). Military OneSource is another resource center addressing mental health (U.S. Department of Defense 2020). Other military initiatives to promote healthy behaviors and mental health include the Performance Triad program (Army Medical Department, U.S. Army 2019). and ARMYFIT™ Ready and resilient (R2) (Human Performance Resource Center 2019). Additionally, the Army is implementing the comprehensive Holistic Health and Fitness (H2F) initiative (U.S. Army 2019), a multi-phase program combining doctrine and techniques to improve performance, cognitive dominance, and resilience.

Limitations

The phenomena in question, and their inter-relationships, represent complex behavioral, physiological, psychological, and genetic phenomena, which are challenging to evaluate with a self-report questionnaire. We are thus aware of our inability to comprehensively address every aspect of the equations in question. In addition, as noted in the Methods, the survey assessment tools for the behaviors and psychological disorders used various time points and durations (e.g., "last 2 weeks", "in the last year"), and the behaviors and disorders may themselves have variable latency periods and durations. Some such time variations cast doubt on the plausibility of, for example, associating illicit drug use in the last year (without further time granularity) with anxiety symptoms in the prior two weeks. Other relationships, such as those between BMI (a condition which may be chronic or episodic) and depression (which also may be chronic or episodic) are similarly inscrutable given the lack of time granularity in the present analyses and cross-sectional nature of the data.

Additional limitations of this study include its cross-sectional design and the exclusive use of self-reported data. While the anonymous survey design may have limited social desirability bias (Warner et al., 2011), stigma about having or reporting mental health difficulties may have lowered response to related questions (Sharp et al., 2015, Coleman et al., 2017). Social desirability may have also had the reverse effect on health-related behavior reporting. Although we used statistical weighting approaches to better approximate associations in the overall military population, low survey response rates likely limit our inferential ability. The publicly available data set excluded data on deployment history, and combat deployment in particular is a known contributor to adverse psychological outcomes (Castro, 2014) as is exposure to biological warfare agents (Smith et al., 2009). In addition, we were unable to disaggregate stressors underpinning psychological disorders into military-specific stressors, versus other types of stressors (e.g., general or personality-associated levels of distress, social anxiety, or predisposition to adult PTSD originating in childhood) that could better inform treatment approaches.

Conclusion

Sleep, especially short sleep, was the health-related behavior most consistently associated with depression, GAD, and PTSD, while obesity was consistently associated with depression and GAD. Higher levels of aerobic activity were associated with reduced anxiety and PTSD. Self-reported psychological disorders were unfavorably associated with health-related behaviors. Encouraging and improving health-promoting behaviors, especially sleep hygiene, maintaining a healthy weight, and exercising, may contribute to positive mental health in military personnel, and encouraging those with mental health conditions to engage in health-related behaviors may benefit symptomology.

Author Contributions

TJS and AH conceived of and designed the study. AH conducted the analyses and drafted the manuscript. HRL revised the article for important intellectual content. All authors reviewed, edited, and made important intellectual contributions to the manuscript. TJS and AH had full access to all the data in the study and take full responsibility for the integrity of the data and the accuracy of the data analysis. All authors read and approved the final manuscript.

Research in context

Evidence before this study

The relationships between health-promoting behaviors, such as maintaining a healthy weight, exercising, and not smoking, and psychological disorders have been widely studied in civilian populations. Often, but not universally, higher adherence to healthy behaviors is associated with lower risk of psychological disorders. Similarly, those

with these disorders often, but not always, benefit from higher adherence to healthy behaviors. Military personnel are at higher risk than civilian populations for certain psychological disorders, notably post-traumatic stress disorder. However, they are also generally more physically healthy owing largely to the military culture of fitness.

Added value of this study

We aim to answer the question of whether, in an already fit and healthy, but psychologically at-risk population, such as military personnel, relationships between health behaviors and mental health are similar to those in civilian populations.

Implications of all the available evidence

Results highlight that certain behaviors, notably maintaining a healthy weight and obtaining adequate sleep, are related to better mental health, across the disorders studied. In addition, certain psychological disorders may benefit from a concurrent treatment approach that targets specific health behaviors, for example, cigarette smoking in anxiety.

Funding Sources

This work was supported by the US Army Medical Research and Development Command. The study sponsor had no role in the study design; in the collection, analysis, or interpretation of data; in the writing of the present report; or in the decision to submit the paper for publication.

Declarationof Competing Interest

The authors declare that they have no conflicts of interest.

Acknowledgements

The authors thank members of the US Armed Forces and US Coast Guard who responded to the 2011 and 2015 HRBS. The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of the US Department of Defense, US Coast Guard, or the Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc. Any citations of commercial organizations and trade names in this report do not constitute an official endorsement of approval of the products or services of these organizations. U.S. Army Medical Research and Development Command.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2021.01.029.

References

Redmond, S, Wilcox, S, Campbell, S, et al., 2015. A brief introduction to the military workplace culture. Work (1), 9–20. https://doi.org/10.3233/WOR-141987.

Adler, AB, Castro, CA., 2013. An Occupational Mental Health Model for the Military. Mil. Behav. Health 1 (1), 41–45. https://doi.org/10.1080/21635781.2012.721063.

Castro, CA., 2014. The US framework for understanding, preventing, and caring for the mental health needs of service members who served in combat in Afghanistan and Iraq: a brief review of the issues and the research. Eur. J. Psychotraumatol. 5 https://doi.org/10.3402/ejpt.v5.24713.

Pflanz, S, Sonnek, S., 2002. Work Stress in the Military: Prevalence, Causes, and Relationship to Emotional Health. Mil. Med. 167 (11), 877–882. https://doi.org/10.1093/milmed/167.11.877.

Kelly, MM, Vogt, DS., 2009. Military stress: Effects of acute, chronic, and traumatic stress on mental and physical health. Living and Surviving in Harm's Way: A Psychological Treatment Handbook for Pre- and Post-Deployment of Military Personnel. Routledge/Taylor & Francis Group, pp. 85–106.

Brooks, SK, Greenberg, N., 2018. Non-deployment factors affecting psychological wellbeing in military personnel: literature review. J. Ment. Health 27 (1), 80–90. https://doi.org/10.1080/09638237.2016.1276536.

Gadermann, AM, Engel, CC, Naifeh, JA, et al., 2012. Prevalence of DSM-IV major depression among U.S. military personnel: meta-analysis and simulation. Mil. Med. 177 (8 Suppl), 47–59. https://doi.org/10.7205/milmed-d-12-00103.

Cohen, GH, Fink, DS, Sampson, L, Galea, S., 2015. Mental Health Among Reserve Component Military Service Members and Veterans. Epidemiol. Rev. 37 (1), 7–22. https://doi.org/10.1093/epirev/mxu007.

Kessler, RC, Heeringa, SG, Stein, MB, et al., 2014. Thirty-day prevalence of DSM-IV mental disorders among nondeployed soldiers in the US Army: results from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS). JAMA Psychiatry 71 (5), 504–513. https://doi.org/10.1001/jamapsychiatry.2014.28.

Stahlman, S, Oetting, AA., 2018. Mental health disorders and mental health problems, active component,U.S. Armed Forces, 2007-2016. MSMR 25 (3), 2–11.

Kessler, RC, Berglund, P, Demler, O, Jin, R, Merikangas, KR, Walters, EE, 2005. Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. Arch. Gen. Psychiatry 62 (6), 593–602. https://doi.org/10.1001/archpsyc.62.6.593.

Kessler, RC, Chiu, WT, Demler, O, Merikangas, KR, Walters, EE., 2005. Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. Arch. Gen. Psychiatry 62 (6), 617–627. https://doi.org/10.1001/archpsyc.62.6.617.

Brody, DJ, Pratt, LA, Hughes, JP., 2018. Prevalence of Depression among Adults Aged 20 and over: United States, 2013–2016. National Center for Health Statistics. Accessed December 8, 2019. https://www.cdc.gov/nchs/products/databriefs/db303.htm.

Russell, DW, Cohen, GH, Gifford, R, Fullerton, CS, Ursano, RJ, Galea, S., 2015. Mental health among a nationally representative sample of United States Military Reserve Component Personnel. Soc. Psychiatry Psychiatr. Epidemiol. 50 (4), 639–651. https://doi.org/10.1007/s00127-014-0981-2.

Smith, TJ, White, A, Hadden, L, AJ, Young., Marriott, BP., 2014. Associations between Mental Health Disorders and Body Mass Index among Military Personnel. Am. J. Health Behav. 38 (4), 529–540. https://doi.org/10.5993/AJHB.38.4.6.

Speed, MS, Jefsen, OH, Børglum, AD, Speed, D, Østergaard, SD., 2019. Investigating the association between body fat and depression via Mendelian randomization. Transl. Psychiatry 9 (1). https://doi.org/10.1038/s41398-019-0516-4.

Chekroud, SR, Gueorguieva, R, Zheutlin, AB, et al., 2018. Association between physical exercise and mental health in 1•2 million individuals in the USA between 2011 and 2015: a cross-sectional study. Lancet Psychiatry 5 (9), 739–746. https://doi.org/10.1016/S2215-0366(18)30227-X.

Schuch, FB, Vancampfort, D, Firth, J, et al., 2018. Physical Activity and Incident Depression: A Meta-Analysis of Prospective Cohort Studies. Am. J. Psychiatry 175 (7), 631–648. https://doi.org/10.1176/appi.ajp.2018.17111194.

Azevedo Da Silva, M, Singh-Manoux, A, Brunner, EJ, et al., 2012. Bidirectional association between physical activity and symptoms of anxiety and depression: the Whitehall II study. Eur. J. Epidemiol. 27 (7), 537–546. https://doi.org/10.1007/s10654-012-9692-8.

Biddle, DJ, Hermens, DF, Lallukka, T, Aji, M, Glozier, N., 2019. Insomnia symptoms and short sleep duration predict trajectory of mental health symptoms. Sleep Med. 54, 53–61. https://doi.org/10.1016/j.sleep.2018.10.008.

Alvaro, PK, Roberts, RM, Harris, JK., 2013. A Systematic Review Assessing Bidirectionality between Sleep Disturbances, Anxiety, and Depression. Sleep 36 (7), 1059–1068. https://doi.org/10.5665/sleep.2810.

Li, YI, Starr, LR, Wray-Lake, L., 2018. Insomnia mediates the longitudinal relationship between anxiety and depressive symptoms in a nationally representative sample of adolescents. Depress Anxiety 35 (6), 583–591. https://doi.org/10.1002/da.22764.

Osgood, JM, Finan, PH, Hinman, SJ, So, CJ, Quartana, PJ., 2019. Combat exposure, post-traumatic stress symptoms, and health-related behaviors: the role of sleep continuity and duration. Sleep 42 (3). https://doi.org/10.1093/sleep/zsy257.

Gehrman, P, Seelig, AD, Jacobson, IG, et al., 2013. Predeployment Sleep Duration and Insomnia Symptoms as Risk Factors for New-Onset Mental Health Disorders Following Military Deployment. Sleep 36 (7), 1009–1018. https://doi.org/10.5665/sleep.2798.

Rush, T, LeardMann, CA, Crum-Cianflone, NF., 2016. Obesity and associated adverse health outcomes among US military members and veterans: Findings from the Millennium Cohort Study. Obes. Silver Spring Md. 24 (7), 1582–1589. https://doi.org/10.1002/oby.21513.

Stubbs, B, Vancampfort, D, Rosenbaum, S, et al., 2017. An examination of the anxiolytic effects of exercise for people with anxiety and stress-related disorders: A meta-analysis. Psychiatry Res. 249, 102–108. https://doi.org/10.1016/j.psychres.2016.12.020.

Smith, BN, Tyzik, AL, Neylan, TC, Cohen, BE., 2015. PTSD and obesity in younger and older veterans: Results from the mind your heart study. Psychiatry Res. 229 (3), 895–900. https://doi.org/10.1016/j.psychres.2015.07.044.

Kivimaki, M, Lawlor, DA, Singh-Manoux, A, et al., 2009. Common mental disorder and obesity: insight from four repeat measures over 19 years: prospective Whitehall II cohort study. BMJ 339 (2). https://doi.org/10.1136/bmj.b3765 b3765-b3765.

Hall, KS, Hoerster, KD, Yancy, WS., 2015. Post-Traumatic Stress Disorder, Physical Activity, and Eating Behaviors. Epidemiol. Rev. 37 (1), 103–115. https://doi.org/10.1093/epirev/mxu011.

Scott, KM, Bruffaerts, R, Simon, GE, et al., 2008. Obesity and mental disorders in the general population: results from the world mental health surveys. Int. J. Obes. 2005 32 (1), 192–200. https://doi.org/10.1038/sj.ijo.0803701.

Doré, I, O'Loughlin, JL, Beauchamp, G, Martineau, M, Fournier, L., 2016. Volume and social context of physical activity in association with mental health, anxiety and

depression among youth. Prev. Med. 91, 344–350. https://doi.org/10.1016/j.ypmed.2016.09.006.
Saneei, P, Esmaillzadeh, A, Keshteli, AH, et al., 2016. Combined Healthy Lifestyle Is Inversely Associated with Psychological Disorders among Adults. PloS One 11 (1), e0146888. https://doi.org/10.1371/journal.pone.0146888.
Hoerster, KD, Campbell, S, Dolan, M, et al., 2019. PTSD is associated with poor health behavior and greater Body Mass Index through depression, increasing cardiovascular disease and diabetes risk among U.S. veterans. Prev. Med. Rep. 15, 100930 https://doi.org/10.1016/j.pmedr.2019.100930.
van den Berk-Clark, C, Secrest, S, Walls, J, et al., 2018. Association between posttraumatic stress disorder and lack of exercise, poor diet, obesity, and co-occuring smoking: A systematic review and meta-analysis. Health Psychol. 37 (5), 407–416. https://doi.org/10.1037/hea0000593.
LeardMann, CA, Woodall, KA, Littman, AJ, et al., 2015. Post-traumatic stress disorder predicts future weight change in the Millennium Cohort Study: PTSD and Weight Change. Obesity 23 (4), 886–892. https://doi.org/10.1002/oby.21025.
Pan, A, Sun, Q, Czernichow, S, et al., 2012. Bidirectional association between depression and obesity in middle-aged and older women. Int. J. Obes. 2005. 36 (4), 595–602. https://doi.org/10.1038/ijo.2011.111.
Meadows, SO, Engel, CC, Collins, RL, et al., 2018. 2015 Department of Defense Health Related Behaviors Survey (HRBS). RAND Corporation. Accessed August 10, 2018. https://www.rand.org/pubs/research_reports/RR1695.html.
Hoge, CW, Toboni, HE, Messer, SC, Bell, N, Amoroso, P, Orman, DT., 2005. The Occupational Burden of Mental Disorders in the U.S. Military: Psychiatric Hospitalizations, Involuntary Separations, and Disability. Am. J. Psychiatry 162 (3), 585–591. https://doi.org/10.1176/appi.ajp.162.3.585.
Dall, TM, Zhang, Y, Chen, YJ, et al., 2007. Cost Associated With Being Overweight and With Obesity, High Alcohol Consumption, and Tobacco Use Within the Military Health System's TRICARE Prime–Enrolled Population. Am. J. Health Promot. 22 (2), 120–139. https://doi.org/10.4278/0890-1171-22.2.120.
White, MR, Phillips, CJ, Vyas, KJ, Bauer, L., 2016. Demographic and Psychosocial Predictors of Early Attrition for Drug Use in U.S. Marines. Mil. Med. 181 (11) https://doi.org/10.7205/MILMED-D-15-00507 e1540-e1545.
Centers for Disease Control and Prevention, National Center for Health Statistics, 2018. National Health Interview Survey, Glossary - Alcohol. Accessed January 5, 2020. https://www.cdc.gov/nchs/nhis/alcohol/alcohol_glossary.htm.
Watson, NF, Badr, MS, Belenky, G, et al., 2015. Recommended Amount of Sleep for a Healthy Adult: A Joint Consensus Statement of the American Academy of Sleep Medicine and Sleep Research Society. Sleep 38 (6), 843–844. https://doi.org/10.5665/sleep.4716.
Spitzer, RL, Kroenke, K, Williams, JBW, Löwe, B., 2006. A Brief Measure for Assessing Generalized Anxiety Disorder: The GAD-7. Arch. Intern. Med. 166 (10), 1092. https://doi.org/10.1001/archinte.166.10.1092.
Kroenke, K, Spitzer, RL, Williams, JBW., 2001. The PHQ-9: Validity of a brief depression severity measure. J. Gen. Intern. Med. 16 (9), 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x.
Weathers, F, Litz, B, Herman, D, Huska, J, Keane, T., 1993. The PTSD Checklist (PCL): Reliability, Validity, and Diagnostic Utility. In: 9th Annual Convention of the International Society of Traumatic Stress Studies, San Antonio, TX..
Bush, K, Kivlahan, DR, McDonell, MB, Fihn, SD, Bradley, KA., 1998. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. Ambulatory Care Quality Improvement Project (ACQUIP). Alcohol Use Disorders Identification Test Arch. Intern. Med. 158 (16), 1789–1795. https://doi.org/10.1001/archinte.158.16.1789.
Bradley, KA, DeBenedetti, AF, Volk, RJ, Williams, EC, Frank, D, Kivlahan, DR., 2007. AUDIT-C as a brief screen for alcohol misuse in primary care. Alcohol Clin. Exp. Res. 31 (7), 1208–1217. https://doi.org/10.1111/j.1530-0277.2007.00403.x.
American Psychiatric Association, 2000. Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR).Vol 1, 4th edn. American Psychiatric Association. Accessed November 28, 2015. http://www.psychiatryonline.com/resourceTOC.aspx?resourceID=1.
American Psychiatric Association, 2013. Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, 5th edn. American Psychiatric Association. Accessed November 28, 2015. http://psychiatryonline.org/doi/book/10.1176/appi.books.9780890425596.
Jansson-Fröjmark, M, Lindblom, K., 2008. A bidirectional relationship between anxiety and depression, and insomnia?A prospective study in the general population. J. Psychosom. Res. 64 (4), 443–449. https://doi.org/10.1016/j.jpsychores.2007.10.016.
Johnson, EO, Roth, T, Breslau, N., 2006. The association of insomnia with anxiety disorders and depression: exploration of the direction of risk. J. Psychiatr. Res. 40 (8), 700–708. https://doi.org/10.1016/j.jpsychires.2006.07.008.
Jacobson, NC, Newman, MG., 2017. Anxiety and depression as bidirectional risk factors for one another: A meta-analysis of longitudinal studies. Psychol. Bull. 143 (11), 1155–1200. https://doi.org/10.1037/bul0000111.
Talbot, LS, Neylan, TC, Metzler, TJ, Cohen, BE., July 15, 2014. The Mediating Effect of Sleep Quality on the Relationship between PTSD and Physical Activity. J. Clin. Sleep Med. https://doi.org/10.5664/jcsm.3878. Published online.
Luppino, FS, de Wit, LM, Bouvy, PF, et al., 2010. Overweight, Obesity, and Depression: A Systematic Review and Meta-analysis of Longitudinal Studies. Arch. Gen. Psychiatry 67 (3), 220. https://doi.org/10.1001/archgenpsychiatry.2010.2.
Kivimaki, M, Jokela, M, Hamer, M, et al., 2011. Examining Overweight and Obesity as Risk Factors for Common Mental Disorders Using Fat Mass and Obesity-Associated (FTO) Genotype-Instrumented Analysis: The Whitehall II Study, 1985-2004. Am. J. Epidemiol. 173 (4), 421–429. https://doi.org/10.1093/aje/kwq444.
Morris, J, Bailey, MES, Baldassarre, D, et al., 2019. Genetic variation in CADM2 as a link between psychological traits and obesity. Sci. Rep. 9 (1) https://doi.org/10.1038/s41598-019-43861-9.
Gordon, BR, McDowell, CP, Lyons, M, Herring, MP., 2017. The Effects of Resistance Exercise Training on Anxiety: A Meta-Analysis and Meta-Regression Analysis of Randomized Controlled Trials. Sports Med. 47 (12), 2521–2532. https://doi.org/10.1007/s40279-017-0769-0.
Ensari, I, Greenlee, TA, Motl, RW, Petruzzello, SJ., 2015. Meta-analysis of acute exercise effects on state anxiety: An update of randomized controlled trials over the past 25 years. Depress Anxiety 32 (8), 624–634. https://doi.org/10.1002/da.22370.
U.S. Department of the Army. Army Regulation 600-85: The Army Substance Abuse Program. Accessed January 5, 2020.https://www.army.mil/e2/downloads/rv7/r2/policydocs/r600_85.pdf.
Contractor, AA, Weiss, NH, Dixon-Gordon, KL, Blumenthal, H., 2019. Heterogeneity in the Co-occurrence of Substance Use and Posttraumatic Stress Disorder: A Latent Class Analysis Approach. J. Dual Diagn. 15 (2), 105–117. https://doi.org/10.1080/15504263.2019.1572258.
Uniformed Services University, Consortium for Health and Military Performance. Mental Fitness. Human Performance Resources, Total Force Fitness. Accessed January 5, 2020.https://www.hprc-online.org/mental-fitness/mental-health.
U.S. Department of Defense. Mental Health - Resources.Military OneSource Resources. Accessed January 5, 2020.https://www.militaryonesource.mil/health-wellness/mental-health/mental-health-resources.
Army Medical Department, U.S. Army. Performance Triad (P3).Accessed July 22, 2019. https://p3.amedd.army.mil/.
Human Performance Resource Center, Uniformed Services University. R2: Ready and Resilient. Total Force Fitness.Accessed July 22, 2019.https://www.hprc-online.org/page/total-force-fitness/r2-ready-and-resilient.
U.S. Army. Holistic Health and Fitness (H2F). Leader Training Brigade, Army Physical Fitness. Accessed July 22, 2019.https://usacimt.tradoc.army.mil/LTB/Leader%20Fitness.html.
Warner, CH, Appenzeller, GN, Grieger, T, et al., 2011. Importance of anonymity to encourage honest reporting in mental health screening after combat deployment. Arch. Gen. Psychiatry 68 (10), 1065–1071. https://doi.org/10.1001/archgenpsychiatry.2011.112.
Sharp, M-L, Fear, NT, Rona, RJ, et al., 2015. Stigma as a barrier to seeking health care among military personnel with mental health problems. Epidemiol. Rev. 37, 144–162. https://doi.org/10.1093/epirev/mxu012.
Coleman, SJ, Stevelink, S a.M, Hatch, SL, Denny, JA, Greenberg, N, 2017. Stigma-related barriers and facilitators to help seeking for mental health issues in the armed forces: a systematic review and thematic synthesis of qualitative literature. Psychol. Med. 47 (11), 1880–1892. https://doi.org/10.1017/S0033291717000356.
SmithTC, WingardDL, RyanMAK, et al. PTSD prevalence, associated exposures, and functional health outcomes in a large, population-based military cohort. *Public Health Rep Wash DC 1974*. 2009;124(1):90-102. doi:10.1177/003335490912400112.